MATHEMATICAL DREAMWORLDS: SPECULATIVE FICTIONS OF MATHEMATICS FROM THE ENLIGHTENMENT TO THE GLOBAL ANGLOPHONE NOVEL

By

MOYANG LI

A dissertation submitted to the

School of Graduate Studies

Rutgers, The State University of New Jersey

In partial fulfillment of the requirements

For the degree of

Doctor of Philosophy

Graduate Program in Literatures in English

Written under the direction of

Mukti Lakhi Mangharam

And approved by

____

____

____

____

New Brunswick, New Jersey

October 2020

ABSTRACT OF THE DISSERTATION

Mathematical Dreamworlds: Speculative Fictions of Mathematics from the Enlightenment to the Global Anglophone Novel

by MOYANG LI

Dissertation Director:

Mukti Lakhi Mangharam

At its core, my project asks whether people who are excluded from liberal notions of the human can use these notions towards liberatory ends. *Mathematical Dreamworlds* explores how women and postcolonial subjects use mathematical language to reimagine the universal human in the long 20th century. Rather than a calculative or quantitative discourse, Anglophone novelists portray mathematics as *dreamworlds,* realms removed from the actual, real world that individuals inhabit through mathematical thinking. In this space of mathematical thinking, Enlightenment thinkers formulated what it means to be human and to be universal. I argue that Anglophone novelists remake this mathematical dreamworld in ways that invite readers to rethink mathematics' claim to transparency and objectivity, and to form more inclusive notions of the human and the world.

Part One of the project consists of a single chapter, "Universal Man Emerged Out of a Mathematical Dreamworld," that reads mathematics in Enlightenment philosophical texts. Within liberal modernity, mathematics was understood as training in reason that produced the universal, rational subject. Part 1 takes a deeper look at the way that mathematics was understood to operate on thinkers through readings of Descartes'

Discourse on the Method (1637) and Kant's *Critique of Pure Reason* (1781). This analysis reveals that Descartes and Kant produced mathematical dreamworlds, writing that narrates pure mathematical thinking as an experience that takes place in a realm beyond the real, physical world. In the space of pure mathematical thinking, a sensible realm where all markers of time, place, culture, and history are absent, Enlightenment philosophers understood the universal human to come into being. Appearing in 19th-century discourses on liberal education, this notion of a mathematical realm where individuals could transcend their subjective experience was used to justify British imperial authority: mathematical training turned individuals into rightful rulers of empire. I call these writings that narrate mathematics as the experience of being in another realm beyond the real world *speculative fictions of mathematics*. This makes it clear that although mathematics appears in fantastical and dreamlike forms in Anglophone novels, their authors did not make them so. Rather, Enlightenment philosophers of the human produced the speculative fiction that these authors are still unpacking.

Part Two of the project consists of three chapters that trace how Anglophone authors challenged this mathematical dreamworld that is the birthplace of the universal human, both from within and beyond empire. They turned to the novel because its capacity for linguistic diversity allowed them to comment on mathematical discourses from the outside. My second chapter begins with Virginia Woolf's *Night and Day* (1919), where Katharine uses mathematics to imagine an alternative space in which she experiences freedom from imperial and patriarchal forms of subject-constitution. The third chapter moves from metropole to postcolony to analyze Amitav Ghosh's use of a transcendental realm of mathematics to imagine a subaltern woman at the center of a global history of science in *The Calcutta Chromosome* (1990). The fourth and final chapter takes up Nnedi Okorafor's use of mathematical dreamworlds in her writing of African speculative fiction in her *Binti* trilogy (2015-2017). Binti, a young girl from the Namib Desert in southwestern Africa, finds in a mathematical dreamworld an immaterial, imaginative geography through which she can formulate a view of her self and of her value that challenges neoliberal discourses of progress and development. Placing Binti into a dreamworld of mathematics, Okorafor reworks what it means to be human and to be universal. Mathematical dreamworlds, appearing in the Anglophone novel as spaces that thinkers can dwell in and become modified by, cannot be explained by previous approaches to mathematics and literature that see mathematics as formalism or as descriptive language. By writing characters excluded from liberal modernity's notions of the universal human into mathematical dreamworlds, Anglophone authors interrogate and remake the ground of emergence of the universal human.

AKNOWLEDGEMENTS

This dissertation would not have been possible without the help of many people. I am so grateful, first and foremost, for my dissertation chair, Mukti Lakhi Mangharam, who took me in when I was at the point of leaving. Mukti encouraged me to take risks, to write about something I cared about, and to think about the larger story that I was telling. Her generosity with ideas, opportunities, and food—biscuits in office hours, lunches in Philadelphia—sustained me throughout my graduate studies. I'd also like to thank Stéphane Robolin, for his thoughtful, challenging feedback that helped me to sharpen my theoretical framework. I don't know what I would have done without Allan Isaac, who discussed nascent, unformed ideas with me with infectious enthusiasm. Early in my graduate career, I took a modern fiction seminar with Maria DeBattista that introduced to me forms of thinking, conversation, and intellectual generosity that I would carry with me throughout graduate school. I am grateful to Maria for joining my dissertation committee as the fourth reader, and for her helpful feedback on my Woolf chapter.

Beyond my committee, many people at Rutgers have helped me to grow as a scholar and as a person. I first met Lynn Festa on the N.J. Transit from New York on the way to Rutgers' Open House. She was so smart and so dazzling in the way that she moved ideas around that I decided, then and there, that I would attend Rutgers, despite the two hundred years separating our fields of interest. Lynn's *Eighteenth Century Fictions of the Human* seminar ended up playing a significant part in my thinking for this project. And through my narratology orals list, MTA, and two writing seminars, Lynn continued to deepen my understanding of what it means to be a scholar and a teacher. She has been an invaluable mentor and advocate. I am also grateful to Stacy Klein for leading another dissertation writing seminar in which I began to sketch out my chapter on Ghosh. My deepest gratitude goes to Courtney Borack and Cheryl Robinson, who make everything run smoothly, and hold our department together.

I have a wonderful circle of friends. Elizabeth Greeniaus, my dear friend and roommate in Highland Park, made Rutgers feel like home immediately. It was in our kitchen conversations that the idea for this dissertation first began to take shape. Sushil Sivaram, my fellow postcolonialist, thank you for the wonderful, meandering conversations on world literature outside of *Hidden Grounds* café, and the endless phone chats about literature, writing, academia, and teaching. Tara Gildea, thank you for being a wonderful friend—I loved our dissertation-writing support group in the fall of 2018. Margarita Castromán and Gabrielle Everett, thank you for keeping me sane when I moved to New York, as we wrote our dissertations together at New York City coffee shops in Washington Heights and in upper Harlem. Downtown in Washington Square Park and across the world in Copenhagen, I am grateful for the company of the witty and incisive Sushmita Sircar. Thanks also to Scott Challener, Bakary Diaby, Lech Harris, Jennifer Lalli, and Caro Pirri, for enriching my intellectual and social life at Rutgers.

I am fortunate to have a caring and wonderful family. To my mom and dad, Minghong Zhang and Jiang Li, thank you for instilling in me a love of reading, for encouraging me to be curious, and for your love. To my brother Johnny, your own graduate studies in computer science continue to inspire me. To Bill Carpenter and Donna Gold, thank you for your endless support.

To Daniel Carpenter-Gold, I couldn't imagine a more caring, sweet, and brilliant partner. Thank you for (at least!) three years worth of breakfasts, dinners, and laughs.

TABLE OF CONTENTS

INTRODUCTION

My project looks at novels where women are mathematicians, and where mathematics is a form of dreaming beyond the real world. Rather than a calculative or quantitative discourse, the authors studied in this dissertation portray mathematics as *dreamworlds*, realms removed from the actual, real world that individuals inhabit through mathematical thinking. In these novels, women and postcolonial subjects are imagined to be mathematicians, who experience through mathematics a kind of freedom from the restrictive particularities of their place and time. Such an idea of math can be found in global Anglophone literature from Britain, South Asia, and the Africa Diaspora. I ask why these authors represent mathematics in this way.

These appearances are surprising because of the relationship that math takes to Enlightenment and imperial discourses of the rational subject, which excluded women and postcolonial subjects. Within modern liberal philosophy, mathematics was used to posit the universal human as the rational subject. Enlightenment philosophers understood math as training in reason that could turn individuals into rational subjects. Through reason, individuals could arrive at truths that were true not only for them, from their subjective vantage point, but that were true objectively—true for everyone. Mathematics, understood as a way of thinking common to all humans, made it possible to imagine the universal human as the rational subject.

The idea of the rational subject, grounded in mathematical thinking, constituted a notion of the universal human that was exclusive. Not only were women and colonial subjects excluded from this notion of the human as rational subject, they were represented as irrational within modernity's logic. "Woman," Rita Felski elucidates in her readings what it means to be modern in 19th- and 20th- century texts, "is aligned with the dead weight of tradition and conservatism that the active, newly autonomous, and self-defining subject must seek to transcend."[1] Moreover, the idea of a lack of rationality, this supposedly universal capacity, on the part of the soon-to-be-colonized was used as a rationale for colonization. In other words, mathematics played a central part in the production of the universal subject that, at the same time, produced the racialized, the feminine, the colonized, the minor: subjects excluded from universality.[2]

Why then do women and postcolonial writers, excluded from this tradition of thinking about the human through rationality, engage with it in their creative work? In novels where mathematical dreamworlds appear, writers are not ready to dismiss this Enlightenment tradition of thinking about the human, but rather are interested in how it could be used by subaltern subjects. Writing women, colonial, and postcolonial subjects, in the place of the mathematician, they ask how this form of thinking and imagining, which are not often associated with these subject positions, can be *remade*. In other words, they ask how mathematics and the universal human—as ideas and forms existing into the present—could be enlisted into alternative configurations. How can subjects

---

[1] Felski, Rita. *The Gender of Modernity.* Cambridge: Cambridge University Press, 1996, p. 2.

[2] Lisa Lowe writes of the process of thinking about the human within liberal modernity as a "process by which 'the human' is 'freed' by liberal forms [forms of understanding the human to be free—and therefore classifiable as human], while other subjects, practices and geographies are placed at a distance from 'the human'."

[3] I take the term "minor" subjects from Kandice Chuh, who argues in *The Difference that Aesthetics Makes* of the importance of taking into account representations of the human in texts by minor authors—those subjugated in the name of liberal humanism. Chuh, Kandice. The Difference Aesthetics Makes: On the Humanities "after Man". Durham: Duke University Press, 2019

[4] "Pure mathematics, n.". OED Online. June 2020. Oxford University Press. https://www-oed-com.proxy.libraries.rutgers.edu/view/Entry/267871 (accessed June 17, 2020).

[5] The question of what mathematical objects are and how they came into being has preoccupied philosophers of mathematics. There are many schools of thought on the subject, but they all agree that once

Lisa Lowe writes of the process of thinking about the human within liberal modernity as a "process by which 'the human' is 'freed' by liberal forms [forms of understanding the human to be free—and therefore classifiable as human], while other subjects, practices and geographies are placed at a distance from 'the human'."

excluded from liberal modernity's notion of the human *use* this notion towards liberatory ends? As rewritings often occasions new readings of the original, they reveal, in the process, strange and fantastical qualities of Enlightenment thinking about rationality. They reveal also intimacies between mathematics and literature within Enlightenment thought.

In this project, I argue that these writers, all "minor" subjects, subjects excluded from liberal modernity's notion of the human, are participating in a kind of writing back, but a kind of writing back that first seeks to unpack how weird the "text" is that is being written back to.[3] This text is Enlightenment math. It is at first glance not a literary text. But reading Enlightenment math through the global Anglophone novel, we see that it was in many ways a fiction. As I argue in "Part 1: Mathematical Dreamworlds: The Enlightenment," Enlightenment philosophers conceived of the universal human by narrating into being mathematical dreamworlds as the site where such a human could emerge. In "Part 2: Dreamworlds Reconfigured," I show how writers from Virginia Woolf, to Amitav Ghosh, to Nnedi Okorafor reveal the fictional qualities of mathematical dreamworlds, and remake these dreamworlds into imagined environments that empower subaltern subjects.

I begin by clarifying my project's key term: *mathematics*. When we think of mathematics, we often think of *applied mathematics*: mathematics employed as a tool in geography, social science, or economics—i.e. to count distance, populations, or money.

[3] I take the term "minor" subjects from Kandice Chuh, who argues in *The Difference that Aesthetics Makes* of the importance of taking into account representations of the human in texts by minor authors—those subjugated in the name of liberal humanism. Chuh, Kandice. The Difference Aesthetics Makes: On the Humanities "after Man". Durham: Duke University Press, 2019

But mathematical thinking itself—often referred to as "pure mathematics"—does not attempt to describe the world. Pure mathematics "is concerned with the behaviour and properties of numbers, functions, and other abstract entities and structures, *studied for their intrinsic interest rather than for their application to solving problems in the real world.*" [4] In pure mathematical fields such as number theory and geometry, mathematicians think with concepts that are defined not in relation to the world, but rather in relation to other concepts and in mathematical language. It is this kind of mathematical thinking that my project focuses on.

In pure mathematical thinking, mathematicians seek to know about a set of invented concepts signified by mathematical symbols. These concepts may have come into being through a process of generalization and abstraction (the circle from circular objects), but as mathematical concepts they have lost their origins in the real world.[5] The work of pure mathematicians can be described as *thought experiments*, and understood through analogy to experiments in a physical laboratory. To take an example from the empirical sciences, imagine that you are trying to figure out what happens to

[4] "Pure mathematics, n.". OED Online. June 2020. Oxford University Press. https://www-oed-com.proxy.libraries.rutgers.edu/view/Entry/267871 (accessed June 17, 2020).

[5] The question of what mathematical objects are and how they came into being has preoccupied philosophers of mathematics. There are many schools of thought on the subject, but they all agree that once a mathematical idea has been formulated, it can no longer be traced back to any specific thing in the real world. Schools of thought on the ontology of the mathematical objects are split between those who think that mathematical objects exist independently of the human mind and those who do not. Of those who understand mathematics to exist independently of the human mind (mathematical realists), Platonists understand mathematics to exist in a realm apart from the real world, while empiricists understand mathematical ideas to be a part of the real world, inhering in its laws, which humans discover. Others understand mathematics to be dependent on the human mind: mathematical constructivism and factionalism understand mathematical ideas to be completely made up in the mind, whereas embodied mind theory understands mathematics to emerge as a part of the human cognitive apparatus because it is useful to understanding the world. In other words, most theorists understand mathematical objects to inhere in some other realm than the real world, whether this is in the human mind or in a Platonic realm. Although mathematical realist empiricists think that mathematical ideas come from empirical experience—that we know 2+2=4 because we have seen how pairs coming together form four—they understand that once the idea is expressed (generalized as, abstracted into) mathematical form—2+2=4—it is no longer traceable to any particular instance of addition.

supernovas—stars when they explode—by looking at the light that is given off by the star, and by using a machine that captures this light. In pure mathematics, all of the objects that you are trying to find out about (stars), and the machines that you use exist only in the mind. "What corresponds in mathematics to an empirical world studied by science—mathematics' external 'reality' as it were—is already a symbolic domain, a vast field of ideal, semiotic objects," writes semiotic scholar of mathematics Brian Rotman.[6] As a form of thinking about objects that exist only in an imaginative realm, mathematics can be understood as an activity that is akin to *dreaming*. "Doing mathematics constitutes a kind of waking dream or thought experiment in which a proxy of the self is propelled around imagined worlds that are conjured into intersubjective being through signs."[7] Dreaming describes mathematical activity from the point of view of the thinker: how it feels to the thinker.

While dreaming describes the interior and subjective experience of mathematical thinking, "speculative" captures the relationship that mathematical thinking takes to the empirical sciences. "Speculative," "of the nature of, based on, or characterized by speculation or theory, in contrast to practical or positive knowledge,"[8] describes thinking that takes place at a relative remove from reality and what one might call "the facts." I use it to describe the way that mathematics defines a set of objects without reference to

---

[6] In *Laboratory Life*, Bruno Latour and Stephen Woolgar describe knowledge production in the sciences as a process in which scientists in a laboratory use instruments, collect data, and argue over this data, where the most convincing explanation becoming accepted as science ("science is a process of being convinced and convincing others"). Mathematical work involves all of these parts, except everything happens in the mind, from the things the mathematician is trying to find out about, to the instruments, data/output, and arguments that are produced and assessed. For more on this see Rotman, Brian. "The Technology of Mathematical Persuasion." In *Inscribing Science: Scientific Texts and the Materiality of Communication.* Edited by Timothy Lenoir. Stanford University Press, 1998.

[7] Rotman, Brian. *Mathematics As Sign: Writing, Imagining, Counting*. Stanford, Calif.: Stanford University Press, 2000.

[8] "Speculative, adj. and n.". OED Online. June 2020. Oxford University Press. https://www-oed-com.proxy.libraries.rutgers.edu/view/Entry/186115?redirectedFrom=speculative (accessed June 18, 2020).

the real world. I take "speculate" rather than "imagine" as my operative term because although mathematical thinking is an act of imagination—of forming mental images—it is also a part of a larger project of knowledge-production. The knowledge that pure mathematics produces is not of the world but rather of its special realm of objects. That is to say, I use "speculation" to refer to mathematics because it is a particular kind of imaginative activity that exists in tension with dominant, empirical formations of knowledge ("in contrast to practical or positive knowledge"). The term captures also the strange position of mathematics within Western formations of knowledge, as a science (producing "objective knowledge") that shares many characteristics with literature, as this project will show.[9]

In this Introduction, I briefly discuss the fields and methods involved in this project, and end with my chapter layout.

Mathematics in Postcolonial Studies

Postcolonial studies has generally thought of mathematics as applied mathematics: mathematics as a quantitative, descriptive tool used in capitalism and governance. Mary Poovey argues that such a notion of mathematics as a tool for knowledge emerged in 16th- century Britain; by the 19th century, mathematics was seen as *the* tool for the production of knowledge in the social sciences[10]. As postcolonial scholars have argued,

---

[9] I am thinking here of speculative fiction as a term that has long been used to describe genres of fiction that are non-mimetic, and that strives to present a world unlike the reader's sense of reality. While mimetic and realist texts strive to capture reality as it is experienced, and with such verisimilitude that readers can share in the experience, speculative fiction sometimes includes elements that are unlike the reader's reality in order to demarcate the textual space from the real world. It is this non-mimetic impulse, this desire to create a space that is radically unlike the physical world, that I find in Enlightenment texts on mathematics.

[10] Poovey, Mary. *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society.* Chicago: The University of Chicago Press, 2010.

mathematics in this sense, as a quantitative, descriptive discourse—a system of numbers that are applied to the world in order to know it—has a history of being used to produce knowledge that is violently reductive and subtractive. Applied mathematics produces a view from above, a God-like gaze that is associated with objectivity as well as mastery and control.[11] Imperial officers used geometric diagrams to direct activity in places far away, replacing these places with the reductive representation of the diagram.[12] In colonial governance, mathematics was used to count, categorize, and keep track of inherently hybrid populations.[13] In the slave trade, numbers provided a way of representing the world that framed human beings as opportunities for profit.[14]

However, the mathematics that appears in the novels of this dissertation is not applied to the real world as a form of description, as is the case with math in economics, governance, and the sciences. Rather, they describe pure mathematical thinking that is not interested in knowing or controlling the world but rather in knowing about a set of objects that do not exist in the world, that are constructed artificially, and about their relationships to each other. For this study, postcolonial readings of applied mathematics and its ties to governance and capitalism are less helpful. Therefore I turn to histories of mathematics, science studies, and semiotic analysis for my methods of reading, as I elaborate in the next section.

---

[11] Haraway describes objectivity as a "god-trick of seeing everything from nowhere." Haraway, Donna Jeanne. *Simians, Cyborgs, and Women: The Reinvention of Nature.* New York: Routledge, 1991, p. 189.

[12] Latour, Bruno. "Visualisation and Cognition: Drawing Things Together." *AVANT. Pismo Awangardy Filozoficzno-Naukowej*, no. 3 (2012): 207-257

[13] Appadurai, Arjun. *Modernity at Large: Cultural Dimensions of Globalization.* Minneapolis: Univ. of Minnesota Press, 2010. Bhabha, Homi K. *The Location of Culture.* Routledge, 1994.

[14] Baucom, Ian. *Specters of the Atlantic: Finance Capital, Slavery, and the Philosophy of History.* Durham: Duke University Press, 2005.

What this project draws from postcolonial studies and minor literatures are its critiques of liberal humanism. Taking Western humanism as an object of study, Lisa Lowe has argued that when European thinkers created the universal subject, they also produced the racialized, feminine, the colonized, and the minor—subjects excluded from universality. The role of minor discourses, Sylvia Wynter argues, is to uncover the processes by which European man is produced as the human, and to think more inclusively about what it means to be human.[15] *Mathematical Dreamworlds* participates in this uncovering by focusing on the role of mathematical dreamworlds within Enlightenment thought, as a site through which philosophers wrote European Man as the universal human. This project contributes to postcolonial notions of mathematics and universalism by asking how these forms of thinking can and have been channeled by postcolonial and subaltern subjects.

Ontologies of Mathematics

In this section, I call on the fields of science studies, history of mathematics, and media studies for a way of reading novelistic portrayals of math as dreaming.

Drawing insight from these fields, I understand mathematics to be a field of knowledge production about objects that *do not exist in the real world*.[16] In this way, mathematics is unlike the sciences. In the sciences, scientific concepts and ideas are created in the attempt to understand the real, physical universe. As Lorraine Daston writes of early developments in cloud science, the creation of cloud types is the creation

---

[15] Wynter, Sylvia. "On Disenchanting Discourse: "Minority" Literary Criticism and Beyond." Cultural Critique , no. 7 (1987): 207-24

[16] Rotman 12-13. "Clearly such worlds are imagined, and the actions that take place in these worlds are imagined actions."

of *a way of seeing.*[17] Cloud atlases, by teaching readers to trace the shapes of different cloud types as they look up into the sky, "furnish the universe" with this way of seeing. The universe exists (the sky exists, with its variegated colors and evanescent shapes)—scientists do not "create" the universe—but they furnish the universe with objects of study, "objects that are amenable to sustained and probing investigation," objects that a community of scientists can use to refer to and talk about activity in the sky. By contrast, pure mathematical thinking does not attempt to know the universe, but rather a set of imagined objects that are defined through mathematical language. In other words, mathematics both creates its universe of objects and furnishes it with ways of seeing—or as Rotman puts it, "mathematical language *creates* and *talks about* its world of objects."[18]

Mathematical language asks thinkers to imagine themselves within this field of objects and also to act on them. As Rotman writes in his study of the mathematical proof, a form of writing used across fields of mathematics, proofs make imperative statements that ask thinkers to imagine mathematical objects (e.g. the set of even numbers, the two dimensional plane), and also to act on these objects ("count," "show that alpha is the case," "define a mapping"). These directions at times require the thinker to do things that are not possible for them in the real world, such as count to infinity. Nowhere—not in the language in which these objects are defined or in the directions that are issued to readers—is any reference made to time, place, history, culture, or identity.[19] This means

[17] Daston, Lorraine. "On Scientific Observation." *Isis* 99, no. 1 (2008): 97-110.

[18] Rotman 37.

[19] Rotman. There is "the total absence of any expression connecting the Subject to the inhabited world: no mention of his/her immersion in culture, history, or society nor any reference to psychological, physical, temporal or spatial characteristics. Crucially, the user of the Code is never asked to interpret a message which makes reference to the Subject's embodied presence."

Rotman takes a discourse analysis approach that understands language to contain forms of subjectivity that speakers can use to constitute themselves as subject (what Emile Benveniste calls "empty forms" that constitute "the possibility of subjectivity"; what Michel Foucault calls the "modes of existence" that in the space of mathematical thinking, the thinker's experience is radically different from their experiences of the real world, as it is missing the dimensions of history and culture. This also means that the thinker finds herself differently in this space, for if we understand language to contain possible forms of subjectivity, the only form of subjectivity that can be expressed in mathematical discourse is one that is transhistorical and transcultural.

From the perspective of the thinker, this space of mathematical thinking can be characterized as a *dreamworld*.[20] Like dreaming, the thinker finds herself in an imagined world that is different from her experience of the real world. And like dreaming, the dreamer is not herself-in-the-real-world, but rather someone who takes shape in relation to the world of the dream, what Rotman calls an "avatar" of the self.[21]

The dreamworld of mathematics, unlike the dreamworlds of our personal dreams, exists beyond the dreams of any one person. It exists for a community of mathematicians who understand the language in which it is defined. The circulation of mathematical proofs shapes and secures this dreamworld of mathematics for this community of

---

afforded by a discourse—"what are the modes of existence in this discourse? ... What are the places in it where there is room for possible subjects?"). Thus he asks what forms of subjectivity the language of the mathematical proof makes possible. (See Benveniste, Emile. "Subjectivity in Language." In *Problems in General Linguistics.* Miami, Florida: University of Miami Press, 1971, p. 227. Foucault, Michel. "What Is An Author?" In *Language, Counter-Memory, Practice: Selected Essays and Interviews.* Edited by Donald F Bouchard. Translated by Josué Harari. Ithaca, NY: Cornell University Press, 1977.)

[20] Rotman calls it a "waking dream."

[21] I use the word "dreamworld" rather than "imagined space" to highlight the immersive nature of the space of mathematical thinking: it is not merely an imagined space—for it is possible to imagine many spaces without imagining yourself in them—but rather a space that the thinker is directed to place themselves in relation to by the language of the proof, to relate to and act on its objects, which sometimes involves a change in their self-conception. (The thinker for example cannot count to infinity as she is finite being. But in mathematical proofs, she is asked to imagine herself doing so.)

When I say 'dreaming,' I do not mean a Freudian notion of dreaming in which objects in the dreamworld directly correspond to things and issues in the real world that the dreamer is working through. Rather, the relationship between the dreamworld of mathematical thinking and the real world is more obscure. Instead of a relation of direct correspondence, I suggest that the dreamworld of mathematical thinking adds to the spaces that individuals experience, and the collection of spaces, real and imagined, that shape subjects.

mathematicians.[22] This dreamworld is a *virtual* environment: a realm of objects that do not exist in the real world and yet are shared by a community, a world in addition to the real world that avatars of the self can enter into and act within.[23]

What happens to this virtual dreamworld, created by mathematical language, in literature? Although mathematical proofs produce a dreamworld that is absent the dimensions of time, place, culture, and history—I call this "mere space"— narratives of mathematics turn this space into something more, reconfiguring it so that that it gathers cultural and historical resonances. By narratives, I do not mean only writing that appears in literary forms such as the novel and poetry, but simply writing in ordinary language that narrates the phenomenological experience of mathematical thinking. Such writing can appear in novels as well as philosophical texts, and also in writing by mathematicians for a general audience.[24]

---

[22] Historians of mathematics look to mathematical texts and their circulation to understand how mathematical ideas are secured for a community of users. See Warwick, Andrew. *Masters of Theory: Cambridge and the Rise of Mathematical Physics.* Chicago: University of Chicago Press, 2003.

[23] Mathematical thinking produces a virtual reality in that it substitutes the interface between a person and the physical environment with an interface to a simulated environment. In fact, early thinkers about cyberspace imagined it in mathematical terms. Theorists of cyberspace argue that in virtual spaces, we do not become disembodied but place ourselves into a new embodied landscape, describing a process similar to what I will describe to happen in mathematical thinking: "When the body acts to enframe digital information—or, as I put it, to forge the digital image—what it frames is in effect itself—its own affectively experienced sensation of coming into contact with the digital. In this way, the act of enframing information can be said to "give body" to digital data—to transform something that is unframed, disembodied, and formless into concrete embodied information intrinsically imbued with (human) meaning." Hansen, Mark B. N. *New Philosophy for New Media*. Cambridge: MIT, 2004, 10. Rotman writes about mathematics as a precursor to and template for virtual reality, and the connection between mathematical and and virtual worlds in "Thinking Dia-Grams: Mathematics, Writing, and Virtual Reality" (1995) in *Mathematics, Science and Postclassical Theory,* Ed. Smith and Plotnitsky, 389-415.

[24] I am referring to the way that mathematicians talk about their experience of mathematical thinking, where they often furnish the space of mathematical thinking with real-world objects (e.g. houses, mountains, the sea) and describe the experience in emotionally intense terms. In a study of these narrative accounts of mathematical experience, Hersh writes that "[w]hat some mathematicians say they are doing" include finding their way through a "labyrinth," "landscape," or "geography of mathematical reality." "There is no 'furniture' or 'labyrinth' in any literal sense… [they] are encountering mental mathematical entities. These mental mathematical entities are experienced as actual objects, more or less clearly or obscurely perceived, that have their own properties, which the mathematician may struggle for a long time to ascertain" (95). Hersh notes that these aspects of mathematical experience, emerging from practitioner

Narratives of mathematics, sitting outside of the academic fields of mathematics proper, transform the mere space of mathematical dreaming produced by the mathematical proof. In *Poetics of Space*, Gaston Bachelard writes that all the spaces that we inhabit will begin to acquire emotional and psychological resonances. The house in the beginning is merely a geometric space—"every house is at first a geometric object of planes and right angles"—but observe "how such rectilinearity so welcomes human complexity, idiosyncrasy, how the house adapts to its inhabitants."[25] For Bachelard, it is poetry—with its emphasis on phenomenological experience, and its ability to create the textures of dreaming which characterize our experience of place—that captures the simultaneous transformation of the house into a home and the subject into the person who is at home in it. I suggest that narratives about mathematics do something similar—that they capture and intensify the phenomenological experience of mathematical thinking in such a way that the space itself begins to transform. They intensify the inhabited textures of this dreamspace of mathematics, so that this field of objects—which, unlike science, was not directed towards understanding the real world—begins to speak to the real world, becoming, for example, a shelter for the thinker from the real world, and a way of living in the real world; it begins to speak to feelings of need and lack that originate in the real world. In narratives of mathematical thinking, the space of mathematics becomes reconnected to the world and more than mere space.[26]

---

accounts, have not received serious attention. See Hersh, Reuben. "Experiencing Mathematics: What Do We Do, When We Do Mathematics?" *American Mathematical Society* (2013): 92-95.

[25] Bachelard, Gaston. *The Poetics of Space.* Translated by Maria Jolas. Massachusetts: Beacon Press, 1994.

[26] I write that in narratives of mathematical thinking, the space of mathematical thinking produced by the proof becomes reconnected to the real world and more than mere space. This raises the question of whether the space of mathematical thinking is actually like it is described in these narratives, or whether this space has transformed under the narrator's embellishment, or whether it emerges out of the pitfalls of translation, in the attempt to render how an experience feels that is only defined in mathematical

Narratives of mathematics shape a conception of mathematics that becomes meaningful to a larger community beyond mathematicians, as they are written in ordinary language rather than the specialized language of mathematics. This suggests that what we know of math, if we are not mathematicians, is a literary notion of it—an idea of mathematics conveyed through literary technique and form. In addition, narratives of mathematics shape an idea of math that has endured through time, despite changing notions of math in its academic fields.[27] The most significant way that mathematics becomes more than mere space is in Enlightenment thought, where through literary thinking and form, mathematical thinking is turned into a virtual space in which the modern subject, the objective world, and reason can emerge.

Literature Review

At heart, this project seeks to explain what mathematics is doing when it appears in literature. I find that previous approaches to reading mathematics in literature do not explain the kind of mathematics that appeared in these novels. Scholarship on mathematics in literature tends to see mathematics through either a formalist or a

language into ordinary language—in the attempt to find correlates for this experience. It is outside the scope of this project to determine which one these is true—I am only interested in the fact that this space has transformed (that it is no longer mere space), and the shape that it transforms into.

[27] Rotman notes that even among mathematicians, a notion of mathematics as a process of discovery about a transcendental realm of objects has endured into the 21st century. Despite mathematical developments in the 20th century—most notably Gödel's incompleteness theorem that undermined the certainty of mathematical knowledge by showing that an axiomatic system cannot be both consistent and provable—a Platonic conception of mathematics persists, Rotman notes. Mathematicians persist in thinking of mathematics as a transcendental field of objects existing beyond the real world, the truth of which mathematical thinking strives to discover. See Rotman, Brian. "When to Stop Counting." Review of *Fermat's Last Theorem: Unlocking the Secret of an Ancient Mathematical Problem*, by Amir Aczel. *London Review of Books* 19 no. 23 (1997): 10, https://www.lrb.co.uk/v19/n23/brian-rotman/when-to-stop-counting. The tension between a post-Gödel notion of mathematics and a Platonic view is dramatized in Zia Haider Rahman's novel *In the Light of What We Know* (2015).

materialist lens. The formalist approach takes mathematics to be abstract ideas, divorced from context, used in literary texts as a kind of pattern or figure. An example is Jocelyn Rodal's work on modernist literature, where she relates Woolf's mathematics to her thoughts about pattern and literary form. The materialist approach takes mathematics to be a discourse of quantity and calculation. An example is Melanie Benson Taylor's study of numbers in postcolonial Southern literature, where she finds that they register how marginalized groups have internalized their worth under capitalism. In studies of 20th century literature, the formalist approach tends to appear in modernist studies, and the materialist approach in postcolonial studies.[28]

Mathematics as a dreamworld, a realm of imagining detached from the real world that people can enter into, does not fall squarely into either of these approaches to reading mathematics. In *Night and Day*, Katharine finds herself in her mathematical thinking in a space removed from the real world of the drawing room. Mathematical ideas, detached from the real world, offer her a measure of imaginative freedom. However, this space is not merely a space of ideas, but rather a space that she experiences herself to be inside of and in which she finds herself shaped and formed in ways that are different from in the real world. In other words, as a dreamworld, mathematics is not merely ideas divorced from context but rather a way of thinking and a space of thinking that contributes to processes of subject formation. As I will suggest, this dreamworld of mathematics is intimately linked to notions of the modern subject, and to ideas of reason and freedom, as

[28] For a postcolonial approach, see Taylor, Melanie Benson. *Disturbing Calculations: The Economics of Identity in Postcolonial Southern Literature, 1912-2002.* University of Georgia Press, 2010. For modernist approaches, see Rodal, Jocelyn. "Patterned Ambiguities: Virginia Woolf, Mathematical Variables, and Form." *Configurations* 26, no. 1 (2018): 73-102, and Brits, Baylee. *Literary Infinities: Number and Narrative in Modern Fiction.* Bloomsbury Publishing USA, 2017. (Rodal writes that Woolf uses mathematics to reinvent "the shape of ambiguity"—"mathematical attention to Woolf's patterns offers an understanding of what it is that we call literary form, an understanding built from pattern rather than particularity.")

the thoughtspace through which these concepts are rendered coherent. Mathematics as dreamworld plays a role in the history of colonialism, not as a way of counting and calculating, but rather as a way of creating and imagining the modern subject. In the dreamworld of mathematics, European man imagined himself as the universal human, with the right and authority to rule over empire.

Methodology

My project explores notions of mathematics that exist beyond academic fields of mathematics, are shaped through narrative, and participate in the imagining of the universal human. Therefore my method needs to be flexible, and to cross disciplinary and field boundaries. This method is informed by my undergraduate study of theoretical mathematics, which revealed to me that mathematicians often talk about mathematics in the language of narrative and aesthetics. I do not assume, *a priori,* that objects from different disciplines perform different functions—i.e. that mathematics always serves an administrative function, and literature a narrative or aesthetic one.

Abandoning disciplinary blinders, I suggest, we see how objects perform multiple functions at once, and in particular how mathematics performed the function of scaffolding the formative realm of the universal human. *Mathematical Dreamworlds* began in reading novels that portrayed mathematics as dreaming in another space. As a postcolonialist, I knew mathematics as a quantitative and descriptive discourse that turns human beings into controllable populations and objects of exchange, as Appadurai, Bhabha, Massey, Latour, and Baucom write. Novelistic portrayals of mathematics as dreaming, however, did not fit this interpretation. Aware of the imaginative labor of mathematical thinking, I looked further into these portrayals of mathematics, rather than ascribing them to the authors' fantasies. This project uses semiotic studies of mathematics (Rotman) to explain how mathematical language creates and defines a virtual space of objects, paired with cultural studies of mathematics (Warwick, Richards, Hottinger) to analyze how contemporaneous texts about mathematics for general audiences make a version of this virtual space available to the authors studied in this dissertation. Tracing mathematical narratives to their common source in Enlightenment theories of the universal human, I apply literary and narrative analysis to analyze how Enlightenment texts produce a speculative fiction of mathematics. I take up gender theory, postcolonial theory, and critical race theory to consider the allure that this dreamworld holds for subjects excluded from the universal.

Chapter Overview

Part One of the project consists of a single chapter, "Universal Man Emerged Out of a Mathematical Dreamworld," that lays out the stakes of the project by reading mathematics in Enlightenment philosophical texts. Within liberal modernity, mathematics was understood as training in reason that produced the universal, rational subject. Part One takes a deeper look at the way that mathematics was understood to operate on thinkers through readings of Descartes' *Discourse on the Method* (1637) and Kant's *Critique of Pure Reason* (1781). This analysis reveals that both Descartes and Kant produced mathematical dreamworlds, writing that narrates pure mathematical thinking as an experience that takes place in a realm beyond the real, physical world. In the space of pure mathematical thinking, a sensible realm where all markers of time, place, culture, and history are absent, Enlightenment philosophers understood the universal human to come into being. Appearing in the 19th century, this notion of a mathematical realm in which individuals transcend their subjective experience was used to justify British imperial authority: mathematics turned individuals into rightful rulers of empire. I call these writings, which narrate mathematics as the experience of being in another realm beyond the real world, *speculative fictions of mathematics.* This makes it clear that although mathematics may appear in fantastical, dreamlike, and speculative ways in the Anglophone novel, their authors did not make them so. Rather, I contend, Enlightenment philosophers of the human produced the speculative fiction that these authors are still unpacking.

Part Two contains chapters two to four, which trace how this notion of mathematics is taken up in the Anglophone novel in the long twentieth century. How do writers who are minor subjects, excluded from liberal modernity's notion of the human, write back? In each novel, a dreamworld of mathematics appears as an alternative space to the real world that characters can inhabit. Within this dreamworld, characters experience new possibilities that are not present in their experience of the real world, and that ultimately transform their relationship to the world. In other words, these novels re-imagine the Enlightenment dreamworld of mathematics as a space in which characters can rework their relationship to forms of subject-constitution and interpellation that are imperial and Enlightenment legacies. In the process, they forge new notions of the human and universality that better serve a postcolonial project. In their engagement with this dreamspace of mathematics, this imagined world in which selves feels more free than they do in the real world, they pose a question that is at the heart of all literary work: what is the use of imaginative freedom in the face of material reality?

I begin in the metropole in the early 20th-century in my second chapter, "Dreaming in the Metropolitan Drawing Room: Virginia Woolf's *Night and Day* (1919)." A realist coming-of-age novel set in Edwardian London, *Night and Day* explores how empire interpolates and genders its subjects through both real places (the drawing room) and imagined spaces (the space-time of imperial adventure). The protagonist of the novel, Katharine, is a mathematician. Like her daydreams of adventure, mathematical thinking takes her away from the real world of the drawing room in which she feels her identity to be fixed. In the dreamworld of mathematical thinking, she feels freer still than in the dreamworld of adventure, where she finds herself always in the role of the woman who eagerly awaits the adventurer's return from empire's peripheries. Katharine's mathematical activity opens up a third space for her to inhabit that interrupts the affective construction of the self issuing forth from both the real world of the drawing room and the imagined space of imperial adventure. Woolf takes this idea of mathematics from Bertrand Russell, who described mathematics in essays for a general audience as the experience of dwelling in a realm where one could feel free and unlimited by the realities of the real world. Woolf takes Russell's literary notion of mathematics—as a virtual space beyond the real world that is accessible to people within it—and explores how it can be used to imagine new forms of being beyond the gendered construction of subjects in the metropole. In this way, she foreshadows the approach that other novels in this dissertation will take, as they use the dreamworld of mathematics to disrupt the legacies of empire.

The third chapter, "Speculating in the Colonial Laboratory: Amitav Ghosh's *The Calcutta Chromosome* (1995)," moves from empire to postcolony. While Woolf explored how a dreamspace of mathematics can be used to disrupt the gendered construction of imperial subjectivity, Ghosh explores how a dreamspace of mathematics can be used to disrupt imperial legacies of writing history that locate the actors of history in the West. *The Calcutta Chromosome* follows the story of Murugan, a South Asian immigrant, as he investigates the discovery of malaria, which has been attributed to the British colonial doctor Ronald Ross. Murugan suspects however that there were other, yet uncovered actors at work. Employing elements of historical fiction, science fiction, and the supernatural, *The Calcutta Chromosome* explores how discourses shape knowledge by shaping who can be seen as actors and what can be seen as causes. Murugan's discovery that one of Ross's laboratory assistants helped him at key moments in his work is based on historical fact. But the story goes beyond the historical record when Murugan discovers that this assistant was acting at command of a woman named Mangala, who cleaned Ross' laboratory, and who was the leader of a covert group that wanted to use Ross's research for their own ends. Unable to explain how this woman could without training or reading ability learn enough about Ross's work to intervene, Murugan asks that we step into a dreamworld of mathematics, a field of objects existing across time and place that anyone anywhere can access and know, which he introduces through the biography of the Indian mathematician S.R. Ramanujan. In such a dreamworld, where Ramanujan in India makes the same discoveries as mathematicians in Europe, material context seems unimportant, and it is possible to imagine that Mangala too could have learned about malaria without access to resources such as textbooks and instruction. But malarial science is not mathematics: juxtaposing these incongruous fields, Ghosh draws attention to the strangeness of mathematical knowledge, as knowledge about a field of objects that do not exist in the real world and yet exists within everyone, that sets it apart from all other fields of knowledge in the Enlightenment. He explores how such a dreamspace of mathematics—a space that transcends time and space and is accessible to everyone—circulating within popular biographies of mathematicians, can be used in writing about subaltern subjects, as a way of locating agency within female subalterns without limiting or defining this agency. In this respect, he prefigures the work that Okorafor does with mathematics in my next chapter.

My fourth chapter, "Trancing in the Deserts of Namibia: Nnedi Okorafor's *Binti* (2015-2018)" explores how a dreamspace of mathematics offers new possibilities for imagining that challenge a view of progress and development from the global north. In *Binti*, Binti is a young girl from an agrarian community in the desert of Namibia whose special power is her mathematical ability. All of her people have this ability, although she excels at it. Written by the Nigerian-American author Nnedi Okorafor, *Binti* is a part of a larger group of postcolonial science fiction works that re-imagine ideologies of global development by locating technology and resources in the peripheries. The most well known example of this work, and a project Okorafor has also taken part in, is the Marvel world of *Black Panther*, where a fictional nation in Africa is the most technologically advanced society on earth due to the development of vibranium, a metal resource. In *Binti,* however, the resource that Binti possesses is mathematics, a form of thinking and imagining that removes her from her surroundings, which is not tied to any particular physical object. This chapter asks what possibilities are opened up for the writing of speculative fiction by mathematics, an immaterial resource, that may not be available for material resources such as vibranium. I suggest that this allows for forms of speculative imagining less tied to a European model of industrial development. Binti's mathematical thinking opens up another space removed from the real world in which she finds a version of herself that is different from how she is interpellated by people both within her traditional community and beyond it. In the dreamworld of mathematics, Okorafor reworks notions of what it means to be human and to be universal.

Okorafor's work, belonging to the genre of speculative fiction, raises questions about my use of the word "speculative" to describe mathematical thinking. Indeed, I suggest that all of these texts are "speculative fictions of mathematics." All fiction is to some degree "speculative"—that is, it is not about the real world and real events. And yet in each of these novels, mathematics opens up a space detached from a pre-existing notion of reality within the fictional text, taking the same effect in both in realist texts and "speculative" texts. I define speculative fiction, in other words, not as fiction that deviates from a consensus notion of reality but rather as fiction that presents an alternative realm within its textual real world. In Woolf's realist novel *Night and Day*, mathematics works to open up an imagined space that is set in opposition to the space of the drawing room and the cultural and affective space-time of the British empire (issuing forth from the adventure novel), a space in which Katharine can access a different form of being. For Ghosh, mathematics disrupts the pre-existing reality that is a set of narratives for writing history that locate the agents of history in the West. For Okorafor, this pre-existing notion of reality is a view of the global south from the global north. This approach allows us to see how novels themselves theorize the act of speculative making—of imagining a realm beyond the real world. In these novels, we see that speculative making is not primarily about presenting a defamiliarized view of reality, but rather about the creation of another space that individuals can experience and use to shape themselves.

In the absence of actual, real spaces in which one is seen as fully human, people imagine alternative spaces in which they are. If this feels like fantasy, these novels draw attention to the presence of this very fantasy with Enlightenment philosophy, where it is European man who becomes formed in this alternative realm as the universal human, losing their coordinates in place, time, and history. Excluded in different ways from a concept of the human that purports to be universal, Anglophone writers in the long twentieth century labor to reveal the limits of the concept of the universal human, and to extend its reach. They take up mathematical dreamworlds, as it was here that Enlightenment thinkers understood the universal human to come into being. Placing female, postcolonial, and racialized bodies into mathematical dreamworlds, they remake the thought-worlds of Enlightenment philosophy that shape modern thought, opening new ways of thinking the human and the world. These ways of thinking, I contend, need to be taken into account in reformulating humanism. At stake in this project is the role that literature can play in the lives of marginalized subjects, by shifting how we see and understand the human.

Part 1: Mathematical Dreamworlds in the Enlightenment

CHAPTER 1: UNIVERSAL MAN EMERGED OUT OF A MATHEMATICAL DREAMWORLD

In this chapter, I embark on close readings of Enlightenment philosophical texts to elaborate the way that mathematics appears as a dreamworld. First, I set the scene by placing mathematics into a larger discourse of liberal modernity and its production of the human. That is, I want to uncover why notions of mathematics matter—how they inflect notions of the human in relation to gender and colonialism.

Mathematics in Modern Liberal Philosophy

Modern liberal philosophers understood that humans could become free through reason and progress, through the application of rational thought to science, politics, and the economy. And yet this imagination of the human and freedom existed paradoxically alongside the material reality of slavery and colonialism.[29] For thinkers such as Lisa Lowe, the origin of this notion of the universal human in discourses that construct the human as a category of exclusion means that it cannot be used for an emancipatory project. My readings in this chapter will suggest that at the heart of Enlightenment thinking—about what it means to be human, to be free, and to be modern—may not be so much a philosophical idea as a mathematical one. This mathematical idea, in turn, may be at base a literary fiction. If so, the literary becomes a privileged site for rewriting notions of mathematics, and with them notions of the universal human.

---

[29] As Lowe argues in *The Intimacies of Four Continents* (2015), indigenous peoples, Africans, and Asians in the Americas of liberty were not understood as humans whose labor and resources formed the material conditions for liberal notions of freedom. Their exclusion from the category of the human is explained by "the attribution of racial difference," and through the language of being "unfit for liberty"' and 'incapable of civilization'" (3-7). Paul Gilroy's *The Black Atlantic: Modernity and Double Consciousness* (1993) and Dipesh Chakrabarty's *Provincializing Europe: Postcolonial Thought and Historical Difference* (2000) also chart the relationship between liberal notions of the human and liberty and the material realities of slavery and colonialism.

Mathematics is central to modern liberal notions of the human as it grounded the idea of the rational subject who was understood to be the universal human. Enlightenment philosophers understood mathematics as a way of training people to reason, where reason is defined as a way of thinking where the results of thought could not be false. Through mathematical thinking, individuals could learn to think for themselves, and not be wrong. Mathematics, as training in reason, made it possible to believe in the authority of the individual over the authorities of religion, tradition, and the state. Thus mathematics was central to the idea of what it meant to be modern. Because mathematics was understood as a universal capacity—something that everyone could learn to do—the rational subject could be imagined to be the universal human.[30] Scientific fields of study, from physics to sociology and ethnography, acquired authority through the notion of universal reason that was grounded in mathematical thinking.

The idea of the rational subject, grounded in mathematical thinking, constituted a notion of the universal human that was exclusive. Rationality does not so much emerge in the Enlightenment as become located in particular subjects. Women and colonial subjects were excluded from this notion of the universal human as rational subject, and also represented as irrational within modernity's logic. "Woman," Rita Felski elucidates in her readings what it means to be modern in 19th- and 20th-century texts, "is aligned with the dead weight of tradition and conservatism that the active, newly autonomous, and self-defining subject must seek to transcend."[31] By grounding rationality, mathematics

---

[30] Historian of mathematics Matthew Jones explains the relationship between mathematics as a universal capacity and the idea of universal knowledge in Rene Descartes' thinking: "Descartes assumed all real knowledge could come only from a reason common to all humans. The universality of the knowing thing and the processes of knowing make this Cartesian subject a transcendental one. Above all, mathematics, with its proof techniques, and formal thought, modeled on mathematics, exemplify those things that can be intersubjectively known by individual but importantly similar subjects." (Jones 41).

[31] Felski, Rita. *The Gender of Modernity.* Cambridge, MA: Cambridge University Press, 1996.

plays a central part in the process that Lowe speaks of, a "process by which 'the human' is 'freed' by liberal forms, while other subjects, practices and geographies are placed at a distance from 'the human'."[32]

And yet, the idea of the universal human as the rational subject who comes into being through mathematical training surprisingly contains some resistance to being gendered male. The immateriality of mathematical activity made it more difficult to align with masculinity than other, more physical activities. As an intellectual activity, its abstraction from thinking about politics, economics, and other 'spheres of men' made it also difficult to secure firmly onto the realm of the masculine. So even as mathematics was seen as a way of training gentlemen of empire, and associated with uppercrust English masculinity,[33] this association was not secure. Mathematical groups in Cambridge made great effort to masculinize mathematics by associating it with sports through the language of "teams," "coaches," and "exercises."[34] And yet at the turn of the century, when women agitated to attend Cambridge, these associations with masculinity were easily undone: mathematics was one of the few courses of study where there was little resistance to women attending because in its nonphysical nature as well as its nonengagement with worldly topics it was thought to be best suited to their 'feminine'

A particularly illustrative example of the way that rationality does not so much emerge in the Enlightenment but become gendered can be found in the history of fashion. Historian Elizabeth Semmelhack traces the transformation of high heels from a unisex item, worn by both men and women, to a female-only item after the French Revolution. In post-revolution France, with its emphasis on reason and practicality, heels were considered impractical and irrational, and unsuitable for men. Semmelhack, Elizabeth. *Heights of Fashion: A History of the Elevated Shoe.* Toronto: Bata Shoe Museum, 2008.

[32] Lowe 3.

[33] Jones, Claire. *Femininity, Mathematics and Science, 1880-1914.* London: Palgrave Macmillan, 2009, p. 8. "The connections between Cambridge mathematics and notions of superior English masculinity were long-standing and profound. To mid-century and beyond, the middle and upper classes sent their sons to study mathematics at Cambridge in order to train them as gentlemen, not to turn them into mathematicians."

[34] Warwick, Andrew. *Masters of Theory: Cambridge and the Rise of Mathematical Physics.* Chicago: University of Chicago Press, 2003.

nature.[35] That is to say, the *immateriality* of mathematical thinking offers a certain resistance to gendered thinking about the universal human. Language and narrative play a significant role in the gendering of mathematical activity by materializing a contextual world in which it takes place.[36]

In colonialism, a belief in the superiority of European science and technology formed the ideology of Western dominance that shaped colonial decision-making. "Better machines and equations," Adas writes, demonstrated that "men of one type were superior to those of another," and was used to justify a relationship of rule. The rise of the natural sciences in the Enlightenment gave European thinkers reason to believe that their grasp of the natural world was superior, and through this superior command over the natural world asserted their right to rule over existing rulers and societies.[37]

Mathematics, as a form of thinking that grounded rationality, is at the heart of the scientific developments in the Enlightenment that constituted European thinkers' belief in their superior command over the natural world. And yet this mathematics, this form of

---

[35] Jones 18. "By its very nature, mathematics was clean, sedentary, safe (unlike the laboratory) and (mostly) removed from the grim and some-times immoral realities of the real world. In the 1890s a questionnaire was circulated to Cambridge lecturers canvassing their opinion on opening lectures to women. Respondents in classics and the natural sciences complained that the subject matter of lectures had to be modified if given in the presence of ladies. Earlier, the Vice Chancellor of the University had argued that the study of Greek authors was 'bad enough for men, let alone women'. Here the very abstraction of mathematics could be perceived as of benefit to women, rather than an obstacle. This perception was reinforced by the use of symbolic language which ensured the discipline's remoteness from unpleasant aspects of the world, preserving innocence and purity… Paradoxically, it was viewed as the elite 'masculine degree', yet it could also preserve a woman's femininity, which other more 'knowing' disciplines may threaten."

[36] Mathematics is gendered through literary forms and narrative: through the metaphors of sport (Warwick), and also through biographical narratives of the mathematician that figure the mathematician in the type of the young male genius. Hottinger, Sara N. *Inventing the Mathematician Gender, Race, and Our Cultural Understanding of Mathematics.* Albany: State University of New York Press, 2016.

[37] The belief that Europeans "possessed not only the knowledge and skills that Africans and Asians could never acquire on their own but a vastly superior way of approaching both the natural and supernatural worlds was central to the European colonizers' sense of themselves and their mission in overseas societies…. they had the right to rule and the duty to surprise and transform because, in contrast to the corrupt and unpredictable African and Asian elites who contested their claims to dominance, they were disciplined, foresightful, and reliable." Adas, Michael. *Machines As the Measure of Men: Science, Technology, and Ideologies of Western Dominance.* Cornell University Press, 1990, p. 14, 267.

thinking that grounded rationality, is not itself directed towards knowing the world, and does not itself offer this command. In *History of British India* (1811), James Mill uses the state of mathematics in India to justify continued colonial rule.[38] "The astronomical and mathematical sciences afford conclusive evidence against the Hindus. They have been cultivated exclusively for the purposes of astrology; one of the most irrational of all imaginable pursuits; one of those which most infallibly denote a nation barbarous." Commentators on this text have noted that Mill's understanding of mathematics in India is limited. This makes how he goes about drawing the line between Indian and European mathematics, and figuring the latter as superior, even more interesting. Mill makes a distinction between European mathematics and mathematics in ancient and medieval India through *use*: Indian mathematics is inferior because it is used "for the purposes of astrology," an "irrational" pursuit. Mill's use-based distinction between European and Indian mathematics does not hold up against European mathematics own framing as thinking detached from use and also from all referents that could inflect mathematical thinking with use-oriented concerns, as I will elaborate.

---

[38] Mill, James. *The History of British India.* 4 ed. 10 vols. London: James Madden and Co., 1858, p.159. For Mill, a long history of mathematics in India did not count because it is also engaged in questions about astrology.

In Kim Plofker's book-length study on mathematics in ancient and medieval India, she writes: "'astronomy' and 'mathematics' are names of sciences in the Western intellectual tradition that have no exact counterparts in ancient and medieval India. Their closest equivalents are the Classical Sanskrit śāstras ('treatises' or 'disciplines') of jyotisa (from jyotis, 'light,' 'luminary,' 'celestial body') and ganita (from the root gan, 'to count, enumerate')... Both words have connotative links to astrology... and grew out of the ancient Vedangas or categories of knowledge that supported the correct performance of Vedic recitation and worship." In these texts, complex mathematical ideas in the fields of geometry, algebra, and number theory were interspersed with ideas of worship, ritual, divination, and questions about the stars. But there are also separate essays on mathematical ideas. Plofker's work illustrates a phenomenon that is often seen in studies of mathematics outside of Europe—that there is a wealth of mathematical knowledge that is not configured as a separate entity from other inquiries into the universe or into human society. In other words, the disciplinary framework that separates the sciences from the humanities is often a colonial inheritance. See Plofker, Kim. *Mathematics in India.* Princeton: Princeton University Press, 2010; and Plofker, Kim. "Astronomy and Mathematics."

Mill's views on mathematics in India show that European thinkers defined mathematics in a very peculiar way compared to other parts of the world. Ethnographic studies of mathematics have shown that mathematical knowledge inheres in many different cultures of the world, embedded in literary, cultural, political, and artistic productions, and as a part of a broader social world or cosmology.[39] In these cultures, mathematical knowledge emerges out of practical need (bartering and building) and in relation to religious and spiritual beliefs (making sense of the heavens, time, and the universe). In this context, European thinkers are unique in imagining mathematics as a realm of thought radically disembedded from all realms of experience and belief. Enlightenment thinkers understood mathematics to have come into being through an act of radical detachment by the Greeks, who turned embedded practices of mathematics into an abstract system of thought about concepts no longer attached to the real world or the realm of myth. In this new mathematics, "the figure formed by three matchsticks, the triangular boundary of a piece of land… the earth, sun, and moon at any instant" all became "the abstract triangle."[40] Not only did the Greeks make mathematics abstract, they also turned it into a deductive system of thinking: rather than moving from a set of empirical observations to their generalizations, they began with a set of definitions for

---

[39] I am drawing on scholarship in the field of enthnomathematics, a subfield of anthropology inaugurated by the Brazilian mathematician Ubiratan D'Ambrosio in 1971. Since then, Marcia Ascher has explored mathematics in cultures in North America, South America, and for Caroline Islanders, and Claudia Zaslavsky in Africa. Both Ascher and Zaslavsky find that mathematics that is embedded within cultural forms, in ways of connecting past and present, self and group, in games, and navigation (Ascher) and in literature, art, architecture, and weaving (Zaslavsky). (See D'Ambrosio, Ubiratan. "Ethnomathematics and Its Place in the History and Pedagogy of Mathematics." *For the Learning of Mathematics* 5, no. 1 (1985): 44-48; Ascher, Marcia. *Ethnomathematics: A Multicultural View of Mathematical Ideas.* Pacific Grove, CA: Brooks/Cole, 1991; Ascher, Marcia. *Mathematics Elsewhere: An Exploration of Ideas Across Cultures.* Princeton, N.J: Princeton University Press, 2002; and Zaslavsky, Claudia. *Africa Counts: Number and Pattern in African Cultures.* Chicago, Ill.: Lawrence Hill Books, 1999.)

[40] Kline, Morris. *Mathematics in Western Culture.* Oxford: Oxford University Press, 1964, p. 30-31.

these abstract concepts and arrived at their conclusions. This is what Enlightenment philosophers mean when they say that the Greeks gave birth to mathematics, understood as an abstract, deductive system of thinking, and to the mathematical spirit, understood as the spirit of rationality.

There is something inherently speculative about the way that European mathematics formulates itself from classical texts, involving the opening up of a realm detached both from the real world and also from the realm of myth. Mathematics is detached from the empirical world—mathematics is no longer a descriptive language for the real world but rather secures a whole other realm of objects and their relations, none of which exist in the real world. And mathematics is detached from the celestial realm—from the description of the movements of bodies in the sky, but also from the relationship between the present and the future, and between humans and the universe, that these movements conveyed—in order to describe a set of objects that do not exist in the real world.

This act of detachment is seen as a rational act, undertaken in Europe, which drove the arrow of progress forward. And yet it is not at all clear how the creation of European mathematics can be seen as a rational act, in no small part because Western notions of reason and rationality came out of mathematical thinking (such arguments tend to be circular). The readings that follow, which take a closer look at the relationship between Enlightenment mathematics and reason, suggest that the relationship is cohered and managed through a kind of narrative fiction. European mathematics, like other mathematics, is embedded in a social world, but a fiction of radical detachment is necessary to the social function that it performs.[41]

Reading Mathematics in Descartes and Kant

Following Peter Gay, I understand the Enlightenment to be a set of ideas catalyzed by the influx of classical thought and shared by a family of philosophers that included 18th century French thinkers as well as thinkers from the Scottish and German Enlightenment. For Gay, understanding Enlightenment thought requires understanding how philosophers interpreted classical texts, for these texts constitute the thought world from which they drew and composed their ideas.[42] Likewise in my readings, I ask how these philosophers interpreted mathematics—what it looked like within their thought world. My approach to reading philosophical texts is influenced by Mary Poovey's attention to things that are not explicitly defined but are necessary to the thrust of the argument.[43] In the work of Rene Descartes and Immanuel Kant, mathematics appears in their thinking about the question of knowledge, that is, whether we as humans can know the world. In my readings of mathematics in their writings, I ask: what qualities of

[41] As Sylvia Wynter writes, the realms that seem the most remote from the social world are often the realms through whose 'description' social order is authored, and this authorship is concealed. Wynter, Sylvia. "Unsettling the Coloniality of Being/Power/Truth/Freedom: Towards the Human, After Man, Its Overrepresentation—An Argument." *CR: The New Centennial Review* 3, no. 3 (2003): 257-337.

[42] "The Enlightenment was a family of philosophes, it was something more as well: it was a cultural climate, a world in which the philosophes acted, from which they noisily rebelled and quietly drew many of their ideas, and on which they attempted to impose their program. But the philosophes' world, their eighteenth century, was at least in part an ideological construct… I found it essential therefore to account not merely for the philosophes' ideas and for the interplay of these ideas with their world but also to judge the adequacy or inadequacy of their perceptions. Is Jefferson's virtuous Roman Republic the Roman Republic of twentieth-century scholarship? Is Hume's Cicero our Cicero?" (i). These questions, Gay writes, are important to understanding the Enlightenment as it was constructed and experienced by the *philosophes*. Gay, Peter. *The Enlightenment: An Interpretation.* New York: Knopf, 1967.

[43] Poovey reads philosophical texts with attention to things that may not be explicitly stated or defined but are necessary to the persuasive thrust of the argument, identifying "leaps of faith," "canons of belief," and "fictions" at work in theories of society and wealth. Poovey, Mary. *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society.* Chicago: The University of Chicago Press, 2010, p. 16-17.

mathematics as it is in the text are necessary to the operations of the argument and the ideas that are produced in it? To the persuasive force of the argument? For both thinkers, mathematics is an activity of thinking that produces an imaginative space detached from the real world. It is in this detached, separate space that the universal subject is constituted.

I begin with Descartes because his approach to the question of the possibility of knowledge, in the distinction he makes between body and mind, and in his radical skepticism, shaped the approaches of later Enlightenment thinkers. What is mathematics for Descartes? For Descartes, in the realm of mathematical contemplation, a special realm separate from the real world, the thinker transforms and becomes the rational subject, as I will elaborate.

In *Discourse on Method,* Descartes writes that he becomes persuaded of the possibility of knowledge of all things while dwelling in the realm of mathematical contemplation.

> Those long chains composed of very simple and easy reasonings, which geometers customarily use to arrive at their most difficult demonstrations, had given me occasion to suppose that all the things which can fall under human knowledge are interconnected in the same way. And I thought that, provided we refrain from accepting anything as true which is not, and always keep to the order required for deducing one thing from another, there can be nothing too remote to be reached in the end or too well hidden to be discovered.[44]

In the realm of mathematical contemplation, geometers begin with very simple ideas about geometric objects and work from them to demonstrate ideas that are much more complex. This movement from what is simple to what is complex gives him "occasion to

---

[44] Full title: *Discourse on the Method of rightly conducting one's reason and seeking the truth in the sciences, and in addition the Optics, the Meteorology, and the Geometry, which are essays in this Method* (1637). Descartes, René, John Cottingham, Robert Stoothoff, and Dugald Murdoch. *The Philosophical Writings of Descartes*, Volume 1. 1985, p. 120. I will refer to this as CSM.

suppose" that all knowledge may be obtained in the same way. From mathematical thinking, Descartes draws inspiration for his own method of inquiry, one that would likewise move from simple ideas to complex ones, through small steps for which it is possible to ensure that each step is sound. This is a method of reasoning, a way of thinking that if one follows exactly "one will never take what is false to be true." Through this method, one can acquire certain knowledge of the world —as he writes, "there can be nothing too remote to be reached in the end or too well hidden to be discovered."

Descartes begins his quest for knowledge that is true, and for a method of inquiry that can produce certain knowledge, in the realm of mathematical contemplation, because it is here that he finds the inspiration for his method. He also begins here because, as he writes, something is possible here that is not possible anywhere else:

> Of all those who have hitherto sought after truth in the sciences, mathematicians alone have been able to find any demonstrations—that is to say, *certain and evident reasonings*—I had no doubt that I should begin with the very things that they studied.[45]

In the realm of mathematical contemplation, "certain and evident" knowledge is possible. It is possible to see for statements made about the "things that [mathematicians] studied" whether or not they are true, where truth is certain and evident. But how can the certain and evident quality of knowledge about mathematical objects be used to establish certain knowledge of the world?

In the realm of mathematical contemplation, Descartes writes, "the only advantage I hoped to gain was to accustom my mind to nourish itself on truths and not to

[45] CSM 120 (my emphasis).

be satisfied with bad reasoning."[46] This realm provides Descartes with a kind of *experience* that he cannot find in the real world—experiences of "truth" and good "reasoning." These experiences allow for the formation of habit—he becomes "accustom[ed]" to truth—and also of taste and desire for good "reasoning," as the language of "nourish[ment]" and "[dis]satisf[action]" suggest. The realm of mathematical contemplation is a special, separate realm from the real world where certain and evident truth is possible. And yet, this realm is similar to the real world in the way it acts on and shapes the thinker—it is another realm for the thinker to (in)habit. In the realm of mathematical contemplation, with its limited set of objects about which it is possible to say what is true and what is false, the thinker develops a taste and a habit for the feeling of truth, undergoing what Descartes calls a spiritual transformation.[47] It is through this transformation in their spirit that the qualities of mathematical contemplation can be carried into other spheres of life. "In studying these principles," he writes, "one will accustom oneself, little by little, to judge better everything one encounters, and thus become more Wise."[48] In other words, Descartes extends the possibility of certain and evident knowledge in the special realm of mathematical contemplation to other fields of knowledge and investigation through the transformation of the self who inhabits both the mathematical realm and the real world.

---

[46] Descartes, René, John Cottingham, Robert Stoothoff, and Dugald Murdoch. *The Philosophical Writings of Descartes, Volume 1.* Cambridge University Press, 1984, p. 120.

[47] "Cultivating your *esprit* and exercising yourself with [geometrical problems] is the key thing that one can take away from [them]." From *Geometry* of 1637, in Descartes, René. *Oeuvres De Descartes.* Translated by Charles Adam and Paul Tannery. Paris: Librairie philosophique J. Vrin, 1996. Volume 6, p. 374. I will refer to this text as AT. This quote is translated in Jones, Matthew L. "Descartes's Geometry As Spiritual Exercise." *Critical Inquiry* 28, no. 1 (2001): 40-71. "I stop before explaining all this in more detail, because I would take away... the utility of cultivating your *esprit* in exercising yourself with them, which is... the key thing that one can take away from this science." In this text Descartes introduces the basic principles of geometry.

[48] AT, 9:2:18. Translated in Jones, p. 53.

To summarize, for Descartes mathematical problems place the thinker in the realm of mathematical contemplation where it is possible to say with certainty what is true and what is false. Dwelling in this realm, the thinker becomes shaped by it: she acquires experiences of truth that habituate her to the feeling of truth, and develops a taste for truth, therefore becoming the rational subject. The realm of mathematical contemplation does not act directly on the real world but rather takes effect precisely *by being another world to the real world*, in which the rational subject can emerge, who can step back into the real world.

I move from Descartes to Kant, from a thinker who came before the 18th-century thinkers who are understood to form Enlightenment thought but who inaugurated many of the questions that would preoccupy them, to a thinker who comes towards the end of the 18th century, in order to capture what happens to this idea of mathematics in the Enlightenment—namely, that it endures. Descartes' argument for the possibility of knowledge, though he places the emphasis on individual reason, still depends on an understanding of God. It is by the grace of God, who is not an evil deceiver, that things that seem certain and evident are true.[49] In *Critique of Pure Reason* (1781), Kant attempts to establish the possibility and scope of knowledge without appealing to God.[50]

What is mathematics for Kant? For Kant, mathematics belongs to a realm beyond empirical experience. Mathematical thinking is a contemplative activity in which all of

[49] See the fifth meditation in *Meditations on First Philosophy* (1641), in which Descartes discusses the existence of God who does not deceive, and whose existence guarantees that all clear and distinct ideas are true.

[50] By "the critique of pure reason," "I understand… *a critique of the faculty of reason in general,* in respect of all the cognitions after which reason might strive independently of all experience, and hence the decision about the possibility or impossibility of a metaphysics in general, and the determination of *its sources*, as well as *its extent and boundaries*, all, however, from principles" (101: Axiii).

the objects are made up, and yet are also sensible to the thinker. These qualities of the realm of mathematical contemplation make it a special realm in which more things are possible than are in the real world, as I will elaborate.

Kant writes that mathematics belongs to a realm of contemplation removed from the real world and outside of empirical experience. Mathematics appears in *Critique of Pure Reason* as an example of *a priori* truth, truths that originate prior to and independently of experience, as opposed to *a posteriori* truths*,* truths that are derived from experience. *A priori* truths are important because for Kant no knowledge originating in experience can be proven to be universally true.[51] Thus *a priori* truths constitute the realm of universal knowledge:

> "It is easy to show that in human cognition there actually are such necessary and in the strictest sense universal, thus pure *a priori* judgments… one need only look at all the propositions of mathematics."[52]

To demonstrate that mathematical ideas are a priori truths, truths that can be accessed without the aid of experience, and through the mind alone, Kant directs readers to perform a kind of thought experiment. He asks that they consider particular mathematical ideas, such as 7+5=12, and the idea that a straight line is the shortest distance between two points. And then he asks that they try to imagine otherwise—that 7+5 does not equal 12, or that a straight line is not the shortest distance between two points. These ideas—and ideas like them—that we cannot imagine otherwise (that we "cannot leave

---

[51] Guyer writes in his introduction to *Critique of Pure Reason* (CPR): "While [Kant] attempted to criticize and limit the scope of traditional metaphysics [establishing that certain metaphysical questions are unanswerable], Kant also sought to defend against empiricists its underling claim of the possibility of universal and necessary knowledge—what Kant called *a priori* knowledge, knowledge originating independently of experience, because no knowledge derived from any particular experience, or *a posteriori* knowledge, could justify a claim to universal and necessary validity." See p. 2 in the "Introduction" of Kant, Immanuel. *Critique of Pure Reason.* Translated by Paul Guyer and Allen W. Wood. Cambridge: Cambridge University Press, 1998. All quotes from Kant are from this text.

[52] CPR B5, p. 138.

out"), are "*a priori*": "Convinced by the necessity with which this concept presses itself on you, you must concede that it has its seat in your faculty of cognition *a priori.*"[53] Ideas that we cannot imagine under any circumstance to be false belong to a realm beyond empirical experience that is the realm of *a priori* knowledge. In this argument, Kant places mathematical thinking into the realm of *a priori* knowledge, a special realm separate from our experience of the real world. This in turn serves as evidence for the existence of *a priori* knowledge, and by extension of universal knowledge.

Everything in the realm of mathematical contemplation has been made up in that realm. Kant makes this clear in his description of how mathematics comes into being through the labor of the Greek mathematician Thales:

> [Thales] found that what he had to do was not to trace what he saw in this figure, or even trace its mere concept, and read off, as it were, from the properties of the figure; but rather that *he had to produce* the latter *from what he himself thought into the object* and *presented (through construction)* according to *a priori* concepts, and that in order to know something securely *a priori* he had to ascribe to the thing nothing except what followed necessarily from what he himself had put into it in accordance with its concept.[54]

Thales produces the mathematical object not from real-world objects but by making the object up ("through construction") from thought alone ("he had to produce the latter from what he himself thought into the object"; to "ascribe to the thing nothing except what followed necessarily from what he himself had put into it"). In the example of the triangle, Thales does not trace the triangle from a real-world object with a triangular aspect, but rather makes up the triangle in his mind. Thales detaches the mathematical idea from the real world, and in this act, Kant writes, gives birth to mathematics. In other words, Kant reminds us that objects in the contemplative realm of mathematical thinking, no matter

---

[53] CPR B6, p. 138.
[54] CPR, p. 108.

how they may resemble aspects of real-world objects, do not exist in the real world, but rather are artificially constructed in the realm of contemplation. When a mathematician talks about a triangle, they are not talking about a triangular aspect of a real object but rather the idea of a triangle that is defined only in the realm of mathematical contemplation, and in relation to other ideas in that realm.

Although mathematical truths are *a priori*, meaning we encounter them in a realm prior to experience, mathematical thinking constructs sensible objects for these *a priori* ideas. In mathematical thinking, Kant writes, the "abstract concept" (i.e. the intelligible/mental idea of the triangle) is made "sensible" through "the construction of... an appearance present to the senses."[55]

The qualities of the realm of mathematical contemplation—that it is a realm prior to experience, and the objects in this realm are made up and yet sensible to the thinker—make it a very special space. In this realm of mathematical contemplation, individuals find something that they cannot find in the engagement with the real world and in their other contemplative activities, which is the experience of certain knowledge. As Kant elaborates, the problem with knowing the real, empirical world, is that the character of the world (sensible) is not the same as the character of the concepts and categories (intelligible) with which one approaches it. In the realm of mathematical contemplation however, there is always parity between the ideas with which one comprehends an object and the object itself, as they are both intelligible. The problem

[55] "It is also requisite for one to make an abstract concept sensible, i.e., to display the object that corresponds to it in intuition, since without this the concept would remain (as one says) without sense, i.e., without significance. Mathematics fulfills this requirement by means of the construction of the figure, which is an appearance present to the senses (even though brought about a priori)" (*CPR* 356). For more on the "sensible" quality of mathematical thinking for Kant, see Shabel, Lisa. "Kant's Philosophy of Mathematics." In *The Cambridge Companion to Kant and Modern Philosophy*. Edited by Paul Guyer. Cambridge ; New York: Cambridge University Press, 2006.

with non-mathematical forms of contemplative activity, such as philosophical questions about God, is they involve thinking about intelligible ideas that have no sensible dimension (no "field of sensibility"). The sensible quality of mathematical objects is important because it activates the intuition, which allows us to judge whether an idea is true or false. Thinking about questions detached from a sensible dimension, philosophers "slip into... an insecure territory… where they are allowed the ground neither to stand nor to swim, mak[ing] perfunctory steps of which time does not preserve the least trace," Kant writes, "*while on the contrary* their progress in mathematics is a high road on which even their most remote descendants can still stride with confidence."[56] As a separate realm from the real world that is a realm of ideas rather than of things, where ideas also have a sensible dimension and are felt and experienced by the thinker, mathematics constitutes a special place in which individuals can always be sure that what they are thinking is true.

In summary, for Kant, our mathematical knowledge comes from a realm prior to our experience of the real, physical world. And yet mathematical ideas are also sensible to the thinker, so that this realm of thought is also a realm of experience. The constructed, intelligible, and yet sensible qualities of mathematical ideas are important to Kant's argument because it is through these qualities that he explains the certainty of mathematical knowledge (why we feel so certain our mathematical judgments are true). This certainty undergirds the persuasive force of his argument that mathematical ideas are

---

[56] Philosophers "slip unnoticed from the field of sensibility to the insecure territory of pure and even transcendental concepts, where *they are allowed the ground neither to stand nor swim* (instabilis tellus, innabilis unda), and can make only perfunctory steps of which time does not preserve the least trace, while *on the contrary their progress in mathematics* is a high road on which even their most remote descendants can still stride with confidence" (CPR A726, p. 636).

a priori truth, and therefore evidence the existence of *a priori* truths, and by extension the existence of universal knowledge.

For Descartes, because God is not an evil deceiver, the things that we recognize to be true in the world actually exist in the world, not only as it is to us but also as it is without us.[57] In other words, the certain and evident quality of truth that we learn to recognize in mathematical thinking can ground knowledge of the objective world. Kant, who does not depend on God in his argument, cannot use the realm of mathematical thinking to make a strong claim about our ability to know the world. The things we are certain of are not necessarily true. Instead, Kant uses the certain quality of mathematical truth to develop an idea of the universal human. These *a priori* ideas that cannot be false and that could not have come from experience lends support to the existence of a universal subject, which he calls the transcendental subject—understood as a set of abilities and concepts that constitute the human mind which perceives the world.[58] In other words, for Kant, our minds shape our knowledge of the world, putting into jeopardy the possibility of *objective* knowledge. But there can still be universal knowledge, in the sense of knowledge that is common to all humans.

---

[57] For Descartes, "all that can be formulated in mathematical terms can be meaningfully conceived as the properties of the object in-itself… *the thing not only as it is with me, but also as it is without me*," writes Quentin Meillassoux (my emphasis). Meillassoux, a speculative realist, uses Descartes' work to advance his theory that mathematics gives access to a world and past where humanity and life are absent—a world prior to human access. I am not interested in making the case for the existence of an objective world, but rather in the way that mathematical contemplation is repeatedly conscripted—by Meillassoux, by Badiou, who wrote the introduction to Meillassoux's book, by Descartes, and by Kant—into the task of constructing a notion of the objective world that is knowable by an idea of the human. Meillassoux, Quentin. *After Finitude: An Essay on the Necessity of Contingency.* Translated by Ray Brassier. London: Bloomsbury Academic, 2017.

[58] As Baidou puts it, "Kant upholds the necessity of the laws of nature, whose mathematical form and conformity to empirical observation we have known since Newton, concluding that since this necessity cannot have arisen from our sensible receptivity, it must have another source, that of the constituting activity of the universal subject, which Kant calls 'the transcendental subject.'" From the Introduction to Meillassoux's *After Finitude.*

This section of the introduction began with the question of what it means to say that mathematics grounded an idea of reason and the universal subject in the Enlightenment. As I have shown, mathematics lent support to an idea of reason and of the universal subject by opening up a space that is radically different from the real world. Both Kant and Descartes begin by characterizing how mathematical objects are ontologically different from objects in the real world: they are intelligible rather than sensible. In this difference inheres the possibility of certain knowledge. But then they flesh out how mathematics is similar to the real world in its activation of sense experience: for Descartes this allows the certainty of mathematical thinking to be extended to our judgment in the real world, and for Kant, this explains why we can be so certain of the truth of mathematical statements, where in our certainty inheres evidence of the existence of *a priori*, universal knowledge and also the universal subject who is the transcendental subject.

For both Kant and Descartes, mathematics is the act of dwelling in a realm where nothing from the real world is present; it is a prolonged interaction with objects in this realm. In this realm, with its limited objects, it is possible to say with certainty what is true and what is false, and to be right in our judgment. These are not merely intellectual judgments, for the thinker senses and feels out what is true (taste, sensibility), and yet they do so without prejudice or bias. In other words, mathematics scaffolded the imagination of a realm in which people could dwell and follow their intuitions, and yet where the only parts of them that were called were those parts that would produce objective or universal knowledge. In the realm of mathematical thinking, people are interpellated not as they are in the real world, as specific individuals forged from social, cultural, and historical backgrounds, but rather as the universal human. In the Enlightenment, mathematics grounded the idea of the universal human by constituting the imagination of a space for it to emerge.

Mathematics as Speculative Fiction

In Descartes' and Kant's writings about mathematics, they create *a literary fiction of mathematics*. I call their writing a *literary fiction* to draw attention to the way that both at times employ a narrative that is focalized through the mathematical thinker. In this narrative, mathematical thinking is portrayed as an activity in a contemplative space that is not located in place and time, culture or history, with transformative effects for the thinker. Both Descartes and Kant write about mathematics from the point of view of the phenomenological experience of mathematical thinking. That is to say, they focus on the thinker's subjective experience of mathematical ideas and concepts. I call their writing a *fiction of mathematics* because in their focus the phenomenological experience of mathematics and in their attempt to make this experience answer to their desire to establish the possibility of knowledge, they produce an understanding of mathematics that exceeds the concerns of mathematics as it is later formulated.[59]

---

[59] I say "later formulated" because mathematics is usually understood to have emerged as a distinct field from philosophy (and philosophy from science) at a later date. Note however that Descartes was well aware that he was shaping a mathematics that would answer to his desire for something on which to ground the idea of reason. Descartes was opposed well-known mathematicians of his day, such as Pierre de Fermat because Fermat's presentation of solutions without any explanation for how he arrived at them gave mathematics a mysterious, marvelous, and revelatory air that directly contradicted the idea of mathematics that Descartes was trying to put forth: mathematics as a step-by-step method of thinking, which he had glimpsed in classical texts. (Descartes understood that "Fermat's mathematics was… inferior as mathematics because it failed as a more general cultivating activity," Jones writes (50-51).) In *Geometry,* Descartes labors to describe mathematics in the way that is most conducive to training individuals to reason, advising against all practices of mathematics that take one away from "the habit of using our reason" (CSM 18).

In their writing about mathematics, the mere space of mathematics that Rotman describes to be secured by the language of mathematical proof transforms in two ways. Rotman describes a virtual space of mathematical thinking secured by the language of mathematical practice and present to a community of mathematicians as a space eerily different from all other inhabited places in that it is not situated in a place, time, or history. He describes the subject as someone who is asked to engage in an extended fashion with objects that have no such reference: thinking about these objects, coming up with possible claims about them, testing these claims on her judgment, and acting on them. And he theorizes that because for the duration of mathematical thinking, only this language is available to her, she cannot constitute herself as a subject with the dimensions of place, time, and history, and can only constitute herself without reference to these dimensions. In Descartes' and Kant's writings about mathematics, two things happen to the virtual space of mathematical thinking elucidated by Rotman. The first thing that happens is that this space becomes inflected with desire, and is made to speak to questions about the possibility of knowledge and who can access this knowledge. The subject who is missing the dimensions of place, time, and history becomes configured as the subject who *transcends* place, time, and history—that is, the universal subject. The second thing that happens is that Descartes and Kant transform the audience for whom this virtual space exists, making it available to an audience beyond mathematicians. Through their literary fictions of mathematics, which narrate the activity of mathematical thinking from the phenomenological experience of the thinker, they make available the experience of mathematical thinking—with all the strangenesses of the space that Rotman characterizes—to a much wider audience, while at the same time articulating this space as this constituting space of the universal subject. We can understand their phenomenological account of mathematics as a *translation* of mathematics from the signs and symbols in which it is usually expressed into ordinary language. As all acts of translation, this act is both additive and subtractive—in this case, what is added is meaning, as the space becomes the birthplace of the modern subject, and what is lost are the possibilities of the space before it is fixed onto meaningful ground.

Furthermore, Descartes' and Kant's writings about mathematics can be understood as *speculative fictions of mathematics*. Here, I draw on the idea of speculation as a form of imagining beyond present reality, and an understanding of speculative fiction as an anti-mimetic genre, one that purposefully presents a world unlike the real world,[60] to highlight the way that mathematics in the Enlightenment performed the function of opening up a realm beyond the real world. I define *the speculative fiction of mathematics* a way of writing that describes the experience of mathematical activity as the experience of another realm within the real world, where mathematical activity opens up such a realm. The difference between this realm and the real world is a theme of the writing—often this difference is that something that is desired is possible in this realm that is not possible in the real world. By the end of the writing, this possibility has been integrated into the textual real world. As I have shown, both Descartes and Kant use

[60] By speculative fiction, I mean fiction that opens up (scaffolds the imagination of) an alternative space to the real world, where different things are possible. I draw this notion of speculative fiction from the way it is used as a catchall term to describe genres of science fiction, fantasy, utopian and dystopian fiction, and the supernatural. Common to all these genres is the presentation of a world that is unlike the reader's sense of reality—that is, of a "changed, distorted, or alternated reality" (*Handbook of African American Literature*). While mimetic and realist texts strive to capture reality as it is experienced, and with such verisimilitude that readers can share in the experience, speculative fiction draws its creative sap from the non-mimetic impulse, purposefully including elements that are unlike the reader's world to demarcate a space that is clearly different from the real world. In Darko Suvin's theorization of science fiction, for example, it is this clear demarcation of the textual world from the real world of the reader that enables the effect of defamiliarization and recognition that for him defines science fiction. (See Suvin, Darko. "On the Poetics of the Science Fiction Genre." *College English College English* 34, no. 3 (1972): 372-382).

mathematics to initiate the imagination of an alternative realm to the real world where different things are possible. For both Descartes and Kant, mathematics refers to an activity of thinking that takes place in a realm beyond the real world in which all of the objects are made up and yet also sensible. When mathematics appears in their work, it opens up the imagination of a realm in which—in relation to its limited objects—certain knowledge becomes possible. And both use this newly opened realm as the ground for their arguments for the possibility of knowledge (that universal knowledge is possible), and for the universal human who is the knower of this knowledge.

Another reason I call mathematics in the Enlightenment a speculative fiction is to make it clear that mathematics, which appears in fantastical, dreamlike, and speculative ways in the novels that I read, is not made this way by fanciful thinking on the part of the author, or by their lack of understanding of mathematics. Calling Enlightenment mathematics a speculative fiction more accurately registers the parity between these Enlightenment philosophies and the novels that I am reading. There is an abiding understanding of Western mathematics and science as unique or exceptional in being a system of thinking about abstract ideas that are detached from the real world, a system of thinking that is formulated independently of social and cultural concerns. And yet, as my readings show, mathematics in the Enlightenment is deeply engaged in a social and cultural world. Enlightenment philosophers think with mathematics to produce notions of what it means to be modern and to be human, by creating a realm from which the universal subject can emerge. In this light, the detachment of this realm from the real world, as an ontologically different space, is a necessary fiction that allows it to perform its function of constituting the universal subject.[61]

The activity of mathematical thinking in Descartes and Kant shares many qualities with the activity of dreaming. They understand mathematics to be, like dreaming, a mental activity. And like dreaming, mathematical thinking makes up the objects it thinks about. As is often the case with dreams, mathematical thinking takes place in a realm that is not the real world. Like dreams, which take place in the mind, and yet the dreamer feels herself also to be inside the dream, in mathematical thinking the dreamer feels herself to be within the contemplative realm of mathematical thought, sensing and experiencing the objects in that realm. As in some dreams, in the realm of mathematical contemplation more things feel possible than in real life. In dreams, individuals may find that they have transformed; likewise mathematical thinking transforms the dreamer, in this case turning them into the universal human. Dreaming aptly captures how Descartes and Kant understand individuals to interface with this alternative realm to the real world that is opened up by mathematical contemplation.

How dreams become real: the making of British rulers of empire

This dreamworld of mathematics, as an alternative realm to the real world where one could transform into the universal human, appeared in 19th-century Britain as a way of justifying imperial rule, in particular as the mechanism by which it was understood that individuals could transform into rightful rulers of empire. 19th-century British liberal

[61] I draw the term "necessary fiction" from Mary Poovey, who uses the term to describe ideas that come into being in the service of a larger systematic coherence, for example "money" in book-keeping; the apolitical nature of laboratory work that allows a demonstration found credible by the Royal Academy to hold "for the world at large"; and the "(necessary) fiction" of God in theories of inductive knowledge (11, 13, 15). In this case, "necessary fiction" describes ideas within an argument that receive less evidentiary elaboration and yet are necessary to the persuasive force of the argument.

thinkers understood higher education primarily as a way of building character, rather than as skill-based training or as knowledge acquisition. They designed the higher education system so that it would perform this building of character.[62] Classics and mathematics were taught as essential training at Oxford and Cambridge, and up to midcentury were the only courses of study available; at Cambridge until 1854, even students reading classics had to take mathematics until their final year.[63] The heavy load of mathematics in the university curriculum reflected the importance that British educators assigned to mathematics in the building of the liberal subject. In debates about the mathematical curriculum at midcentury, William Whewell emphasized the importance of mathematics as a way of training individuals to reason, and of producing the rational, liberal subject; in a heated debate among many proponents of mathematics, this was the only point that was not in contention.[64] Mathematics, he wrote, "is the best instrument for educating men in reasoning" and should be used "primarily [as] a vehicle for teaching men to reason." As Claire Jones writes, "To mid-19th century and beyond, the middle and upper classes sent their sons to study mathematics at Cambridge not to turn them into mathematicians, but in order to train them as gentlemen. Mathematics, as an essential component of a 'liberal education', was believed to train the character and the intellect,

---

[62] Richards, Joan. *The Pursuit of Geometry in Victorian England*. 2011, p 21, 26.

[63] Jenkins, Alice. "George Eliot, Geometry, and Gender." In *Literature and Science.* Edited by Sharon Ruston. Woodbridge, Suffolk, UK; Rochester, NY: D.S.Brewer, 2008.

[64] Whewell, William. "Thoughts on the Study of Math As Part of a Liberal Education." In *On the Principles of English University Education.* J. W. Parker, 1838, p. 139. "The object of a liberal education is to develop the whole mental system of man... This complete mental culture must, no doubt, consist of many elements; but it is certain that an indispensable portion of it is such a discipline of the reasoning power as will enable persons to proceed with certainty and facility from fundamental principles to their consequences…it is a proper object of education to develop and cultivate the reasoning faculty.... what is the best instrument for educating men in reasoning?... In [mathematics], the student is rendered familiar with the most perfect examples of strict inference; compelled habitually to fix his attention on those conditions on which the cogency of the demonstration depends; and in the mistaken and imperfect attempts at demonstration made by himself or others, he is presented with examples of the most natural fallacies, which he sees exposed and corrected."

producing the fair judgment and unclouded mind necessary for men who were to assume their rightful, elevated place in society and Empire."[65] Here we see not only Descartes's belief that mathematics trains persons to reason, but also the idea that having undergone such training makes one a rightful ruler of empire. For mathematics, by training individuals to think in such a way that they could be free of prejudices and biases, to think in a way that could not be false, could train them to make decisions *for* people and places far away. As in Descartes, the realm of mathematical contemplation is understood as an alternate realm to the real world in which the self can transform in ways that become useful in the real world: Cambridge mathematics, Jones writes, was integral to the production of rightful rulers of empire.

---

[65] Jones, Claire. *Femininity, Mathematics and Science, 1880-1914.* Springer, 2009, p. 8.

Part 2: Dreamworlds Reconfigured

CHAPTER 2: DREAMING IN THE METROPOLITAN DRAWING ROOM: VIRGINIA WOOLF'S *NIGHT AND DAY* (1919)

This chapter makes the argument that Virginia Woolf reconstitutes mathematics in her second novel *Night and Day* as a generative and creative site from which she experiments with freer forms of subjectivity and setting from within the realist novel. The novel has long been seen by its contemporary readers, critics, and scholars of Woolf as a creative failure of a novelist who would go on to write *To the Lighthouse.* It is an "oddly traditional novel by a writer about to revolutionize the form of the English novel," Mark Hussey writes. *Night and Day* is traditional in its language, form and content.[66] For some scholars, Katharine's mathematics—interpreted as symbols without meaning—registers most acutely the novel's failure to articulate a vision.[67]

[66] Critics of *Night and Day* have noted this. Perhaps most memorable is Katharine Mansfield's critique that *Night and Day,* set in the late-Edwardian period, was a "lie in the soul," written as if the First World War had not taken place. Gilbert and Gubar note that the fantastic new languages of her later work may be spoken here, but simply not as evidently. Of its form, Rachel Duplessis observes that *Night and Day* falls prey to the usual limitations of the romance plot in the representation of female subjectivity.

Recent scholarship on the novel, however, has shown that the novel is subversive in its content, if not in its form. Kathy Phillips writes in *Virginia Woolf Against Empire* that Ralph's socially fostered traits of domination are precisely those qualities that drive the imperial urge. Alex Zwerdling notes that like *The Years*, *Night and Day* details the collapse of the family, and the love of power inherent in courtship. Although Woolf's later novels are more formally experimental than *Night and Day,* Victoria Rosner observes that there is a certain social optimism in *Night and Day*, which she locates in the belief in "the impact that life in the city can have on women's public and private lives," and which I find in the idea that Katharine can so radically rework existing forms of sociality and desire through acts of dreaming.

[67] Scholars have understood Katharine's love of mathematics through the idea that mathematical symbols have no meaning in the real/human world, so that in the novel they indicate a lack or absence of content. For Ann-Marie Priest, mathematics stands in for the new forms of being that Katharine seeks out but that are ultimately not articulated in the novel. For Jocelyn Rodal, mathematical symbols train readers to read as formalists, refocusing readerly attention onto form rather than content. I hope to show in this chapter that a thicker understanding of how mathematical language operates outside of academic fields of mathematics will help us to see that the seeming meaninglessness of mathematical language is what gives it cultural significance. See Priest, Ann-Marie. "Between Being and Nothingness: The "'Astonishing Precipice'" of Virginia Woolf's Night and Day." *Journal of Modern Literature* 26, no. 2 (2003). Rodal, Jocelyn. "Patterned Ambiguities: Virginia Woolf, Mathematical Variables, and Form." *Configurations* 26, no. 1 (2018): 73-102.

I contend, however, that Katharine's mathematics is not evidence of the failure to articulate but rather the origin of another form of articulating. Through her portrayal of Katharine as a mathematician, Woolf begins to work out some of the experimental qualities that we find in her later work. In addition, in *Night and Day*, Woolf uncovers and gives representation to a dream-like notion of mathematics within the late-imperial period. In the novel, mathematics is akin to literature—it is a form of dreaming that produces for the dreamer an imaginative realm in the same way that adventure and romance narratives produce an imaginative realm of heroes, horses, and shorelines, only with abstract objects that do not refer the reader back to the real world. Although this notion of mathematics as dreaming cannot be located in contemporary developments in the fields of pure mathematics, aspects of it can be found in writing about pure mathematics for a general audience, and in texts about philosophy and education. Unlike texts from within academic fields of mathematics, writings for a general audience are tasked with explaining mathematics to those who do not already find it meaningful, of setting this "inhuman" subject within discourses that are meaningful to humans.[68] That is, they are tasked with creating what I call a *living notion of mathematics*.[69] I use *living notions of mathematics* to refer to the meanings, implications, and significance that mathematics can acquire within a culture, which may be political, philosophical, social, religious, magical, or affective. These meanings often stem from the non-referential

[68] The British mathematician G.H. Hardy notes that in the process of writing *A Mathematician's Apology* (1940), a popular text about mathematics, he was forced to consider questions that he had not needed to consider in his mathematical work, namely: "Why is it really worth while to make a serious study of mathematics? What is the proper justification of a mathematician's life? Is mathematics, what I and other mathematicians mean by mathematics, worth doing; and if so, why?" That is to say, he had to make the activity of mathematical thinking meaningful to those who did not already find it meaningful.

[69] I use the term "*living*" because the criticism of Katharine as a mathematician that I am thinking with often starts with the idea that mathematics is cold, impersonal, and inhuman, that it has no human meaning. (Priest, Rodal)

qualities of mathematical language. In *Night and Day,* Woolf draws on a cultural notion of mathematics and reconstitutes it, turning it into a realm of imagining that could potentially enable Katharine to experience forms of being beyond empire.

I begin in "I. Imperial Spaces" with Katharine's feeling of limitation. Woolf traces Katharine's limitations to familial and social expectations but also to Katharine's own daydreaming. In her daydreams of adventure, Katharine finds herself not as the adventurer but as the woman who awaits his return. Through Katharine's daydreams of adventure, Woolf connects Katharine's domestic discomfort to the patriarchal narratives of the British empire. In this context, Woolf's portrayal of Katharine as a mathematician, and her mathematics as another kind of dreaming that is the "opposite" of literatures of romance, take on a new significance. In portraying Katharine this way, Woolf suggests that mathematics could be a way of dreaming in which Katharine would not find herself as British woman within empire, as she does in her adventure daydreams. Where does this notion of mathematics as dreaming come from?

The second section, "II. Mathematics in Early 20th-Century England," seeks to recover the contexts for Katharine's idea of mathematics as dreaming. It draws on granular cultural and institutional histories of mathematics to present an account of mathematics in the period. In particular, I locate Woolf's notion of mathematics as dreaming within Bertrand Russell's *general audience* writings about mathematics.

The third section, "III. Mathematics Remade in *Night and Day*," explores how Woolf reconstitutes cultural notions of mathematics in her representation of them in *Night and Day*, through close readings of moments when Katharine's mathematics is described. I contend that Woolf rewrites mathematical dreamworlds into an anti-imperial imagination—into a realm in which Katharine experiences momentary freedom from the desires that are a part of how she is constituted as a female subject in the metropole.

In the last section, "IV. Situating Night and Day in Woolf's Corpus," I return to a discussion of Woolf and the modernist novel to show how a deeper understanding of mathematics in the novel could help us to think about the place of *Night and Day* within Woolf's corpus. I suggest that in her representation of Katharine's mathematical thinking—an activity of imagining that takes place at a remove from one's actual, physical surroundings—Woolf explores from within the confines of the realist novel a kind of looseness with setting and time in her representation of subjectivity. In particular, the qualities of a more free-floating subjectivity, settinglessness, and timelessness that I locate in Woolf's description of Katharine's mathematics all appear, on the level of form, in her next novel, *To the Lighthouse.*

In *Night and Day*, Susan Raitt writes, "identities are so carefully moulded and pressed by familial and other relationships."[70] Katharine feels "hemmed in" and "cut out" by the expectations of her family and also by their illustrious past, represented in the portraits and relics that populate the family home. Thus, throughout the novel, Katharine repeatedly spaces out to imagine other "worlds" in which she could feel free, and where she could become "another person."[71]

---

[70] Woolf, Virginia. *Night and Day.* Edited by Frank Kermode and Suzanne Raitt. Oxford: Oxford University Press, 2009, p. xvii. All cites from *Night and Day* are from this edition.

[71] "She… fell into a dream state, in which she became another person, and the whole world seemed changed."

"…cast her mind out to imagine an empty land where all this petty intercourse of men and women, this life made up of the dense crossings and entanglements of men and women, had no existence whatever…"

When Katharine spaces out, she indulges in two kinds of daydreaming: one is described as fantasies of ships and horses, and the other is described as mathematical:

> Sitting with faded papers before her [these from her mother's biography-writing], she took part in a series of scenes such as the taming of wild ponies upon the American prairies, or the conduct of a vast ship in a hurricane round a black promontory of rock, or in others more peaceful, but marked by her complete emancipation from her present surroundings and, needless to say, by her surpassing ability in her new vocation… Upstairs, alone in her room, she rose early in the morning or sat up late at night to work at… mathematics.

The first kind of dreaming, with its scenes of "the taming of wild ponies upon the American prairies," "a vast ship in a hurricane," can be described as dreams of adventure, of going out into new lands. Katharine slips into this dreamworld of adventure, with its ponies, prairies, and ships, when the activities that she is expected to do in the real world fail to capture her energies, such as when she is helping her mother with her grandfather's biography. This is one "scene" of imagining that she partakes in; her mathematics, the passage suggests, is another scene. In this description of both Katharine's fantasies of adventure and her mathematics as scenes for a daydreamer to take part in, Woolf frames mathematical work in the novel as a form of dreaming. She suggests, moreover, with the word "scene"—"the place where an incident occurs or occurred"[72]—that mathematical contemplation, like fantasies of imperial adventure, produces a kind of dreamworld (a place where events "take place"). At the same time, Woolf invests mathematical dreaming with a certain seriousness that is not afforded these fantasies of adventure by describing it as Katharine's vocation: her calling.

Katharine accesses this dreamworld through the reading and writing of mathematical symbols. Her mathematics is pure mathematics, which, unlike the fields of

---

"But… possibly the people who dream thus are those who do the most prosaic things."

[72] *Oxford English Dictionary*.

applied mathematics and the sciences, is not concerned with the real, physical world. In her mathematical work, she detaches from the real world, entering into a kind of "trance." She associates mathematics with openness and freedom, with liberation and emancipation. In her mathematical dreaming, Katharine feels free from her physical surroundings and outside of historical time. Unlike the pages from her grandfather's biography, or his portraits and family relics in the drawing room, her mathematical thinking does not interpellate her in any particular way in her mathematical thinking, as the granddaughter of a great British poet. And unlike the fantasies of adventure, her mathematical dreaming does not situate her within a British imperial cultural imaginary, or within a particular gender.

I. Imperial Spaces

What are the spaces from which Katharine seeks escape? This section articulates Katharine's desire to escape, which impels her into mathematical thinking, as the desire to escape from her gendered position within the metropole of the British empire.[73] Katharine's discontent accumulates as she repeatedly encounters barriers to her desires. These barriers appear in the form of familial obligations that she keep house and work on

[73] On Woolf's thinking about empire between the years 1915-1919, see Barrett, Michèle. "Virginia Woolf's Research for '*Empire and Commerce in Africa* (Leonard Woolf, 1920).'" *Woolf Studies Annual* 19 (2013): 83-122, p. 110; and Snaith, Anna. "Leonard and Virginia Woolf: Writing against Empire." *The Journal of Commonwealth Literature* 50, no. 1 (March 2015): 19-32. Barrett and Snaith's work make it clear that Woolf understood London not only as a city but as a metropole in the center of empire. Woolf was particularly aware of this fact as she wrote *Night and Day,* because she was at the time carrying out extensive research for Leonard Woolf's *Empire and Commerce in Africa* (1920), which would become a critique of economic imperialism (Barrett). Anna Snaith notes that the influence of this research on Woolf's work can be seen as early as in *The Voyage Out* (1915), in the character of Mrs. Flushing, whose husband buys shawls and cloaks cheap in South America and sells them at an enormous profit in London. In *Night and Day,* Woolf's awareness of London not merely as a city but as the metropole of empire can be seen in its opening pages, in the mention of Manchester and the cotton industry; in Katharine's conceptualization of herself through her family tree (she has a literary grandfather, and uncles and aunts "from India"), and in Mary's imagination of London as a center of activity that extends to the plains of Canada and to India.

her grandfather's biography with her mother, and also in the social assumption that she will marry.[74] But also they come from her own daydreaming. Described in the novel as fantasies of "adventure," Katharine's daydreams take the form of imperial adventure stories, which encourage imaginative escape from domestic life. In these fantasies, however, she finds herself not as the adventurer who escapes, but rather once again limited to a female and domestic position. This section analyzes Katharine's daydreams of adventure to show that Woolf connects Katharine's domestic discontent to larger, ideological narratives of the British empire. Woolf suggests that a form of dreaming that could allow Katharine to be unlimited by gender expectations needs also to be a form of dreaming outside of the ideologies of the British empire.

In this section, I build on a substantial body of scholarship on Woolf as a critic of empire. Jane Marcus's 1992 essay on *The Waves,* which fantastically argued that Woolf depicts the "submerged mind of empire," ushered in re-readings of Woolf's feminist and pacifist texts as anti-imperial critique.[75] Yet Woolf's relation to empire is complex and at times complicit, as, for example, in the case of her views on race.[76] I understand Woolf as a critic of empire whose critique is shaped by her position within the metropole. In her novels, she traces what empire feels like to individuals in the metropole, how it is

[74] Although Katharine's parents do not insist that she marry, she feels the pressure to as a part of a broader set of social assumptions. When Rodney proposes to her, she thinks to herself that "she did not want to marry anyone" (252). But what "she herself felt," she reflects, was only "a frail beam when compared with the broad illumination shed by the eyes of all the people who are in agreement to see together" (328).

[75] Marcus, Jane. "Britannia Rules *The Waves." In Hearts of Darkness: White Women Write Race.* New Brunswick: Rutgers University Press, 2004. For a critique of Marcus's argument, see Patrick McGee, "The Politics of Modernist Form; or, Who Rules the Waves." 1991.

[76] For critiques of Woolf's anti-imperialism, see Seshagiri, Urmila. *Race and the Modernist Imagination.* Ithaca: Cornell University Press, 2010; Hayot, Eric. "Bertrand Russell's Chinese Eyes." *Modern Chinese Literature and Culture* 18, no. 1 (2006): 120-15 (Republished in *The Hypothetical Mandarin*).

interwoven into their experience of everyday life, how it gives meaning to ordinary events (the sound of an ambulance, a walk in the park), but also how it forces individual lives into certain shapes. In this way, she illuminates empire as a force in the shaping of selves in the metropole. Beyond illumination, in her style of depicting life in the metropole, scholars have argued that Woolf models forms of thinking and attention that interrupt the self-consolidation of the imperial subject.[77] In other words, Woolf is a critic of imperialism *for the metropolitan subject*—or as Seshagiri puts it, she focuses on "imperialism's damage to England rather than its effects on subject nations," and works on undoing this damage.

It is in these terms that I understand Woolf's *Night and Day* to be an anti-imperialist text: *Night and Day* explores the negative effects of empire on women within the metropole. In a 1920 letter to *The New Statesman,* Woolf makes a powerful critique of structures of domination through the negative effects of that structure on the dominant group: "The degradation of being a slave," she wrote, "is only equalled by the degradation of being a master." The letter was about gender relations, but women in the metropole are in one sense the dominated group, and in another sense the dominant group. The axiomatics of imperialism, as Spivak puts it, become complicated through gender.[78] In Woolf's representation of Katharine's subjectivity, gendered and imperial structures intersect to keep Katharine from the new forms of being and relating that she is after. In

---

[77] For accounts of Woolf's style as a way of disrupting subject-formation in the metropole, see Cuddy-Keane, Melba. "World Modelling: Paradigms of Global Consciousness in and Around Virginia Woolf." In *Virginia Woolf's Bloomsbury: International Influence and Politics.* Edited by Lisa Shahriari and Gina Potts. London: Palgrave, 2010; Walkowitz, Rebecca L. *Cosmopolitan Style: Modernism Beyond the Nation.* New York: Columbia University Press, 2006.

[78] Spivak, Gayatri Chakravorty. "Three Women's Texts and a Critique of Imperialism." *Critical Inquiry* (1985): 243-261, p. 241-2.

mathematical dreaming, Woolf attempts to fashion a new form of imagining that could interrupt imperial and patriarchal forms of subject-formation.

The imperial scenes of Katherine's daydreams

The "scenes" of Katharine's daydreams, taking place on colonial plains and on the way to faraway lands, are fantasies of colonization and exploration. In these daydreams, Ann-Marie Priest writes, "Katharine imagines for herself the adventures from which her social/sexual role excludes her."[79] Katharine's daydreams take on qualities of the genre of the 19th-century British adventure story, which features a young hero in an "unfamiliar and often exotic" setting, who faces "all kinds of complications and difficulties" including "shipwreck."[80] Imperial adventure fantasies encourage readers to take imaginative flight from domestic life and its obligations and to be someone—and somewhere—else.[81] Reading about the exploits of this hero can inspire young readers to want to act and to go on adventures of their own. So argues Martin Green in *Dreams of*

---

[79] Priest, Ann-Marie. "Between Being and Nothingness: The "Astonishing Precipice" of Virginia Woolf's Night and Day." *Journal of Modern Literature* 26, no. 2 (2003), 68.

[80] For more on the genre of the adventure story, see Butts, Dennis, "26. Shaping boyhood: British Empire builders and adventurers (Part II: Forms and genres)" from *International Companion Encyclopedia of Children's Literature*, edited by Peter Hunt. Abingdon: Routledge, 2004. Looking both at canonical texts and popular adventure stories for children, Butts writes of the connection between the adventure story and empire: "one of the strongest features of the genre was its belief in the rightfulness of British territorial possessions overseas;" adventure stories "describe the beginnings and extension of the British Empire."

A subgenre of the adventure story ("adventure [is] something that is sought after by intrepid characters"), "the imperial romance involves an outward journey into unknown, faraway lands and perils. Just as importantly, it enforces a vertiginous descent into the unconscious mind of the adventurer.… "This form of popular fiction… belongs to the late 19th and early 20th centuries (although important elements of the genre may be traced back to earlier examples of prose fiction)." Pierce, Peter, "Adventure Novel and Imperial Romance" from *Encyclopedia of the Novel,* edited by Paul Schellinger. London: Fitzroy Dearborn Publishers, 1998.

[81] Zweig, Paul. *The Adventurer.* London: Basic Books, 1974. "Adventure fiction is obsessed with escape and therefore harbors a corresponding fear of imprisonment. Typically this involves a flight from domestic life and its obligations and, in particular, from the social and sexual power of women… More generally, adventure fiction is escapist. It indulges the primal desire of readers, those happy, vicarious adventurers, to be someone---and somewhere---else. They are transported out of their familiar surroundings into the world of espionage, to a lost world deep in the South American jungles, or to new worlds beyond the solar system. Willingly they surrender to the pleasures and the *frissons* of an escape they know to be temporary" (Pierce).

Adventure: Deeds of Empire. "Adventure is the energizing myth of empire"—adventure stories "inspire action, both military and mercantile."[82] In Green's study, adventure stories are not merely fantasies of escape that help readers to pass the time but stories that inspired young readers in the Victorian period to participate in imperial activity. Katharine's relationship to adventure stories, however, is complicated by her gender: though she may be inspired to act in imperial ways, she cannot actually participate in the "military and mercantile activity" that Green describes. Women did not often appear in adventure stories, and when they did appear, it is at the end, as the person the hero returns to marry.[83] This raises some questions about Katharine's daydreaming: How, where, and as whom does Katharine find herself within these daydreams of adventure? Does she imagine herself as the adventurer? What kind of escape can she find in her daydreaming?

Katharine's daydreaming seems to offer her a kind of freedom at first—she can be whomever she wants in her imagination—but then quickly closes her into a particular role. In what follows, I show that this is the case through a close reading of a moment in the text where Katharine's daydreaming is described. In my reading, I will refer to Katharine within the daydream as the "dreamer," and trace how the daydreamer becomes constituted as a subject in the dreamworld as the dreamworld resolves into the setting of

[82] Green, Martin, *Dreams of Adventure, Deeds of Empire*, London: Routledge and Kegan Paul, 1980, p. xi. Green has also written *Seven Types of Adventure Tale: An Etiology of a Major Genre,* University Park: Pennsylvania University Press, 1991.

[83] "Usually… the hero returns home laden with great wealth to be warmly greeted by his family, and sometimes to marry.… Authors… guide[d] their young readers towards such virtues as loyalty, pluck and truthfulness, nearly always within the ideological framework of Victorian laissez-faire capitalism, a hierarchical view of society, and strict gender divisions. Girls occasionally play a minor role in adventures, and there were even some women writers of adventure stories… But the nineteenth-century genre was dominated by male values…." (Butts).

the adventure story.[84] In the following passage, William Rodney has just proposed to Katharine. She does not want to marry him, but feels unable to say no—"She felt certain that she would marry Rodney. How could one avoid it? How could one find fault with it?" She begins to daydream:

> She sighed and, putting the thought of marriage away, fell into a dream state, in which she became another person, and the whole world seemed changed. Being a frequent visitor to that world, she could find her way there unhesitatingly. If she had tried to analyze her impressions, she would have said that there dwelt the realities of the appearances which figure in our world; so direct, powerful, and unimpeded were her sensations there, compared with those called forth in actual life. There dwelt the things one might have felt, had there been cause; the perfect happiness of which here we taste the fragment; the beauty seen here in flying glimpses only.

Daydreaming, Katharine imagines herself in a different world where she could become "another person." In this dreamworld, she is no longer Katharine Hilbery. Who is she instead? How does she become constituted in this world? So far, we know only that the daydreamer feels very free in this world. It is familiar to her: "she could find her way there unhesitatingly." The dreamworld seems to give way to her desires: nothing there impedes her, and she could feel freely ("so direct, powerful, and unimpeded were her sensations there"). What are the qualities of this dreamworld? All descriptions of the

---

[84] Setting is the place where something takes place. By "the setting of adventure," I mean the elements that often appear when Katharine is described as lost in a fantasy of adventure, namely the elements of "the forest, the ocean beach, the leafy solitudes, the magnanimous hero" (282). Setting is related to genre: for the narratologist Mieke Bal, we can speak of the setting of a genre as *the typical backdrop for a story in that genre*. (By typical, I mean "showing qualities *popularly associated with and expected from* a person, thing, or situation"). In her thinking, the setting of the picaresque *is not the geographical location where stories in that genre are set* (for the picaresque can be set anywhere from Spain to the New World) but rather a set of objects that are commonly in the space where the story unfolds. For the adventure story, for example, there is often a hero on horseback. This space can produce a certain feeling, a certain mood. For Bal the picaresque produces sentimentality. For the genre of the adventure story, the feelings that are produced can range from feelings of pleasure/indulgence (Zweig), or a sense of purpose, the desire to rule (Green/Bristlow).

In this chapter, I use Mieke Bal's *Narratology* to elaborate the literary formal dimensions of my argument. See Bal, Mieke, and Christine van Boheemen. *Narratology: Introduction to the Theory of Narrative.* Toronto: University of Toronto Press, 2009, p. 166.)

dreamworld (the clauses beginning with "there dwelt") end up describing a place where the dreamer is unimpeded, a place that is unlimiting in every way that the real world had been limiting (the dreamer sees realities, not appearances; experiences "unimpeded" sensations; feels "perfect happiness"; experiences beauty more fully). Here, the dreamer could be anyone, and the dreamworld has no qualities except the qualities of giving way to the dreamer's desires.

As Katharine continues to daydream, the dreamworld begins to acquire a few qualities. The passage continues:

> No doubt much of the furniture of this world was drawn directly from the past, and even from the England of the Elizabethan age. However the embellishment of this imaginary world might change, two qualities were constant in it. It was a place where feelings were liberated from the constraint which the real world puts upon them; and the process of awakenment was always marked by resignation and a kind of stoical acceptance of facts. She met no acquaintance there, as Denham did, miraculously transfigured; she played no heroic part….

The dreamworld acquires a kind of setting: "furniture" and "embellishment." This furniture comes "from the past," from "the England of the Elizabethan age" This dreamworld is now situated in a place and a time: it is in England (for the dreamworld shares a past with England) and it is some time after the Elizabethan era. That this dreamworld has in its history, in the story of its becoming, the England of the Elizabethan age is significant. The Elizabethan era was an era of imperial expansion, economic and political stability, and literary renaissance. It is an era that inspired great national pride; this pride was felt both within the era (Britannia, the personification of Great Britain, comes from this period) and after it, as the era is depicted in British historiography as England's "golden age." In other words, this dreamworld becomes situated within a British imperial cultural imaginary. And where is the daydreamer in this dreamworld?

She is no longer completely unlimited—she begins to experience "resignation," begins to accept "facts," and is excluded from "the heroic part." Note that all that has happened to the dreamworld between the previous passage and this one is the acquisition of furniture. But once the furniture is in place, we pass from "liberat[ion]" to "resignation" in the course of a sentence.

The passage continues:

> [There] she played no heroic part. But there certainly she loved some magnanimous hero, and as they swept together among the leaf-hung trees of an unknown world, they shared the feelings which came fresh and fast as the waves on the shore.

These new things in the dreamworld—this setting in an unknown world, with lush trees, by the shore, and with a magnanimous hero—come from Katharine's fantasies of adventure, which are described as taking place in a space in which there are the elements of "the forest, the ocean beach, the leafy solitudes, the magnanimous hero"(282). In this dreamworld, the dreamer finds herself not as the hero, but as one of a couple, and the hero's lover. What does this dreamworld feel like to the dreamer? The dreamer's feelings are feelings for the hero; even so, they are not described as her own, but rather as feelings that are shared with him: "they shared the feelings that came fresh and fast like waves on the shore." It seems that these elements of the adventure story, and perhaps the magnanimous hero in particular, once they are placed into the dreamworld, disrupt the openness of the dreamworld, placing the dreamer into a gendered role. Even the waves and the shore, elements of this setting of adventure that would perhaps speak most to the adventurous spirit, are now incorporated and subsumed into the logic of romance, into the feelings "fresh and fast" between the lovers.[85] The adventure story breaks down when Katharine tries to use it as imaginative escape from her problems: none of the parts work correctly.

What began as adventure—an openness of possibility, a potential transformation of the self—turns into romance. We have moved from certainties ("she was certain she would marry William. How could she avoid it?") to openness (she could become "another person" in the dreamworld), back into certainties again ("there certainly she loved some magnanimous hero"). In her daydreaming, Katharine finds herself not as the hero ("she played no heroic part") but as the woman who loves the magnanimous hero. This fantasy, which she uses to escape the real world that she finds limiting, ends up bringing her back into this world: into the British Empire, into her gendered role within the adventure story as a myth of empire, and into a romantic relationship with a man. The parallel between her daydream and her situation in the real world is not lost on Katharine, who is brought out of her dreamworld and back into the real world in the next sentence, in which she—surprisingly—accepts William's proposal of marriage:

> The sands of her liberation were running fast; even through the forest branches came sounds of Rodney moving things on his dressing-table; [the dreamworld of adventure is penetrated by the gendered expectations and requests that issue from the real world] and Katharine woke herself from this excursion by shutting the cover of the book she was holding, and replacing it in the bookshelf.
>
> "William," she said, speaking rather faintly at first, like one sending a voice from sleep to reach the living. "William," she repeated firmly, "if you still want me to marry you, I will."

[85] Of the romance plot, scholars have written about the way that it muffles female development, substituting the development of a relationship for the development of the individual: "As a narrative pattern, the romance plot muffles the main female character, represses question, valorizes heterosexual ties as opposite to homosexual ones, incorporates individuals in couples as signs of personal and narrative success," writes Rachel Duplessis (1988). Duplesiss and others understand romance as a form of writing that needs to be broken down so that a literature can be developed in which women can be meaningfully captured.

Note that Katharine shuts a book to end her daydream: this daydream of adventure is related to the reading (or non-reading) of a book. In this novel Woolf associates literature with stories of adventure and romance.

While Katharine is described as partaking in imperial dreams of adventure—of traveling to uninhabited lands—these visions give way to visions of romance. Elsewhere in the novel, she sees in her dreams a "magnanimous hero, riding a great horse by the shore," she is waiting at the shore for him, and together "they galloped by the rim of the sea" (108). She appears in the adventure story as an accessory rather than as the protagonist, where her function is similar to the unknown landscape that is the setting of the adventure: both register in different ways the young hero's development—the former as the dangerous world that tests him, and the latter as part of the homecoming that is the reward for his heroism.[86]

Katharine indulges in dreams of adventure and romance when she feels particularly stuck in the real world. For a moment they allow her to escape through her imagination. But ultimately they bring her back to this real world. They do so by interpellating her as a particular figure within the dream—as the woman, who is passive and waiting, rather than as the active adventurer. These dreams constitute Katharine as a

---

[86] "Normally the hero survives, and the end of the story sees him rewarded with wealth and honour. This is sometimes more than the conventional 'happy ending', however, as if the author, having shown how the hero has proved himself through enduring various trials on his quest, and discovered his real worth, deserves symbolic proof of this. The young hero generally discovers the truth about his family, and so his real identity, in such stories as Kingston's *In the Eastern Seas* (1871) and Stevenson's *Kidnapped*. More usually, however, the hero returns home laden with great wealth to be warmly greeted by his family, and sometimes to marry" (Butts).

A similar dynamic is seen when Ralph, whom Katharine later marries, integrates her presence into his account of himself as a hero: "Yet distant as she was, her presence by his side transformed the world. He saw himself performing wonderful deeds of courage; saving the drowning, rescuing the forlorn. Impatient with this form of egotism, he could not shake off the conviction that somehow life was wonderful, romantic, a master worth serving so long as she stood there…." (Chapter 32)

British woman within Empire. In this way, Katharine's daydreams act in tandem with her family, friends, and suitors whose views and expectations she is trying to get away from.

Imperial fantasy shapes the dreamer not only while they dream but also in real life. Katharine, having escaped her engagement to William and seeking to remain single, finds within herself a feeling of desire for Ralph that is produced by the similarity between the environment in which she sees him and the setting of her fantasy world:

> [Ralph] stopped, moreover, and began inquiring of an old boatman as to the tides and the ships. In thus talking he seemed different, and even looked different, she thought, against the river, with the steeples and towers for background. His strangeness, his romance, his power to leave her side and take part in the affairs of men, the possibility that they should together hire a boat and cross the river, the speed and wildness of this enterprise filled her mind and inspired her with such rapture, half of love and half of adventure, that William and Cassandra were startled from their talk, and Cassandra exclaimed, "She looks as if she were offering up a sacrifice! Very beautiful," she added quickly, though she repressed, in deference to William, her own wonder that the sight of Ralph Denham talking to a boatman on the banks of the Thames could move any one to such an attitude of adoration…. (483)

For Katharine, seeing Ralph with his back against the water and talking about ships with another man transfigures him: "he… looked different"; he became "strang[e]" to her. She sees Ralph in the form of the adventurer, familiar with sailing and modes of navigating across water, and with the "affairs of men" which are closed off to her. This similarity between Ralph's pose by the water and the setting of her fantasy—the ocean shore, the magnanimous hero returning from his voyage—and the possibility that she might be able to participate in this venture in a diminished form (a sail across the river rather than a voyage by sea) produces within her feelings of "rapture," "love," and, as her cousin

Cassandra observes, a kind of "adoration"—all of which are new feelings for her.[87] The setting of the adventure, which is narrowed here from ocean to river, later becomes fully incorporated into the setting of romance. At the end of the novel, through her mother's story of a romantic sail with Katharine's father, sailing becomes fully subsumed within the logic of romance, where it symbolizes faith in love against all of the unknowns of life ("who knows anything, except that love is our faith," 506).

The problem with Katharine's daydreaming, then—what keeps it from being an escape from the real world—has to do with the way that objects in the dreamworld of adventure are related to objects in real life. The dreamworld, which at first felt so free, the world in which everything is possible, becomes narrowed as soon as the furniture arrives. Elizabethan furniture, which places the dreamworld into a British imperial cultural imaginary, also effects Katharine's exclusion from the heroic role. In these moments, objects in stories that look like objects in real life can act as a conveyer belt for the baggage of real life to be transferred into the world of the story. The furniture arrives with a sense of time and a place (in the British Empire, and after the Elizabethan period) and with ways of thinking about gender and heroism in this time and place, which now impose themselves on the dreamer. Later, when the elements of an unknown world, lush trees, shoreline, and the magnanimous hero appear into the picture, they do not appear merely as objects but rather appear with their relationship to the dreamer already figured out: they triangulate her as the woman in a romantic relationship with the hero of the story, who plays a bit part. The setting of adventure does not allow Katharine to escape

[87] Of the relationship between fantasy and setting, film critic Elizabeth Cowie writes in her 1984 essay "Fantasia" that "Fantasy involves, is characterized by, not the achievement of desired objects, but the arranging of, a setting out of, desire; a veritable *mise en scène* of desire… the fantasy depends not on particular objects, but on their setting out; and the pleasure of fantasy lies in the setting out, not the having of the objects. It is clear then, that fantasy is not the object of desire but its setting."

from her problem in the real world, the problem of how to avoid marriage, because the objects in the setting put her into the place of the woman who will marry and is very happy to. They do not help her to imagine another way of feeling and being outside of the gendered roles that issue forth from her social world, but rather place her into the feelings and being of someone who would be happy in them.

From these moments in the text, we may draw the following conclusions: Objects in stories interpellate characters. In the genre of the adventure story, objects interpellate characters into gendered positions within empire. Objects in real life that look like objects in the adventure story can interpellate real people into these positions. Katharine sees Ralph by the water talking about ships and sailing with another man and, seeing this through the setting of adventure, with the shore, ships, and the magnanimous hero, she feels for the first time that she could love this man for whom her feelings until now could be best—and most generously—described as ambivalent. The woman's feelings in the adventure fantasy—"fresh and fast like waves on the shore"—become her own. A certain likeness between objects in Katharine's dreamworld (shore, ships, and the magnanimous hero) and objects in the real world (the river, boats, and Ralph) is what keeps Katharine's daydreaming from being an escape from life. Likeness—between objects in the world of the story and objects in the real world—acts as a conduit between these two worlds, allowing the real world to invade the story and the story to invade and act on the real world. I will describe this likeness that objects in Katharine's dreamworld, which is the imaginative realm of adventure, take to objects in her real life as their "referential quality." Could mathematical dreaming, which does not refer to the real world, and in which there are no horses, shorelines, or heroes, serve as a more effective means of escape?

Reading these spaces through postcolonial theories of literature and worlding

These daydreams of adventure and romance are part of what Gayatri Chakravorty Spivak calls the worlding of empire: literature that represents the British Empire to the British as a meaningful project. Spivak writes:

> It should not be possible to read nineteenth-century British literature without remembering that imperialism, understood as England's social mission, was a crucial part of the cultural representation of England to the English. The role of literature in the production of cultural representation should not be ignored. These two obvious "facts" continue to be disregarded in the reading of nineteenth-century British literature. This itself attests to the continuing success of the imperialist project, displaced and dispersed into more modern forms. If these "facts" were remembered, not only in the study of British literature but in the study of the literatures of the European colonizing cultures of the great age of imperialism, we would produce a narrative, in literary history, of the "worlding" of what is now called "the Third World."[88]

In this quote, Spivak highlights the role of literature in empire. Literature plays a role in the "production of [a] cultural representation" of empire for the English, that is, a way for the English to understand empire as a meaningful rather than merely material enterprise: as "England's social mission." In other words, literature participates in imperial "worlding"—in the representation of the metropole and the colonies as parts of a whole that is experienced as meaningful by the English through this idea of the social mission. In this worlding, the colonies and people in it are constructed for the English as the space in which this mission can take place. For this reason, Spivak writes that we can find,

[88] Spivak, Gayatri Chakravorty. "Three Women's Texts and a Critique of Imperialism." *Critical Inquiry* (1985): 243-261.

within British imperial literature the "worlding of what is now called 'the Third World.'" Spivak quotes from St. John Rivers' account of his life in Jane Eyre:

> My vocation? My great work?... My hopes of being numbered in the band who have merged all ambitions in the glorious one of bettering their race—of carrying knowledge into the realms of ignorance—of substituting peace for war—freedom for bondage—religion for superstition—the hope of heaven for the fear of hell....

For St. John Rivers, this account of the social mission gives meaning and purpose to his life—to the everyday activities of life—by placing him into this larger project in which he is playing a meaningful role. The colonies and the people within them take shape as the ground that is necessary for his life's work to be figured as meaningful. Therefore, the same narrative that allows St. John to understand his life as meaningful has a dehumanizing and subtractive effect on colonial subjects. We see also that there is no clear place for women in the metropole within this meaningful narrative of social mission, and by extension the adventure stories that incorporate the social mission at their core.[89]

Spivak makes three points about literature, imperial worlding, and gender in this essay: 1) that literature worlds empire by presenting a representation of it to the English that allows the English to inhabit a meaningful world (to understand their activity in the world as meaningful), 2) that this representation is an unworlding for colonial subjects if they adopt it as their view of the world, and 3) that this worlding is not as effective for (in Spivak's words, "inaccessible to") English women.[90] These points help us to make sense

---

[89] Though we may not think of adventure stories as particularly moralistic, Joseph Bristow suggests that they in fact are, and that adventure stories often *incorporate the narrative of social mission at their core*. Reading Victorian juvenile literature, he finds that stories of adventure figure young boys as heroes setting out to "civilize a savage world." See Bristow, Joseph. *Empire Boys: Adventures in a Man's World,* London: HarperCollins, 1991. More generally, adventure stories function similarly to the narrative of the social mission in the way that it inspires imperial activity, and in its description of unknown regions through the experience of the imperialist, where these regions become the ground for the unfolding of the imperial subject.

[90] For as Spivak argues in "Three Women's Texts," it is Jane's inability to access this myth of imperialism as a social mission as a way of understanding her own place within empire that constitutes the

of why *Night and Day* describes Katharine's experience of the world after she decides to experiment with forms of relating that do not involve romantic relationships and marriage as a "blank" and meaningless, and why for Katharine an increase in freedom would be accompanied by a loss of meaning (she feels "free," but in her freedom "blankness alone remained—a terrible prospect for the eyes of the living to behold").[91] Katharine is a part of the worlding of empire, of the web of stories and myths that give individuals in England a meaningful place within empire, in the sense that they may understand their lives as a part of this larger project, or purpose. Within these stories, the activities of everyday life take on greater meaning and significance—are a part of a larger story spanning centuries. But these meaningful places are gendered: men take part in imperial activity, which involves travel outside of England, while women remain home and participate in the imperial project through marriage and work within domestic space. For Katharine, the worlding of empire makes meaningful existence possible at the cost of freedom, of doing what she would like and being as she would like. For Katharine, who does not want to marry—and more generally for the woman who does not want to fall in love, marry, and have children—the worlding of empire presents a meaningful world but no meaningful way for her to inhabit it.

Thinking about Katharine's relationship to imperial worlding in this more granular way and through her gendered position allows us to explore her dissatisfaction

---

Jane Eyre's problem and its project: to consolidate Jane's subject-position through its figuration of Bertha and the colonies. For Spivak, Jane's progress can only be understood if, as she puts it, we substitute sexual-reproduction for soul-making: the woman's place in the imperial project is limited to the domestic realm, to marriage and to her role within a nuclear family.

[91] In the last few chapters of the novel, Katharine develops a fear of a world without meaning: "When the mist departed a skeleton world and blankness alone remained—a terrible prospect for the eyes of the living to behold" (434). The vision was so terrible that illusion would be preferable to it, as Ralph thinks: "if life were no longer circled by an illusion… then it would be too dismal an affair to carry to an end." It is perhaps this newfound terror of an empty world that makes Katharine so susceptible to her mother's stories of romance, which, as if by "magic," moves Katharine towards marriage.

with imperial worlding, understanding it not only an enabling force but also as a restricting force in her life. Moreover, it allows us to ask, as we encounter these moments where she repeatedly attempts to escape from this world and into another one, why Katharine might want to reworld against imperial worlding in order to make the world inhabitable for herself. In this way, it allows us to think about this novel, and Katharine's desire for another world within it, in the context of world literature under Pheng Cheah's definition as literature that produces a notion of world against the worlding of empire. What would this reworlding against the worlding of empire look like from Katharine's position? How is this project similar and different from world literature that emerges from colonial and postcolonial regions?[92]

Through Katharine's daydreams of adventure, Woolf connects Katharine's domestic discontent to larger ideological narratives of the British empire. Katharine is limited not only by the real space of the drawing room but also by her own dreaming. Katharine's daydreams of adventure are a part of the worlding of empire, narratives that make empire a meaningful rather than simply material enterprise—that place individuals within it into relation as part of a whole that is experienced as meaningful by the male imperialist. These daydreams that she indulges in to escape from the world end up constituting her as a gendered subject of this world. Thus, Katharine thinks of these fantasies of men on horseback that "the people who dream thus are those who do the most prosaic things." But how should one dream that would enable a new way of being?

---

[92] Cheah draws on Spivak's use of the word "worlding" in "Three Texts" to articulate how empire worlded the colonies and to establish his definition of world literature as literature written by postcolonial subjects that reworlds against imperial worlding (in which they are not represented, do not have a history, and/or are reduced to materials/resources) in order to make a more inhabitable world for themselves. Cheah, Pheng. *What Is a World? On Postcolonial Literature As World Literature.* Duke University Press, 2016

Katharine locates the promise for dreaming differently in mathematics, which she sees as the opposite of literature. Mathematics is exact, precise, and impersonal, compared to the "confusion, agitation, and vagueness" of literature:

> in her mind mathematics were directly opposed to literature. She would not have cared to confess how infinitely she preferred the exactitude, the star-like impersonality, of figures to the confusion, agitation, and vagueness of the finest prose. There was something a little unseemly in thus opposing the tradition of her family; something that made her feel wrong-headed, and thus more than ever disposed to shut her desires away from view and cherish them with extraordinary fondness. Again and again she was thinking of some problem when she should have been thinking of her grandfather.

Katharine shuttles between these two forms of dreaming: mathematics, and fantasies of heroes and romantic trysts, as she faces real questions about the relationships in her life. As she sees these daydreams of adventure as part of the past, and unable to help her figure out her way in the world, she associates mathematics with the future and with the promise of new forms of being. For Katharine, mathematics is 1) a form of dreaming, 2) a realm in which she could be differently, and 3) an object of desire. Where does this idea of mathematics come from? In the following section, I seek out the contexts for this idea of mathematics. I show that it comes out of a specifically English notion of mathematical dreamworlds—as realms of training for gentlemen of empire—that coalesced in the mid-19th century and was under stress in the early 20th century.

II. A Recovery of Contexts

Although there is a wealth of scholarship on influences between British modernism and science, there are only a handful of studies of modernism and mathematics.[93] On Woolf and mathematics, Jocelyn Rodal is so far the only scholar to have tackled the subject. In her fascinating 2018 article, "Patterned Ambiguities: Virginia Woolf, Mathematical Variables, and Form," Rodal reads mathematics in Woolf's work through the contemporaneous development of mathematical formalism. In the early 20th century, mathematicians sought to make mathematical thinking more rigorous by more completely severing it from the external world, turning mathematics into a formal language. Interpreting Woolf's mathematics through the well-known German mathematician David Hilbert's version of this project, Rodal suggests that mathematics in Woolf's work trains readers to read formally, for "pattern rather than for particularity."[94] Rodal's work articulates interesting resonances between mathematics and literature in this period. It extends earlier accounts of the opacity of Katharine's mathematics, its failure to "mean anything,"[95] by relating it to contemporary developments in mathematics which purposefully sought to eliminate referentiality from mathematical thinking.

And yet, there are other aspects of Katharine's mathematics, as presented in *Night and Day*, that are not explained through this reading. Why, for example, is mathematics portrayed as a form of dreaming? Why is it an object of desire? And why is it invested with the promise of becoming differently?

---

[93] There is a solid body of work on influences between science and literature in early 20th century Britain; see Albright, Daniel. *Quantum Poetics: Yeats, Pound, Eliot, and the Science of Modernism*. Cambridge University Press, 1997; Whitworth, Michael H. *Einstein's Wake: Relativity, Metaphor, and Modernist Literature*. Oxford; New York: Oxford University Press, 2001. For Woolf's knowledge of the sciences and of philosophy, see Banfield, Ann. *The Phantom Table: Woolf, Fry, Russell and the Epistemology of Modernism*. Cambridge: Cambridge University Press, 2007; and Henry, Holly. *Virginia Woolf and the Discourse of Science: The Aesthetics of Astronomy*. Cambridge University Press, 2003.

[94] See Rodal, Jocelyn. "Patterned Ambiguities: Virginia Woolf, Mathematical Variables, and Form." Configurations 26, no. 1 (2018): 73-102. Rodal's reading of Woolf's mathematical symbols as experimentation with the ambiguity of language dovetails with previous approaches to Woolf's language in the work of Dora Zhang (the indescribable) and Megan Quigley's (vagueness).

[95] See Priest.

These dimensions of Katharine's mathematics are not part of Rodal's explanation, I suggest, because they are not a part of the account of mathematics that she uses to interpret mathematics in the text. In her reading, Rodal makes use of Jeremy Gray's account of early 20th-century mathematics in *Plato's Ghost: The Modernist Transformation of Mathematics*.[96] *Plato's Ghost* offers a retelling of early 20th-century mathematical formalism as a "modernist" movement, comparable to movements in literature, music, and art.[97] Gray approaches the writing of mathematical history in a very particular—though not uncommon—way that limits the picture that emerges when it is used to interpret mathematics in literature. First, as an account of mathematics across Europe, Gray's account elides the particular historical and cultural dynamics that shape how mathematics was understood in England.[98] Second, he defines mathematics based on how mathematicians present mathematics in their academic work. This means that the meanings of mathematics that he elucidates are available to a small and very particular audience—those who can read mathematical language and have the necessary understanding that academic writing presumes. It is therefore difficult to draw relationships between the ideas that he presents and those that appear in literature, as mathematical writing is often inaccessible not only to authors but to anyone without a

---

[96] Gray, Jeremy. *Plato's Ghost: The Modernist Transformation of Mathematics.* Princeton University Press, 2008.

[97] Comparable to the movement away from naturalism in literature, mathematics, in Gray's account, becomes "self-contained," as German mathematicians sought to "build [it] up independently of references to the outside world and even the world of science (Gray 8).

[98] "I chose to investigate how broadly an account of mathematical modernism could be drawn, going beyond its heartland in Germany" (Gray 12).

For the relationship between national myths and mathematics, see Richards, 1998. Richards wonderfully elaborates how national myths influenced mathematical development in Britain in the late 19th century, and explains why Britain lagged so far behind the continent in its development of non-Euclidean geometries. The idea that Euclidean geometry is *the only* geometry is central to British notions of self and world: that the geometry that the self intuits is precisely the geometry of the world, or putting it another way, that the mind intuits the concepts that underlie and order the universe.

level of mathematical training.[99] At the same time, his approach is not designed to capture cultural notions of mathematics that circulate more broadly. As culture historian of mathematics Sara Hottinger writes, mathematicians are not the only people who shape what mathematics means: "the stories we tell about mathematics," appearing in philosophical and educational texts, all produce notions of mathematics.[100] The meanings, promises, and beliefs which become associated with mathematics through its various cultural manifestations are not a part of Gray's work.

In this section, I attempt a different approach to interpreting mathematics in Woolf's work that draws more heavily on cultural and institutional histories of mathematics of this period in order to understand the affective and psychological dimensions of mathematics, and also its relationship to gender. In addition, I look at some general-audience texts about mathematics, including popular writing by mathematicians and accounts of mathematics in newspapers. This approach is used by literary scholars in the study of influences between literature and science. Michael Whitworth takes scientific journalism and popular-science books as his objects of study in his project to interpret

---

[99] Gray's account cannot explain why or how certain mathematical ideas appear in literature. Thus Gray writes: "I do not claim that the modernization of mathematics was part of a broader cultural push, animated by concurrent changes in the arts…. The mathematical changes described here and the better known artistic ones happened independently." Gray 14. Likewise, Rodal writes that it is not possible to say how mathematical ideas appeared in Woolf's texts, but only to point out similarities and resonances across fields. See Rodal 76. "In terms of the broader convergence of literary and mathematical modernism, some third cause must have been involved: the vast and multifarious cultural shifts that produced modernism across fields."

[100] On the existence of cultural notions of mathematics that are not reducible to mathematics within academic fields, see Hottinger, Sara N. *Inventing the Mathematician: Gender, Race, and Our Cultural Understanding of Mathematics*. Albany: State University of New York Press, 2016. Studying a wide range of objects from narratives about mathematicians within mathematical textbooks and media representations of mathematicians, cultural historian of mathematics Sara Hottinger argues that "stories about mathematics contribute to the construction of mathematical subjectivity and the role that mathematical subjectivity played in the West" (7). Importantly, these stories shape "the way that marginalized groups can see themselves as practitioners of mathematics" (6). Mathematicians and scientists, however, are not the only ones who shape how mathematics is understood, as she argues. "The stories that we tell about mathematics" which appear in philosophical, educational, and historiographical texts "underlie and work to reproduce our understanding of mathematics" and, in her analysis, reproduce it as a significant concept for "Western subjectivity and culture."

scientific ideas appearing in works by Woolf, Eliot, and Conrad. As scientific texts are written in specialist language and assume a foundation of knowledge not possessed by the everyday reader, the circulation of general audience writing about science can tell us what scientific ideas meant more broadly to non-scientific readers.[101] Moreover, focusing on general-audience texts enables us to more specifically locate the conduits between mathematics and literature in the period.

Mathematics in early 20th-century England

Mathematics underwent a radical change in England the turn of the 20th century, from geometry to formal language.[102] This change created a crisis, not only among mathematicians, but also among the intellectual elite.[103] The nature of the crisis cannot be understood without reference to the role of 19th-century notions of mathematics in English culture and philosophy. In the 19th century, mathematics was understood, first

---

[101] Whitworth, Michael H. *Einstein's Wake: Relativity, Metaphor, and Modernist Literature*. Following Whitworth, Holly Henry and Katy Price also take this approach to their interpretation of scientific ideas with modernist literature. See Henry, Holly. *Virginia Woolf and the Discourse of Science: The Aesthetics of Astronomy*. Cambridge University Press, 2003; Price, Katy. *Loving Faster Than Light: Romance and Readers in Einstein's Universe*. University of Chicago Press, November, 2012.

[102] For an account of this transformation, see the last chapter of Richards, Joan. *Mathematical Visions: The Pursuit of Geometry in Victorian England*. London: Academic Press, 1988. While there were subtle changes as English mathematicians from the 1860s onward explored forms of non-Euclidean mathematics arriving from the continent, early 20th-century mathematical work (Russell, Whitehead)—which focused on reformulating mathematics as logic—constituted a break from geometry altogether. As Richards explains, "The emergent features of the twentieth century view of geometry in the first decade of the new century replaced the [old, descriptive] approach with startling rapidity. The new interpretation of geometry was so radically different from that which had gone before that it obliterated interest in much of what had concerned 19th century geometers. When they embraced this new point of view, mathematicians changed their subject radically… the establishment of a formal view of mathematics provides a quick and natural end to this study" (10).

[103] This was a crisis in the understanding of certainty and truth, which had been associated with the truth of mathematics, and in particular of Euclidean geometry. As Richards explains, in the 19th century, mathematics and certain truth were inseparable concepts. A series of developments in mathematics and physics in the late 19th and early 20th centuries cast into doubt the certainty of Euclidean geometry. This in turn created doubt about truth more broadly. Richards outlines this crisis, as well as its religious dimensions, in "God, Truth and Mathematics in Nineteenth-century England." *Theology and Science* 9, no. 1 (2011): p. 71. Whitworth shows that this crisis also affected secular subjects (Whitworth 214).

and foremost, as way of educating the liberal subject. Through mathematical thinking, understood as the experience of what is "necessarily and inevitably true," individuals could become familiar with "the form and character" of truth.[104] Joan Richards traces this notion of mathematics, which echoes Enlightenment notions of mathematical dreamworld, to Lockean interpretations of Descartes that re-emerged in the 19th century and became central to English notions of mathematics in the period.[105] Importantly, this idea of mathematics as a way of forming the liberal subject was not merely mentioned in philosophical texts on math, but institutionalized within the higher-education system at Cambridge.[106] In 1838, William Whewell, master of Trinity College, Cambridge, successfully argued for the central place of mathematics in the Cambridge University curriculum as a way of "forming the character of the man," to be used "primarily [as] a vehicle for teaching men to reason." Experiences of mathematical thinking at university, he writes, has a "powerful effect on the general character of their mental habits," effectively preparing university boys to be "lawyers, men of business, or statesmen."[107]

Mathematical thinking could turn university boys into suitable leaders of empire because it constituted an encounter with certain truth. For, unlike in the sciences, truth in

---

[104] "The peculiar character of mathematical truth is that it is necessarily and inevitably true; and one of the most important lessons which we learn from our mathematical studies is a knowledge that there are such truths, and a familiarity with their form and character." Whewell 163.

[105] Richards traces the genealogy of this notion of mathematics from Descartes, through Locke, to 19th-century British thinkers. See Richards, Joan. "God, Truth and Mathematics in Nineteenth-century England." *Theology and Science* 9, no. 1 (2011), p. 53-54. Locke, following Descartes, understood mathematics as a realm of certain truth, through which he explained even religious certainty. Richards argues that this association between mathematics and religious certainty—and certainty more broadly defined—was fundamental to notions of math in the 19th century. "The neo-Lockian joining of mathematics and theology fundamentally affected both mathematical and theological thinking in the first half of the English nineteenth century."

[106] Richards, 1988, 7. Cambridge was the center of mathematical study in England, with Oxford focusing more heavily on the classics (Richards, Warwick, Jones).

[107] "Thoughts on the Study of Math As Part of a Liberal Education ." In *On the Principles of English University Education*. J. W. Parker, 1838, p. 170. Whewell describes mathematical education as a way of "forming the character of the man," in particular the "mental habits"; as a "pursuit that leaves traces of [its] indirect effects on the habits," and prepares university boys to be "lawyers, men of business, or statesmen."

mathematics was understood to be certain rather than probable.[108] 19th-century English philosophers believed also in a unitary view of knowledge—that all fields of knowledge were connected—so that "mathematics [is] an essential part of the closely woven tapestry of human knowledge."[109] Because fields of knowledge are connected in this way, experiences of mathematical truth could enable students to identify truth more broadly, and could guide their judgment in other fields of life. The association of mathematics with certainty coalesced in Euclidean geometry.[110] Euclid's *Elements* began with a set of axioms, understood to be too self-evident to admit of demonstration, and worked its way to a set of necessary conclusions. The conclusions of the *Elements,* worked out through thought alone, were also exactly true in the objective world—"the properties of physical circles, triangles and space itself were precisely what the theory predicted."[111] For the English, Euclidean geometry most clearly evidenced the ability of individual men, trained in mathematics, to know the world and to arrive at truth.[112]

In the 1900s, English notions of truth, man, and world came under threat, as evidence mounted that the universe was, in fact, not Euclidean. Euclidean geometry takes as one of its starting axioms that two parallel lines will never meet. In the 1860s and 1870s, non-Euclidean geometries, which do not begin with this parallel-line axiom, began

---

[108] Richards, 2011, 54.

[109] Richards 1988, 24.

[110] Whitworth 199, Richards 1988, 1-2.

[111] For more on this dual character of geometry, see Richards, 1988, p. 1-2.

[112] Whitworth elucidates the relationship between the belief in the infallibility of Euclidean geometry and the foundation of civilization in the 19th century. As something certain and solid, the axiomatic truths which form the basis of Euclidean geometry, are described in school editions of the *Elements*, as "the foundation of civilization." The association with Euclidean geometry and civilization are made explicit in one edition of the *Elements*, which states that it had been translated into the languages of "all nations that have made any considerable progress in civilization" (Whitworth 199). William Whewell writes in one school edition of Euclid's *Elements* that "the truths of Elementary Geometry…] had in all ages, given a meaning and a real-ity to the best attempts to explain man's power of arriving at truth."

to filter into England.[113] Non-Euclidean geometers ask: what kinds of spaces can be imagined if we do not begin by assuming that parallel lines never meet? These notions of non-Euclidean geometry created discomfort among English mathematicians because they threatened the idea of geometry as both intuitively known and objectively true, which was central to British notions not only of geometry but also of knowledge and judgment more broadly.[114] But in the first decade of the 20th century, Albert Einstein's theories of Special (1905) and General Relativity (1916) proposed that the universe was, in fact, non-Euclidean: that it was a curved space in which parallel lines would, indeed, meet. By the mid-1910s, Einstein's ideas were written up in generalist journals in England.[115] In May of 1919, a few months before the publication of *Night and Day*, proof of Einstein's theory came in an observational test devised by the English scientist Arthur Eddington. By comparing the ordinary night sky to the night sky during a solar eclipse, Eddington confirmed that light from stars in the night sky were indeed affected by the gravitational pull of the sun, as Einstein's theory suggests, rather than as predicted by Newtonian physics. This observational test, which made headlines in London and across the Atlantic, showed that universe was *in fact*, not Euclidean.[116] One of the axioms of Euclidean geometry, understood as certain truth, was verifiably false.

Einstein's theory of relativity, by casting into doubt the truth of Euclidean geometry, challenged broader notions of truth, self, and world that rested upon it. The mathematician and logician Bertrand Russell describes the cascading implications: "I discovered that, in addition to Euclidean geometry, there were various non-Euclidean

[113] For the reception of non-Euclidean geometries in England, see Richards 1988, p. 9, and chapters two and three on Lobachevskii and Bolyai's geometries and projective geometry

[114] Richards 9.

[115] Whitworth 37.

[116] Whitworth 38.

varieties, and that no one knew which was right. If mathematics was doubtful, how much more doubtful ethics must be! If nothing was known, it could not be known how a virtuous life should be lived."

Woolf's relationship to mathematics

Woolf's relationship to this larger cultural history of mathematics was shaped by her gender and coming of age in the 1890s. Her family were not strangers to Cambridge, as her father and her brothers Adrian and Thoby all attended Trinity College, and yet Virginia was not sent there. She was therefore not personally exposed to Cambridge training in mathematics meant to turn male youth into rational, liberal subjects and leaders of empire. This was not unusual: up to 1869, which marked the establishment of Girton College, a women's college, women did not study at Cambridge, and even then, were not allowed at first to study mathematics.[117] Claire Jones describes the view of mathematics at the turn of the century as "rational, often abstract, eminently cerebral and never emotional," "a man's subject and generally held to be altogether too hard for women." Influenced by Darwinian notions of male and female natures, women, understood to have a less evolved brain, possessed a "decreased capacity for abstraction, and a greater subjection to the emotions."[118] Whether or not women were capable of mathematics was important because arguments against women's rights were framed through a lack of such capacity, understood as the capacity for abstract, intellectual thought. The association of mathematics with "elite masculinity" made mathematics an object of desire for women at Girton College, and also made it important to the suffragist

---

[117] Jones, Claire. *Femininity, Mathematics and Science, 1880-1914.* London: Palgrave Macmillan, 2009

[118] Jones 9.

cause.[119] Students who showed any talent in mathematics were discouraged from pursuing any other course of study.[120] When Virginia was eight years old, Philippa Fawcett placed above senior mathematics students in the 1890 mathematical exams at Cambridge, and the event was covered by the *Telegraph* and also by the *New York Times*, where it was framed, tongue-in-cheek, as a testament to the equal abilities of women.[121] In 1892, Grace Chisholm Young achieved the highest mark on the exams, although this event was not covered in the news, and also cannot be located in the records at Cambridge University, as her participation in the exams was an informal arrangement.[122] These successes were easily written off as exceptions rather than as the rule, for the prevailing view, as Maria Corelli writes in "Woman,— or Suffragette?" (1907), was that "woman is not—(*naturally* speaking)—a mathematician," lacking as she is in "self-control" and creativity ("she inspires but cannot create").[123] These meanings of mathematics—its association with masculinity and a kind of full personhood not accorded to women—help us to understand why, for Katharine, mathematics is an object of desire, and the strong affective dimensions of her feelings about the subject.[124]

---

[119] For Emily Davies, feminist and suffragist, and the founder of Girton College, if women could be shown to be intellectual equals, they should be political equals as well. "When [Emily Davies'] students beat men at mathematics, it added ammunition to her argument for intellectual equality between the sexes" (Jones 21).

[120] Jones 16. Sara Burstall, a student at Girton College in this period, writes that it was "specially desirable that women should prove they could be Wranglers," where Wranglers was the term given to male students in mathematics at Cambridge. Emily Davies, the founder of the college, saw the project of producing exceptional female mathematicians as a way of proving the intellectual equality between the sexes.

[121] "We are more than gratified by this result because it removes from our minds one of those lingering doubts which have sometimes interfered with the full and frank admission of feminine superiority"

[122] Jones 15.

[123] Corelli, Maria. Woman,— or Suffragette? A Question of Natural Choice. London: Pearson, 1907. Original italics.

[124] They can also be felt in Woolf's creation of Katharine as a "secret" mathematician, who does mathematics only when no one is looking.

That Woolf did not attend university means that she likely did not grasp the more technical aspects of mathematics that she would have encountered there. She encountered mathematics not in academic and educational spaces (such as the university classroom, or academic journals) but in her home, with her social group, and also in generalist texts. Unfortunately, it is unlikely that she learned much about mathematics in her childhood—she received this education from her father, who was by one account a "disastrous teacher of mathematics" who "made up for it as a teacher of English Literature."[125] However, there were vibrant discussions about mathematics in the years before and during Woolf's work on *Night and Day* by thinkers within Woolf's circle. Bertrand Russell—a logician who had spent the 1900s and 1910s attempting to create a more rigorous understanding of mathematics by formalizing it in the language of logic—occasionally had dinner with Woolf. She wrote in her diary: "I dined [out] tonight and enjoyed society…. Bertie Russell was attentive…. What a pleasure, I got as much out of him as I could carry." He said, "'mathematics… is a form of art.' Art? I said" (1921). Indeed, she wrote in her diary in March 1918, as she was writing *Night and Day*, "I am reading one of Bertie Russell's books." In what follows, I analyze an essay by Russell that I suggest Woolf had been reading, that contains a description of mathematics that bears striking similarities to Woolf's portrayal of math as dreaming.

"The Study of Mathematics," published in *Mysticism and Logic* (1918), is an essay written not for mathematicians but for a general reader.[126] In it, Russell attempts to

---

125 Bell, Virginia Woolf, Volume 1, p. 51

126 Russell, Bertrand. *Mysticism and Logic and Other Essays*. New York: Longmans, Green and Co., 1918. This essay was written in 1902, and first published in *New Quarterly* in November of 1907. It was subsequently published in the essay collections *Philosophical Essays* (1910) and in *Mysticism and Logic: And Other Essays* (1918). An overview of its publication history up until 1917 can be found in the Preface to *Mysticism and Logic,* p. v. This essay is written for readers who do not already find mathematics to be meaningful, and attempts to explain how mathematics could be understood as meaningful. In the

explain what mathematics and why it is meaningful is in plain terms and without the use of symbols. In this essay, Russell describes mathematics in terms that are similar to art, and as the experience of dwelling in a realm of abstract ideas far above the earth:

> Mathematics, rightly viewed, possesses not only truth, but supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show. The true spirit of delight, the exaltation, the sense of being more than man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry. What is best in mathematics deserves not merely to be learnt as a task, but to be assimilated as a part of daily thought, and brought again and again before the mind with ever-renewed encouragement. Real life is, to most men, a long second-best, a perpetual compromise between the ideal and the possible; but the world of pure reason knows no compromise, no practical limitations, no barrier to the creative activity embodying in splendid edifices the passionate aspiration after the perfect from which all great work springs. *Remote from human passions, remote even from the pitiful facts of nature, the generations have gradually created an ordered cosmos, where pure thought can dwell as in its natural home, and where one, at least, of our nobler impulses can escape from the dreary exile of the actual world.*[127]

In this description, Russell focuses on the experience of doing mathematics. The passage begins with a claim about aesthetic feeling, that mathematics possesses "not only truth but supreme beauty." "Delight" and "exaltation" further characterize what mathematical activity feels like to the mathematician. As the passage progresses, mathematics becomes configured as a place: it is where "pure thought can dwell as in its natural home." That is to say, the "remote[ness]" of mathematical thinking from human passions transforms into a remote *place*. This place is a place in the imagination, distinct from the real world (the location of "real life" and the sensible world of "nature"). In this place, the self feels freer

---

Preface to the 1910 *Philosophical Essays*, Russell writes: "I include among the ethical essays the one on 'The Study of Mathematics,' because this essay is concerned rather with the value of mathematics than with an attempt to state what mathematics is."

[127] Bertrand Russell, *Mysticism and Logic,* p. 60.

than the self in the real world: there is "no compromise, no practical limitations, no barrier to the creative activity." The self is constituted differently in this place, becoming "more than man."

In the process of explaining what mathematics is to the general reader, Russell produces a literary notion of mathematics as the experience of dwelling in a realm of abstract ideas far above the earth. This is literary in that it cannot be expressed within academic discourses of mathematics and requires narrative techniques of elaboration. Russell narrates the experience of mathematics—how it feels to the mathematician—turning this abstract realm of ideas into a perceptual realm of experience. Mathematics is now a story, a series of narrated events, focalized through a mathematical thinker. Moreover, mathematics becomes something that the thinker desires—for example, it becomes a way of experiencing freedom and delight that she longs for but are not possible in life.

Although Russell does not use the word "dreaming," his description of mathematics cannot but resonate with readers of *Night and Day*, where Katharine experiences in her mathematical daydreaming states of exultation and freedom that she cannot have in life.

Perhaps the deepest connection between Russell's presentation of mathematics and Katharine's daydreaming lies in the central instability in Russell's perception of mathematical activity: he waffles between understanding mathematical thinking as an indulgent, escapist act, and a liberatory act.[128] At times, Russell believed that thinking

[128] This idea of mathematics as revealing a kind of truth that is free of the biases of the present is not new but rather a part of British notions of reason in the 19th century. Richards, Joan. "God, Truth and Mathematics in Nineteenth-century England." *Theology and Science* 9, no. 1 (2011). Russell expresses the common sentiment at the time that mathematical thinking, because it considers what is necessarily true

about mathematics, because it takes place in a realm that is removed from the real, physical world, could enable the thinker to shed biases in her thinking that come from her position in the world. As he writes in 1912, "by imagining worlds in which Euclid's axioms are false, mathematicians have used logic to loosen the prejudices of common sense."[129] By revealing social truths to be contingent truths, mathematical thinking frees thinkers to imagine what is possible "in all possible worlds." This is the liberatory view of mathematical thinking. And yet, developments in mathematics undermined his faith in mathematics as an encounter with certain truth. If mathematical truths are not necessary truths, mathematical experience turns from an encounter with truth into a form of escapist dreaming no different from fantasy. Indeed, Russell elaborates such a notion of mathematics as momentary escape in 1919. Writing from prison, he notes that mathematical thinking, as it is about "what is possible in all worlds," and "not only in this higgledy-piggledy job-lot of a world in which chance has imprisoned us," could enable a kind of momentary escape from the confines of the present and the realities of the First World War.[130]

Russell's literary notion of mathematics as the experience of dwelling in a realm of abstract ideas that constitutes a form of escape from the real world was a particularly

---

(true in all possible worlds), trains the thinker to think in a way that is free from societally ingrained notions of necessity. This idea that mathematics would train individuals to reason and therefore free them from the traps of tradition and convention was central to how mathematics had been taught in British higher education since the mid-19th century. What is different about Russell's thinking here is that he is putting this in terms of an escape from the present.

[129] Russell, Bertrand. *The Problems of Philosophy.* 1912, p. 147.

[130] This would become the ending to *Introduction to Mathematical Philosophy* (1919). It was written from prison in 1919, where Russell was serving a six-month sentence for an article he wrote critiquing the use of American troops against strikers. Russell, Bertrand. The Basic Writings of Bertrand Russell, 1903-1959. Edited by Lester E. Denonn and Robert E. Egner. Routledge, 2009, xxv.

Russell, 1919, p. 192. "Pure logic, and pure mathematics (which is the same thing) *aim at being true, in Leibnizian phraseology, in all possible worlds, not only in this higgledy-piggledy job-lot of a world in which chance has imprisoned us."*

compelling one. The mathematician G.H. Hardy picks up on it more than three decades later, writing in the middle of the Second World War: "For mathematics is, of all the arts and sciences, the most austere and the most remote, and a mathematician should be of all men the one who can most easily take refuge where, as Bertrand Russell says, 'one at least of our nobler impulses can best escape from the dreary exile of the actual world.'"

Interlude: A semiotic approach

It may be helpful to further discuss the similarities of literary and mathematical technologies for summoning up dreamworlds. These connections can best be understood through semiotic theories of mathematics that understand mathematics as a field of thinking secured by language. In addition, I also discuss in this section what the differences are between these two dreamworld technologies, namely: mathematical dreaming takes place in an imaginative realm in which the objects are more abstract, and are less able to refer the dreamer back into their position in the real world (unlike Katharine's fantasies of adventure, which refer her back to her place in the real world as a woman in the metropole of empire).

Although this idea of mathematical thinking as an experience that is similar to dreaming is not discussed within mathematical texts, Brian Rotman argues that it is embedded in the linguistic structures of mathematical practice. In his semiotic study of the mathematical proof—a form of writing and argumentation in mathematics that is used in many fields of mathematics—he argues that the language and form of the proof structures the reader's thoughts and experience so that:

> Doing mathematics constitutes a kind of waking dream or thought experiment in which a proxy of the self is propelled around imagined worlds that are conjured into intersubjective being through signs….[131]

That is to say, mathematical proof generates a dream-like experience for the reader.

Rotman takes a media- and science-studies approach that understands mathematical fields to be defined through the circulation of mathematical texts and through instruction. The circulation of texts and instruction standardize an understanding of what a particular mathematical field is (the objects within the field, how they may be engaged with), fixing these ideas onto the written figures on the page and on the board. This is what he means when he writes of "imagined worlds" (fields of mathematics) that are "conjured into intersubjective being" (defined for a community of users, which includes readers and students) "by signs" (these written figures on the page and on the board). The mathematician, working out an idea in some field of mathematics, is experiencing an "imagined world," the objects of which take shape from his prior readings of mathematical texts and from instruction; and these objects are the same for him as for any other mathematician.

Why is this a "waking dream," and relatedly, why is the dweller in this world merely "a proxy of the self"? A proof of a theorem in a particular field of mathematics will start by calling to mind for the reader the objects and rules of this field ("conjur[ing]" this "imagined world" "into…being"): "Consider the set of real numbers." It will then ask the reader to act in this world (e.g. "Integrate…" "Count…").[132] These directives do not

---

[131] Rotman, Brian. *Mathematics As Sign: Writing, Imagining, Counting.* Writing science. Stanford, Calif.: Stanford University Press, 2000

[132] It is actually a bit more complicated than this, because the subject does not act in this imagined world, but rather imagines a proxy, an agent, who acts in it for them. So there are nested layers of imagining worlds and imagining subjects in them. These layers are important because they are what

engage the entire person of the mathematician but rather a pared-down version of herself: the self without a place, a time, a culture, a history, or a gender.[133] In describing the self that is "is propelled around" in this "imagined world" as a "proxy of the self," Rotman alludes to the inactivity of these vital aspects of what it means to be a person from mathematical thinking. Therefore, he describes the experience as akin to dreaming—a "waking dream."

Using semiotic studies of mathematics that understand mathematics as a field of thinking secured by language, we see that mathematics and literary genres can be similarly understood as written technologies that summon up dreamworlds for their readers. But there are important differences. One difference between these two dreamworld technologies is that in mathematical dreaming in the dreamworld of mathematics (the dreamworld that is produced by the language and form of the mathematical proof), the objects are not referential—they do not refer back to things in the real world. Mathematical ideas may have come into being through abstraction (the circle from some circular object, for example), but by dint of becoming mathematical ideas, they have lost whatever origins they had in the real world.

Another difference is the kind of subjects that inhabit the mathematical and literary dreamworlds. The objects in the dreamworld of fantasy in *Night and Day*—the shore, horses, the age of empire, a man—produce Katharine the dreamer as the woman in the fantasy, a partial return to reality. But for the dreamworld of mathematics, it seems

---

produces the persuasiveness of a proof: the subject sets out a set of actions for the agent to take, and, observing the outcomes, is convinced (Rotman 16-17).

[133] "An examination the signs addressed to the Subject reveals that nowhere is there any mention of his being immersed in public historical or private durational time, or of occupying any geographic or bodily space, or of possessing any social or individualizing attributes. The Subject's psychology, in other words, is transcultural and disembodied" (Rotman). This paring down is not necessarily a loss: as Katharine's experiences demonstrate, the elimination of a characteristic such as gender can create more, rather than fewer, possibilities for being.

possible for the dreamer to dwell in it without being resituated back in the real world as themselves (a particular person in a particular place or time) or as someone else (in that place and time, in another place and time). If the dreamworld of the fantasy in *Night and Day* produces the woman of the fantasy, the partner to the hero who resides in domestic space, the dreamworld of mathematics, according to Rotman, produces a kind of universal subject (in the sense of a subject without a time or a place). The mathematical language of the proof keeps the thinker from falling into a time or place by never asking them to think about anything that has a place or time attached to it. As Rotman writes, "An examination the signs addressed to the Subject reveals that nowhere is there any mention of his being immersed in public historical or private durational time, or of occupying any geographic or bodily space, or of possessing any social or individualizing attributes. The Subject's psychology, in other words, is transcultural and disembodied."[134]

To summarize, Rotman's semiotic analysis of the mathematical proof helps us to understand how the experience of mathematical thinking could be similar to the experience of daydreaming about adventure. The mathematician imagines a specific set of objects much like a daydreamer would imagine a specific setting for their adventure fantasy, except that in mathematics the objects do not refer to anything in real life (their relation to real life is black-boxed, put aside for the moment). As a result, the dreamer does not become interpellated as anyone in particular, that is, does not become situated back into the real world.

---

[134] Rotman on the way that mathematical language of the proof contrives to eliminate any mention of how the reader is situated in time and place: "An examination the signs addressed to the Subject reveals that *nowhere is there any mention* of his *being immersed in public historical or private durational time*, or of occupying any *geographic or bodily space*, or *of possessing any social or individualizing attributes.* The Subject's psychology, in other words, is transcultural and disembodied..."

Woolf was not a reader of mathematical texts, and was not likely to have experienced the language of the mathematical proof and the dream-like experience it produces. Rotman's elucidation of how the language and form of the mathematical proof produce an experience of dreaming for the mathematician, therefore, cannot explain why mathematics appears as dreaming in *Night and Day*. What it could explain, however, is why thinking about mathematics as akin to dreaming appears in texts about mathematics that are written for a general audience, that describe the experience of mathematics for the mathematician. It is these texts that transmit the experience of mathematical proof to Woolf. Does Katharine become this universal subject—this subject that is time-less and place-less—as she does mathematics in *Night and Day*?

III. Mathematics Remade in *Night and Day*

The previous section traced contemporary discourses of mathematics that likely informed Woolf's portrayal of Katharine's mathematics in *Night and Day*. This section explores how Woolf reconstitutes these ideas of math in her representation of them in *Night and Day*. Through close readings of three moments in the text in which Katharine does mathematics, I show that for Katharine, mathematical dreaming provides an imaginative realm in which to 'set' the self and in which there are different objects for the self to become triangulated by, a realm that Katharine experiences as more freeing than the realms of imperial fantasy or the actual world. I contend that Woolf rewrites mathematical dreamworlds into an anti-imperial imagination, into a realm in which Katharine experiences momentary freedom from the desires that conscript her into empire as a woman.

Dreams of stars

In the following passage, Katharine, thinking about mathematics, becomes temporally and spatially spread out, with parts of her becoming dispersed among the stars. The effects of mathematics are on Katharine's subjectivity: she becomes unlocated in place and time. Mathematical thinking gives Katharine access to a freer, more dispersed form of subjectivity.

In this moment, Katharine's mathematics becomes associated with looking at stars in the night sky, a gaze that enables a kind of escape from her body. In an imagined conversation with her cousin Henry, Katharine says,

> "I should like," she began, and hesitated quite a long time before she forced herself to add, with a change of voice, "to study mathematics—to know about the stars." (210)

The connection that Katharine makes between mathematics and the stars likely comes from the discussion at the time in popular science texts about the universe and how it could only be known through mathematics. Here, speaking of her desire requires a change of voice, a shift in the self who is articulating that desire. As she contemplates the stars, the changes multiply:

> She changed the focus of her eyes, and saw nothing but the stars…. It seemed to her… there was nothing in the universe save stars and the light of stars; as she looked up the pupils of her eyes so dilated with starlight that the whole of her seemed dissolved in silver and spilt over the ledges of the stars for ever and ever indefinitely through space…. (203)

Looking up at the stars in the night sky makes Katharine feel "dissolved," the "whole of her" "spilt over the ledges of the stars." Contemplating the stars initiates a change in sight where only stars are visible. Seeing only stars and their silver rays, she disintegrates—it is as if the boundaries of her body break down—"dissolv[ing]" into a ray of starlight.

Thus "dissolved," she (if we could still refer to her in this way) dissipates in time and space—"for ever and ever indefinitely through space."

In this moment, Katharine's mathematical thinking produces her as a subject outside of place and time. She is no longer where she was, standing outside of her cousin Henry's tower, about to go in, and thinking about what she will say to him when she does. She is also no longer in England, in the 19th century or at any other time, for as the passage notes, "she spilt… for ever and ever indefinitely through space." Katharine experiences timelessness not only in the sense that we forget time while daydreaming, but also in the sense that she is not situated within historical time. Just as Rotman writes of the mathematical subject—of how mathematical dreaming makes the dreamer—Katharine finds herself "outside historical time and geographical space."[135] She is also no longer even one, as her body has "dissolved" in the liquid silver of light—her subjectivity is dispersed among the stars. Mathematical thinking gives Katharine access to a free form of subjectivity: freer in the sense that she is no longer attached to any particular place or time.

Katharine does not become completely disembodied and outside of history and culture, however,. In another moment of mathematical thinking, her position revises. Part of her escapes while another part remains within her own body, a unique positionality that Woolf begins to create in her reconstitution of mathematics in the novel.

---

[135] "An examination the signs addressed to the Subject reveals that nowhere is there any mention of his being immersed *in public historical* or private durational time, or of occupying any *geographic or bodily space*, or of possessing any social or individualizing attributes. The Subject's psychology, in other words, is transcultural and disembodied" (Rotman).

If the Subject's subjectivity is "placed" in any sense, if he can be said to be physically self-situated, then his presence is located in and traced by the single point—the origin—required when any system of coordinates or process of counting is initiated."

Dreams by the river

Walking with Ralph by the river, visions of mathematical symbols transport her—but only part of her—into the sky, into a celestial body far above them:

> Visibly books of algebraic symbols, pages all speckled with dots and dashes and twisted bars, came before her eyes… she was in fancy looking up through a telescope at white shadow-cleft disks which were other worlds, until she felt herself possessed of two bodies, one walking by the river with Denham, the other concentrated to a silver globe aloft in the fine blue space above the scum of vapours that was covering the visible world…. (315)

As before, contemplating mathematical symbols transports Katharine into a celestial realm. Katharine is visualizing algebraic symbols when suddenly part of her seems to be transported into the air. She is transformed, by this contemplation, split in two, one part of her on the ground where she was and the other "concentrated to a silver globe aloft in the fine blue space above." This second part of her could not see down at the first, for it was cloudy—a "scum of vapours" separated the celestial and earthly worlds. ("No star was keen enough to pierce the flight of watery clouds now coursing rapidly before the west wind.") In this moment, Katharine feels free. She feels herself making unhindered "flight," and feels "happier than she had felt in her life"; she "exulted." And yet she knew that part of her was still on the ground: "she was not free; she was not alone; she was still bound to earth by a million fibres, every step took her nearer to home." The problem with mathematical dreaming, it seems, is that despite the intoxicating feeling of freedom and exultation, it can never be permanent—there is always a moment of return.

In these two moments, mathematical symbols initiate an escape from the body through a contemplation of the stars. Katharine escapes from her body in the real world. Yet this escape is only partial. Part of Katharine is still there, walking with Ralph by the river. And it is always followed by a return the real world that reveals it to be unchanged: "Every step took her nearer to home," where she would be again Katharine Hilbery. When Katharine arrives at Henry's door, there is a similar feeling of contraction: "the sense of the stars dropped from her, she knew that any intercourse between two people is extremely partial" (205). Returning from this celestial world to which mathematical symbols transport her, Katharine is struck by the fact that the freedom she had felt there is not retained, that there has not been an actual transformation of the real world into the celestial world. For Katharine, the return from the imaginative space of mathematics to the real world is experienced as a loss. It is like dropping off an "astonishing precipice."

And yet, if the observations of other characters are taken into account, it seems that Katharine does carry something of this mathematical dream world with her as she slips back into the real world—a change within herself, perhaps, in her attitude. As she comes in from her mathematical dreaming, Henry observes something in her attitude that causes him to remark:

> "Perhaps marriage will make you more human."
> "When you consider things like the stars, our affairs don't seem to matter much, do they?" She said suddenly. (206)

She strikes him as somewhere in between the human and the celestial—is there an otherworldliness that she retains in her attitude? Here, Katharine's mathematics is becoming a form of self-making that could potentially transform Katharine in the real world. Why triangulate yourself through marriage, she seems to ask Henry, when you can triangulate yourself through the stars?

Dream walking

This idea of mathematics as a form of self-making becomes more fully articulated in the following passage, in which Katharine has just done mathematics and goes for a walk. Katharine's mathematical dreaming continues to suspend her in a position where she is both in the real world and at a remove from it, and this positionality becomes more refined. Here, her mathematics becomes elaborated as a form of self-making that makes the self somehow outside of the desires and emotions of the present, without taking one out of the present altogether

In the real world, relationships are becoming increasingly complicated—her fiancé William has feelings for her younger cousin Cassandra; Mary is in love with Ralph, but just the night before, Ralph expressed to Katharine that he has feelings for her, which had been a disconcerting experience. In the morning, Mary calls, then William, then Ralph, one after another—all asking questions related to this relationship tangle. Katharine takes out a sheet of paper, and begins to do mathematics. She begins to draw—a circle, a square, and then lines dissecting them—hiding this sheet from her mother:

> Almost surreptitiously she slipped a clean sheet in front of her, and her hand, descending, began drawing square boxes halved and quartered by straight lines, and then circles which underwent the same process of dissection…[136]

And then Katharine puts away her work and goes for a walk.

On her walk, she begins to see the situation from another position.

---

[136] Before this walk, Katharine is working with her mother, and instead of reading a letter to see if it should be included in her grandfather's biography, she takes out a sheet of paper and begins to draw—a circle, a square, then lines dissecting them—hiding this sheet from her mother. Mary calls, then William, then Ralph, one after another. Her mother sees her at her table, and feels a chill, she "struck chill upon her, as the sight of poverty, or drunkenness, or… logic…an unsympathetic world" (320) "Almost surreptitiously she slipped a clean sheet in front of her, and her hand, descending, began drawing square boxes halved and quartered by straight lines, and then circles which underwent the same process of dissection…"

> Her mind, passing from Mary to Denham, from William to Cassandra, and from Denham to herself… seemed to be tracing out the lines of some symmetrical pattern, some arrangement of life, which invested, if not herself, at least the others, not only with interest but a kind of tragic beauty.… The way was not apparent. No course of action seemed to her indubitably right. All she achieved by her thinking was the conviction that, in such a cause, no risk was too great; and that, far from making any rules for herself and others, she would let difficulties accumulate unsolved, situations widen their jaws unsatiated, while she maintained a position of absolute and fearless independence. So she could best serve the people she loved. (330)

She begins to see their situation as a kind of diagram—in her mind, they were all linked together by a pattern: William Rodney, her fiancé; Cassandra, her cousin, with whom her fiancé was beginning to fall in love; Mary, who loved Ralph Denham; Ralph, who loved her; and herself. Katharine's mathematics in the morning, it seems, has helped to bring these thoughts about. These figures from her mathematics—square boxes halved and quartered by straight lines—appear in her thoughts on the walk in the form of these "lines" and the "symmetrical pattern" that she attempts to trace between herself and her friends (Mary, Denham, William, Cassandra). Who would become coupled? And who would be left out of the symmetry? Through the diagram, she looks at their situation from a position outside of herself (for she is also part of the diagram), and in a position somewhere above everyone in the real world, like the position from which she had looked down at the sheet of mathematical figures. But also, she is deeply embedded in the real world, in the relationships that she has with her friends, for she experiences suddenly a deeper feeling of care for her friends and herself.

The effect of this new position is striking: while the discovery that her fiancé William had fallen in love with Cassandra had at first caused her to feel a rush of strong emotions, she now feels "beyond their range." Katharine had felt "surprising anguish": it was surprising because she did not love him and was planning on breaking off their engagement herself. When William asked her, in the drawing room, whether he should forget about Cassandra and continue their engagement, "she was surprised by the violence of her desire that he should never speak of it again. For an instant it seemed to her impossible to surrender an intimacy, which might not be the intimacy of love, but was certainly the intimacy of true friendship, to any woman in the world." Even through Katharine did not love William and did not think they could be happy married to each other, Woolf describes the way that jealousy, possessiveness, and pride made it difficult to let him go. But now, in this new position, looking at herself and others as figures as a pattern that is removed from everything else (drawing rooms, people asking questions), she feels free of these emotions. We may think that Katharine is no longer feeling and thinking as herself. But Woolf suggests, in her description Katharine's perennial "surprise" at her feelings of possessiveness and pride, that these feelings were not her own to begin with, but belong to a patriarchal social structure.

Somewhere above herself in the real world, seeing everyone as a part of this diagram, but somewhere deeply embedded in the real world, seeing also everyone's lives up until this moment, Katharine begins to reconsider their relationships with her and with each other. In this position of half-remove and half-embeddedness, there is a wider sense of what is possible, as she no longer hears the voices around her (the questions that her mother's friends and her aunts will ask) and no longer feels the desires that she once did. She decides to experiment: to invite Cassandra to her house so that William and Cassandra can see if there is really something between them. Rather than worry about how she would ever explain the complex situation to everyone else (she heard their questions in her head), she resolves to let it get messier ("she would let difficulties accumulate unsolved") so that each of them could have a better chance to find out what would make them happy—so that they could all a better chance at happiness ("So she could best serve the people she loved"). This positionality allows Katharine to reconsider how she wants to be in relation to everyone, to formulate a plan for herself that is not determined by the social voices around her or by the desires which are a part of her gendered and imperial subject formation. She decides that she will not hold on to William, she will help him see if there are feelings between himself and Cassandra; she will not, having broken off her part of in this romantic coupling, immediately form another with Ralph, but stay free for a while. Katharine's mathematical thinking helps her to formulate a sense of self that goes against how she is interpellated in the social world, and also how she finds herself in daydreams of adventure as a female imperial subject.

Or so she thinks, walking outside, where no one is there to interrupt her thinking. Returning from her walk, however, the door opens, she sees someone, and becomes unsure of herself: she fears that this new self that she has fashioned may slip away: "The sight of a face, the slam of a door, are both rather destructive of exaltation in the abstract; and, as she walked back to Chelsea, Katharine had her doubts whether anything would come of her resolves." Could she hold on to this new self while being greeted by her family? She did not trust that these people would allow her to continue in her current state of mind:

> If you cannot make sure of people, however, you can hold fairly fast to figures, and in some way or other her thought about such problems as she was wont to consider worked in happily with her mood as to her friends' lives.... (331)

These figures and "the problems that she was wont to consider," that is, her mathematical work, allow her to carry the freedom of thought that she experiences in the street into the interior of the house. For if the street, in its absence of her family or people who have come to see her, affords a kind of freedom from interpellation, mathematical dreaming generates a space of freedom from interpellation that is not tied to a particular location, and that can be set up in her imagination anywhere and anytime she would like it. Her mathematical thinking "worked in happily" with this new attitude (this "mood") that she hopes to preserve. Mathematical thinking is a form of self-making and a way of securing the self when traveling between spaces, and in the presence of social spaces that interpellate differently.

Anti-imperial mathematics

In the novel, mathematics appears as a kind of dreaming, in a way that is similar to how Russell describes. What is different about Woolf's formulation of it, however, is this in-between positionality that she makes for Katharine, where Katharine is both removed from the real world and also deeply embedded within it. Woolf reconstitutes mathematics so that it is, for Katharine, a way of imagining that forms her outside of the desires that construct her as a female subject in the metropole. In drawing mathematics into this literary text, and making it into something that is useful to Katharine, something that she needs, and has been looking for, Woolf produces a transformed notion of mathematics, of what it is and what it can be used for.

Mathematics, as it is reconstituted in the novel, becomes a kind of anti-imperial imagination, in the sense that it presents Katharine with an experience in which she is free from the desires that form her as a subject in the worlding of empire. In this moment in the novel, Katharine's mathematics frees her from the desires that form her as a female subject of empire: the feelings of desire and love for the magnanimous hero that is produced in her daydreams of adventure, and the feelings of love, possessiveness, pride that bind her to William and keep her from releasing her hold on him, even though she does not want to be with him herself. Katharine's mathematics is an anti-imperial imagination in the sense that it enables her to resist her gendered subject-constitution as a part of the imperial world. In this moment, when Katharine feels herself to be free of these desires, and is experimenting with forms of relating that may not be romantic and do not involve marriage, when she no longer indulges in daydreams of adventure,[137] she is described as suddenly beholding a vision of a blank and meaningless world.

> All sense of love left her, as in a moment a mist lifts from the earth. And when the mist departed a skeleton world and blankness alone remained—-a terrible prospect for the eyes of the living to behold. [Ralph] saw the look of terror in her face….

She felt free from feelings of love, but in her freedom "blankness alone remained—a terrible prospect for the eyes of the living to behold" (434).[138] This "blankness," this "terror" emerges in a world from which the "mist" has "lifted," a world that is "no longer circled by an illusion" of romantic relationships and marriage. (It was, Katharine says, "as if something came to an end suddenly—gave out—faded—an illusion—as if when we think we're in love we make it up—we imagine what doesn't exist.") Dreams of romance and adventure, although they place Katharine into a role that she does not want, also offer an meaningful experience of the world, meaningful in the sense that she can

[137] "To think about things that didn't exist—the forest, the ocean beach, the leafy solitudes, the magnanimous hero. No, no, no! A thousand times no!—it wouldn't do; there was something repulsive in such thoughts at present; she must take something else; she was out of that mood at present" (Chapter 21).

[138] The vision was so terrible that illusion would be preferable to it, as Ralph thinks: "if life were no longer circled by an illusion… then it would be too dismal an affair to carry to an end."

understand her life as part of a larger project or purpose—as a part of a larger story spanning centuries (what Katharine calls "an ancient fairy tale" of marriage). Now outside of imperial worlding, she finds what a meaningless world. In its absence, what remains is "dreadfully ugly," something that inspires in Katharine a "look of terror." This look of terror, at blankness, at "raw ugliness" that is redeemed by an illusion only ("if life were no longer circled by an illusion… then it would be too dismal an affair to carry to an end") and remains when illusion is lifted from the world, may remind us of another look of terror as a veil is being lifted: in *Heart of Darkness*, when Kurtz seems to realize what he has become, it was "as though a veil had been rent," Marlow sees on his Kurtz's face "the expression of somber pride, of ruthless power, of craven terror—of an intense and hopeless despair"—his last words, "The horror! The horror!"

IV. Situating *Night and Day* Within Woolf's Corpus

This section considers how Woolf's exploration of mathematics in this novel can be understood as a generative and originary site for the modernist qualities of her later and better-known novels. While in the previous section I looked at what Katharine's mathematics does for Katharine, in this section, I consider what these scenes of Katharine doing mathematics do for Woolf: that is, what Woolf is able to do in her representation of character and subjectivity in these moments that she is not able to do elsewhere in the novel.

Katharine's occupation as a mathematician allows Woolf to portray subjectivity in a way not beholden to realist notions of character and setting from within this realist novel. Woolf describes the way that setting can impose upon subjectivity in her essay "Mr. Bennett and Mrs. Brown." Writing about how different Edwardian novelists would have described Mrs. Brown, this woman she saw on the train, she concludes that they would have done so by describing her house ("House property was the common ground from which the Edwardians found it easy to proceed to intimacy"). However, if she were to proceed in this way with Mrs. Brown, "I knew that my Mrs. Brown, that vision to which I clung, would have been dulled and tarnished and vanished forever." It isn't that this approach—proceeding via the house—is inadequate in conveying a real woman to the reader (it is true that "old women have houses"), but that it would have been too adequate. The reader would have filled in the details (the reader "recognizes [her], [she] stimulates his imagination"), and what would have been conveyed is a person who is not Mrs. Brown, in a way that would have made Mrs. Brown "vanish." Mrs. Brown would be overwritten for the reader by the "who" that inhabits the house that is described. A kind of theory of the subject, of the "who" as a function of where they live—would produce the character instead, preventing Woolf from conveying the character that she wants. In realist fiction, setting—and in particular the house—overdetermines the character. These things—what is in the house, what is outside the window—do not capture human nature.[139] The theory of people and subjectivity that emerges from Woolf's essay is, therefore, more fluid than the Edwardians' approach and not entirely fixed by one's material conditions and surroundings.

And yet *Night and Day* begins in the realist tradition. It opens in the drawing room, where Katharine, the protagonist, is serving tea. Even before we are introduced to

[139] "They have looked very powerfully, searchingly, and sympathetically out of the window; at factories, at Utopias, even at the decoration and upholstery of the carriage; but never at her, never at life, never at human nature."

her, we are told that we are meeting someone who is typical of her gender and class ("in common with many other young ladies of her class"):

> It was a Sunday evening in October, and in common with many other young ladies of her class, Katharine Hilbery was pouring out tea. Perhaps a fifth part of her mind was thus occupied, and the remaining parts leapt over the little barrier of day which interposed between Monday morning and this rather subdued moment….

The serving of tea, being a typical activity for Katherine, explains how she is able to pour tea and distribute bread and butter without really thinking about it ("perhaps a fifth part of her mind was thus occupied"), almost in an automatic way (she "let it take its way").

Almost as soon as Woolf begins in this realist tradition of setting up the drawing room, she attempts to extricate her character from it. First there is a sense that something has escaped from this way of beginning. This sense comes in part from the observation, made in the passage, that only a fifth of Katharine is present at tea. Where are the other four-fifths? As the novel unfolds, these "remaining parts" of Katharine take part in a strange and vibrant inner life that is described through her mathematical occupation. In this first paragraph, however, this idea that four-fifths of Katharine is absent signals to readers how much more there is to Katharine that they do not know—and how little this form of description has conveyed about her. Woolf seems to say: She is not entirely here, in these cups, these chairs, this conversation, this drawing room, that I have set her down in.

Where, then, is she? A set of associations form, in this opening paragraph, in the novel's world, onto its titular concepts of night and day. These cups, drawing room, parents, and "elderly distinguished people" at tea all become associated with *day*. Katharine's inner life, that which cannot be captured and channeled through the events of day, becomes located at *night* and with her mathematical work. “The remaining parts [of Katharine, that is, the four-fifths that we are after] leapt over the little barrier of day which interposed between Monday morning and this rather subdued moment” on Sunday evening. “She… sat up late at night to work at… mathematics.” At night, there are no drawing rooms, cups, parents, social events, or tea. Instead, there is only the imaginative realm of Katharine’s mathematics. Woolf carves out another space from within the realist novel—making use of the time of night, and this imaginative realm of mathematics—for Katharine’s inner life.

In scenes of Katharine’s mathematics, the objects around her seem to work differently than they do elsewhere in the novel.

> Upstairs, alone in her room, she rose early in the morning or sat up late at night to... work at mathematics. No force on earth would have made her confess that. Her actions when thus engaged were furtive and secretive, like those of some nocturnal animal. Steps had only to sound on the staircase, and she slipped her paper between the leaves of a great Greek dictionary which she had purloined from her father's room for this purpose. It was only at night, indeed, that she felt secure enough from surprise to concentrate her mind to the utmost.

Night, a time before and after the events of day, marks space in which she can be “alone”—upstairs, in her room. More than that, it marks a space in which she can do things without anyone knowing. The stretch of staircase between her room and the rest of the house alerts her to visitors, allowing her to hide her activity in time (“Steps had only to sound on the staircase, and she slipped her paper between the leaves of a great Greek dictionary…”). Being able to do something without anyone knowing means also being able to be in a way that it may be difficult, or impossible, to explain to others.

It seems that there is something about bracing for interruption, being addressed and having to respond as someone, that makes mathematical work impossible: “It was only at night, indeed, that she felt secure enough from surprise to concentrate her mind to the utmost." Compared to the cups, bread, and butter of day, night seems to contain very few solid objects, and many more objects of her imagination. In these paragraphs describing Katharine's inner thoughts, objects such as the Greek dictionary in which she hides her mathematical work and the stairs to her room are different still from the objects of day. They are not objects that remind of her of her role and how she should engage but rather objects that she can use to hide what she has been doing and who she has been becoming. The stairs alert her to people who are coming for whom she needs to be differently. Rather than objects that interpellate her as a social being, these objects help to guard a space in which she can be unlimited. In this way they act differently from objects in other moments of the novel, such as the cups, the tea, the bread and butter, and the arrangement of chairs in the drawing room. In scenes of Katharine's mathematical activity, objects function as parts of the setting that do not fix character. Woolf creates mathematics as precisely that activity in which the description of objects in the setting, and the mathematical objects themselves, do not interpellate the character in any particular way. That is, Woolf uses mathematics in the novel to produce effects that we later see in the modernist novel where subjectivity is detached from (realist notions of) setting.

Katharine's mathematics becomes a way for Woolf to explore a freer and more capacious relationship between subjectivity and setting from within the realist novel. Katharine's mathematics, insofar as it allows her a freer form of being (as discussed in the previous section), also allows Woolf a way of representing subjectivity that is free in this way. In Katharine's mathematics, Woolf experiments with representing a freer form of subjectivity from within the realist novel, something that would appear in her next novel, *To the Lighthouse*. In this way, Woolf's exploration of mathematics in this novel can be understood as a generative and originary site for the modernist qualities of her later novels. It makes possible a way of writing (in her later novels) in which, by being more capacious, and by not starting out with the place in which the character is placed (and along with this with a theory of how people are formed by their surroundings), may capture more accurately what the whole is that makes the modern subject.

In conclusion, I have argued in this chapter that Woolf presents mathematical dreamworlds as an alternative realm of experience to gendered, imperial space, represented in the genre of the adventure story. For Katharine, this alternative realm is not enough, as she breaks from her state of experimentation and becomes engaged to Ralph at the end of the novel. And yet, *Night and Day* itself succeeds in challenging the gendered construction of subjects in the metropole in at least two ways. First, in portraying Katharine as a mathematician, the novel challenges contemporary notions that women were incapable of abstract knowledge, which barred them not only from becoming mathematicians but also political subjects. Woolf counters what Claire Jones has called the historical erasure of female mathematicians by writing one into being in fiction, creating a virtual community much like the community of writers she describes in *A Room of One's Own.* Second, by portraying mathematics as dreaming, Woolf challenges the associations of mathematics with rationality and the absence of emotion. *Night and Day* brings to light a second, fantastical and dreamlike mathematics in the early 20th century, existing alongside the "modern," logicist project. Woolf reveals that mathematics, which was becoming formal language, had been a genre of fantasy that shaped the self as the universal human. That is to say, she highlights the fantastical aspects of mathematics that grounded how English men understood their place in the world and in relation to empire. Woolf's work with mathematical dreamworlds foreshadows the approach that other novels in this dissertation will take, as they use the dreamworld of mathematics to disrupt the legacies of empire.

As the first chapter analyzing a literary text, this chapter also sets out my methodology for reading mathematics in literature. I begin by identifying what math means in the literary text, and then seek out the coordinates for this notion, rather than importing contemporary notions of mathematics into the text. That is to say, I make literary texts the authority on what mathematics is in the period, and seek out, from the text, the contexts of this understanding. I contend that this approach can reveal social and cultural dimensions of mathematical meaning circulating within a particular moment.

CHAPTER 3: SPECULATING IN THE COLONIAL LABORATORY: AMITAV GHOSH'S *THE CALCUTTA CHROMOSOME* (1995)

> *“Scientific practice and scientific theories produce and are embedded in particular kinds of stories ...” — Haraway*
> *“If [the fundamental arrangements of knowledge] were to disappear as they appeared... then one can certainly wager that man would be erased, like a face drawn in sand at the edge of the sea” — Foucault*
> *Our present arrangements of knowledge [….] were put into place in the nineteenth century as a function of the epistemic/discursive constitution of the “figure of Man. […] Therefore, the unifying goal of minority discourse […] will be necessarily be to accelerate the conceptual “erasing” of the figure out Man. […] If it is to effect such a rupture, minority discourse must set out to bring a close to our present order of discourse.” — Wynter*

Amitav Ghosh (1965-) is a South Asian novelist whose novels are interested in theories of knowledge. By moving from Woolf to Ghosh, I move from empire to postcolony, and also from real to discursive spaces. By discursive space, I mean ideologies of geographical space that underlie and are produced by discursive practices. While Woolf explored how a dreamspace of mathematics can be used to disrupt the gendered construction of imperial subjectivity in the drawing room, Ghosh explores how a dreamspace of mathematics can be used to disrupt imperialism’s legacies: discursive practices of writing history that locate actors and activity in the West. *The Calcutta Chromosome: A Novel of Fevers, Delirium & Discovery* (1995) tells a fictional story about a subaltern woman, Mangala, who manipulates the British colonial doctor Ronald Ross into making his discoveries about malaria—an important moment in Western histories of science. Shifting between genres of historical fiction, science writing, science fiction, and the supernatural, Ghosh dramatizes in the novel’s very form how discourses shape reality by framing who we can speak of as actors and where as sites of activity. While scholarship on the novel has addressed its engagement with the biological sciences, it has largely ignored the novel's work with mathematics. *The Calcutta Chromosome* introduces a discourse of mathematics—a way of speaking about a set of objects that transcends time and space and can be accessed by everyone—in order to imagine Mangala, an illiterate, sweeper woman, at the center of knowledge production in the history of Western science. It draws attention to a dreamworld of mathematics in the Enlightenment through which thinkers imagined European man to transform into the universal human, losing their coordinates in time, place, and history. Placing Mangala into this dreamworld, the novel asks: could Enlightenment discourses of universality be turned into writing that empowers subaltern subjects?

Sonali Das, a character in Amitav Ghosh's 1995 novel *The Calcutta Chromosome: A Novel of Fevers, Delirium & Discovery,* describes in this passage a homeless boy that she and her partner Romen have taken in.

> He went to school during the day," said Sonali. "But he cooked and cleaned in the evening, when he remembered that was the arrangement. Romen suggested it. One of his contractors or someone found the boy: he was making a living performing mathematical tricks for the rush-hour passengers on local trains. Romen claimed he was a kind of prodigy and took him under his wing[140] . . . "

As the story unfolds, we learn that the boy is part of a group of subalterns in South Asia who have shaped the direction of Western science. In particular, the novel focuses on the event of the British doctor Ronald Ross's discovery in the early 20th century that malaria is transmitted by mosquitos. The discovery, considered groundbreaking at the time, paved

---

[140] Amitav Ghosh, *The Calcutta Chromosome: A Novel of Fevers, Delirium & Discovery* (New York: Harper Collins, 1995), 98. All citations from the novel are from this edition.

the way for an understanding of infectious diseases and their treatment, and earned Ross the 1902 Nobel Prize in Medicine. In the novel's telling, however, Ross only finds out what he does about malaria because a group of subalterns working in and around his laboratory manipulates him into it. They do so because it enables them to achieve their own project of immortality, which they do by using malaria to transmit souls between bodies. Soul in the novel is described as a kind of chromosome: "the Calcutta chromosome," from which the novel gets its title.

Very little information, however, is given about this subaltern group and its members, and how they come into the knowledge and skill necessary to interfere with Ross's work. The boy is only described in this passage, as a mathematical prodigy who "performs mathematical tricks" on trains to earn change from passengers. For the two other members of this group, Mangala and Laakhan, our access is similarly limited. Indeed, scholars of the novel have taken to describing them as "shadowy figures," unseen forces that shape activity in the novel.[141] Even more curiously, when Mangala, the group's mastermind, is described, the abilities of this woman who cleans Ross's laboratory are like the homeless boy's framed in terms of mathematical ability. Mathematical knowledge seems neither here nor there in the novel's focus on the biological sciences. Why then does mathematics appear in the novel?

Following this line of inquiry, this chapter argues that the novel uses an understanding of mathematics to articulate the potential of the subaltern to shape the world. This is an understanding of mathematics as knowledge that is independent of

[141] Mathur, Suchitra. "Caught Between the Goddess and the Cyborg: Third-World Women and the Politics of Science in Three Works of Indian Science Fiction." *The Journal of Commonwealth Literature* 39, no. 3 (2004). "Mangala remains a shadowy figure in the background whose controlling hand (in directing Laakhan, and by implication, Ross) is more guessed at than proven" (134).

context and accessible to anyone. The novel uses this understanding of mathematics, which comes from Enlightenment thought, to imagine subaltern subjects at the center of global knowledge-production. The abstract nature of mathematical language, and the untranslatability of mathematical truths into human meaning, allows this potential to be fleshed out without being located in a particular national or religious site of origin, and without speaking to the content of the project. The appearances of mathematics in the novel, therefore, are significant and what enables it to operate as postcolonial world literature—literature that makes palpable actors, projects, and trajectories other than the colonial that are a shaping force in the present.[142]

In the first section of this chapter, "I. Interpretations of the Novel in Studies of Literature and Science," I discuss existing interpretations of *The Calcutta Chromosome* and make the argument for my approach, which focuses on mathematics. Because *The Calcutta Chromosome* takes on the story of a real doctor, Ronald Ross, it has been studied extensively by scholars of literature and science. This scholarship has read the novel as a project of historical recovery that recovers the role that colonial subjects played in colonial science. This interpretation accounts for the novel's engagement with specific historical characters, events, and facts. But it is unable to explain why the novel lifts off from these facts, embroidering a tale that goes beyond what is available in the historical record—for example, in the creation of the character of the nameless, homeless boy who is mathematical genius, and of Mangala whose abilities are similarly described through mathematics. In these moments, Ghosh points to the limits of the historical

[142] I take this notion of postcolonial literature from Pheng Cheah, who understands it as literature that makes a world more inhabitable for subaltern subjects. As I will discuss later in this chapter, Cheah's concept of world literature is particularly apt for the work that Ghosh does in this novel. Cheah, Pheng. *What Is a World? On Postcolonial Literature As World Literature*. Duke University Press, 2016

archive and of a materialist approach to knowledge, and allies mathematics with the subaltern. Ultimately, I argue that the novel *is* contributing to the project of historical recovery—to the writing of subjects back into history—but that it does so in a way that is uniquely available to fiction: by writing a story that reconfigures what I call *the fictive space prior to knowledge*—the space of narratives and tropes that shape what can become knowledge, in both history and science, by shaping the questions that are asked and what is recorded and archived in the first place, as I argue in "II. An Infrastructure for Subaltern Recognition." In "III. Making Mangala Imaginable," I analyze how a discourse of mathematics entering into the world of the novel, creates a wider sense of agency and possibility, and trace the historical coordinates of this imagining to Enlightenment thought.[143] In "IV. Mathematics in the Writing of Subalterneity and World Literature," I ask how particular qualities of mathematical discourse (abstraction, untranslatability) lend themselves to writing about the subaltern and also to nonspecific worlding—making palpable the coming into being of a world without specifying what it will be. At the end, I discuss how the genre of the novel allows for such an unpacking of disciplinary discourses that transforms who is seen to be human and to be agential.

---

[143] In my exploration of what mathematics is in the logic of the novel, I follow science scholars Lorraine Daston and Peter Galison their understanding that scientific and mathematical ideas are neither completely objective nor subjective, but rather exist in a space *in between* the subject and the world. As they show in *Objectivity* (Daston, Lorraine, and Peter Galison. *Objectivity.* Zone Books, 2007), scientific concepts and technologies, from geometric shapes to microscopic slides, shape how we see the world as much as reveal the nature of the world to us. "Scientists," Daston writes, "furnish the universe" by shaping perception into objects of study, i.e. by "outlining sharp edges, arranging parts into wholes." The objects they choose are those that are "amenable to sustained and probing investigation." But this is not the only way that the universe can be carved up into objects, as Daston notes their objects "rarely correspond to the objects of everyday perception" (Daston, Lorraine. "On Scientific Observation." *Isis* 99.1 (2008): 97-110). Daston and Galison's work shifts the question from whether scientists are objective in their study of the world but rather what kinds of world a particular scientific concept make it possible to perceive, and what kind of subject is shaped in the act of interacting with the world through with that concept. Therefore in order to understand what mathematics is in the novel, I will explore not only how it appears but also the way that it affects how selves and world are perceived when it appears.

I. Interpretations of the Novel in Studies of Literature and Science

The Calcutta Chromosome: A Novel of Fevers, Delirium & Discovery (1995), is a strange novel that straddles the genres of science fiction, fantasy, cyberpunk, and detective fiction.[144] In a New York City apartment in the near future, Antar, an Egyptian immigrant, is at work for the International Water Council, cataloguing items for the branches of the organization that have been shut down. When his high-tech computer Ava flashes an old I.D. card for him to identify, he recognizes the man in the picture: L. Murugan, an eccentric Indian coworker he once knew. When they met in 1995, Murugan had been obsessed with the topic of malaria, in particular with how the British doctor Ronald Ross came to know, in his time in Calcutta, that the Anopheles mosquito is a carrier of the parasite—the discovery for which he received the 1902 Nobel Prize. Antar discovers that Murugan disappeared shortly after their meeting under mysterious circumstances, and begins to investigate what happened to him.

The narrative breaks down into three temporal strands: in the present,[145] Antar tries to figure out what happened to Murugan; in 1995, Murugan travels to Calcutta to retrace Ross's steps; and in 1898, Ross works on malaria in his bungalow laboratory on the grounds of the Presidency General Hospital in colonial Calcutta. Toggling between these three strands, the novel develops the idea that Ross came to know what he did about malaria because an Indian "counterscience" group guided him to this knowledge. This

[144] Because the novel experiments with many different genres of writing, I do not prioritize the genre of science fiction in my reading. The novel, which received the 2007 Arthur C. Clarke award for science fiction, has been read as science fiction by many critics (see Nelson, Mathur, and Chambers). Others have problematized the reading of the novel as science fiction (see Banerjee). My decision not to read the novel as "science fiction" comes from a desire to stay true to its complex, multi-generic structure, which I argue is important to how the novel functions as a story about subalterns and as world literature.

[145] I use the "present" to refer to the point in time at which the novel begins.

group is led by Mangala, a illiterate sweeper woman who cleaned Ross's laboratory, and Laakhan (also known as Lutchman, Lachman, and Lucky), Ross's favorite assistant.

As Ghosh's first novel, *The Circle of Reason* (1986) did with inventors, *The Calcutta Chromosome* (1995) challenges the idea of the scientist as an intentional actor who finds out about the world by insisting that there are forces in the world that contrive for her to make her discovery. What is different about this novel is that it locates these forces in *human actors* ("some*one* wants us to know…" as Murugan puts it) who are part of a subaltern group in the imperial periphery, and who have their own practices and project of knowledge production. Most strikingly, the novel suggests that colonial subjects hired to perform menial labor in Ross's laboratory secretly manipulated his work—they "systematically interfered with Ronald Ross's experiments to push malaria research in certain directions while leading it away from others."

The suggestion that a subaltern group in South Asia may have substantially shaped Ronald Ross's research is one reason why scholars have understood the novel as resisting the dominant vision of the history of science in the 1990s. Since the 1960s, scientific knowledge had been understood to be produced in metropolitan centers and to flow to the imperial peripheries through colonial education, from which scientific institutions in the peripheries developed.[146] This model to understanding science on a global scale, called the "diffusion" model, underwent critique in the 1990s as scholars working on Asia and Africa found evidence challenging the idea that imperial peripheries

[146] George Basalla, "The Spread of Western Science", *Science*, Vol. 156 (5 May 1967), pp. 611—622. George Basalla first proposed the diffusion model in this article, which became the dominant model for understanding science and empire up until the 1980s. For a gloss of his three-stage model for the diffusion of Western science to the rest of the world, see "The European Comprehension of the World." Ghosh challenges the diffusion model by describing how practices emerging from communities in non-European locales have contributed to the development of science and technology.

were merely receptors of knowledge.[147] When Ghosh suggests in the novel that this group from South Asia has “pushed malarial research in certain directions,” he reverses the direction of knowledge flow, suggesting that communities in the imperial peripheries shape and determine the development of science and technology for the West.[148] In this way, *The Calcutta Chromosome* works alongside an emerging group of scholars of science in Asia and Africa in the 1990s that challenged the dominant model of writing the history of science, weaving a tale that turns the diffusion model’s theories of how, where, and by whom knowledge is produced on their head.

A moment in the novel exemplifies this interpretation. In the following scene, set in 1894, when the American scientist Elijah Farley visits Ross’s laboratory in Calcutta, then headed by the British doctor D.D. Cunningham.[149] Farley has come to learn more about the laboratory’s work on malaria, and asks a laboratory assistant to bring him slides. As he studies the slides through the microscope, he feels that he himself is becoming an object of study, watched by the laboratory assistant Laakhan, also by an old sweeper woman Mangala (“he was being minutely observed by a sari-clad woman and a young man dressed in pajamas and a laboratory tunic”). Watching them through the reflection on his glass of water, he notices that Mangala is selecting the slides that Laakhan brings to him, that the woman he thought was “just a sweeper-woman” is curating what he is able to see:

---

[147] Parrish, Susan Scott. “History of Science” in *Atlantic History.* Oxford Bibliographies, 2010.

[148] The trajectory of Western progress is signified by the Nobel Prize in Science which, according to Alfred Nobel’s will, the Nobel Prize in Medicine is awarded to “the person who shall have made the most important discovery within the domain of physiology or medicine.” https://www.nobelprize.org/alfred_nobel/will/. Ross was the second person to be awarded the Nobel Prize in Medicine, which began in 1901 (https://www.nobelprize.org/nobel_prizes/medicine/laureates/). See also https://www.ncbi.nlm.nih.gov/pubmed/2654450

[149] So far as I know, Farley is a purely fictional character, unlike Ross and Laakhan (the unnamed assistant).

> "It was not the young assistant but the woman who went over to the stack of drawers by the wall; it was she who selected the slides that were to be presented to him for examination. Watching carefully, Farley saw her picking them out with a speed that indicated she was not only thoroughly familiar with the slides but knew exactly what they contained. Farley could now barely restrain himself. His mind began to spill over with questions: how had a woman, and an illiterate one at that, acquired such expertise? And how had she succeeded in keeping it secret from Cunningham? And how was it that she, evidently untrained and unaware of any of the principles on which such knowledge rested, had come to exercise such authority over the assistant? The more he reflected on it, the more convinced he became that she was keeping something from him; that had she wished she could have shown him what he was looking for, Laveran's parasite; and that she had chosen to deny it to him because, for some unfathomable reason, she had judged him unworthy." (144).

Here we see a gradual overturning of Farley's assumptions about the laboratory and its workers. When Farley first enters the laboratory on his quest to know more about malaria, Laakhan is merely a slide-bearer, there to deliver slides that he, Farley, chooses to see in order to form his understanding. But as it turns out, Laakhan and Mangala's actions suggest that they know what the slides contain, the knowledge that they carry, and are choosing the slides he is allowed to see in order to limit what he knows. They are the curators and gatekeepers of knowledge ("it was she who selected the slides that were to be presented to him for examination"; "she was keeping something from him… she had judged him unworthy"). Of the two of them, Farley sees that it is Mangala, the untrained and illiterate sweeper woman, and not Laakhan, the trained laboratory assistant, who is in charge. He sees that she possesses both "expertise" and "authority," though he does not understand how. This choice to place Mangala in charge is significant, because in positioning Mangala at the center of knowledge-production, the novel effects a double-reversal where not only is the colonial periphery the location of scientific development, but also the dalit woman—and not the colonial intelligentsia—is the scientist. "The lowest socially ranking 'native' woman," as Chitra Sankaran puts it, "is projected at the center of the power structure."[150]

Through Farley's eyes, readers of the novel encounter a reversal of a Western historiography of science in which subaltern subjects are active participants in the production of scientific knowledge. This scene and others like it are the reason that the novel's project has been interpreted very persuasively within postcolonial scholarship as a revisionary account of the colonial laboratory that gives agency to subaltern groups (Chambers, Khair, Sankaran, Banerjee), and draws attention to the "network of native actors" indispensable to the discoveries of colonial science (Nelson).[151] Farley, having served his narrative function of witnessing Mangala's elevated position and effecting this reversal, conveniently disappears after this scene on train from Sealdah station.

---

[150] See Chitra Sankaran's *History, Narrative, and Testimony in Amitav Ghosh's Fiction*, SUNY Press: 2012, 117.

[151] Scholarship on the novel tends to read it as a rewriting of the colonial laboratory and the history of colonial science, and more broadly, as the writing of a subaltern history. Claire Chambers (2003) reads the novel as a revisionary account of Ross's own account of his research in his *Memoirs,* writing that "Ghosh's main point in this novel is to suggest that Ross was capable of making his name in India only because he drew on the indigenous knowledge he picked up there." Diane M. Nelson (2003) similarly reads the novel as a rewriting of colonial history, with a focus on the laboratory as a vibrant site of activity with many actors. Tuomas Huttunen (2008) also sees the novel as rewriting the colonial laboratory, where colonial science is overturned by "native" cultures of healing. Tabish Khair (2005) understands the novel as an attempt to write a subaltern history of colonial science, one that gives "history—in terms of plot and agency—to subalterns." Other scholars have discussed in more general terms how the novel engages with the writing of subaltern history, and the paradox of writing about a disempowered group in the process of empowering itself (Sankaran 2012), focusing on the role of generic and epistemological hybridity (Banerjee 2010), and narrative techniques that create incomplete, emerging knowledge of the subaltern group that shapes the world of the novel (Vescovi 2017). See Chambers, Claire 2003, "Postcolonial Science Fiction: Amitav Ghosh's The Calcutta Chromosome', *Journal of Commonwealth Literature*, 38.1, pp. 57–72; Nelson, Diane M. 2003, 'Social Science Fiction of Fevers, Delirium and Discovery: "The calcutta chromosome", the colonial Laboratory, and the postcolonial New Human', Science Fiction Studies, 30.2, pp. 246–66; Huttunen, Tuomas 2008, 'Narration and Silence in the Works of Amitav Ghosh', World Literature Written in English, 38.2, pp. 28–43; Khair, Tabish 2005, *Amitav Ghosh: A Critical Companion*, pp. 142-161; Banerjee, Suparno 2010, 'The Calcutta Chromosome: A Novel of Silence, Slippage and Subversion', *Science Fiction, Imperialism and the Third World*: Essays on Postcolonial Literature and Film, ed. Ericka Hoagland, Reema Sarwal & Andy Sawyer, McFarland, Jefferson, Nc. pp. 50–64; Vescovi, Alessandro. "Emplotting the Postcolonial: Epistemology and Narratology in Amitav Ghosh's the Calcutta Chromosome." *Ariel: A Review of International English Literature* 48, no. 1 (2017): 37-69.

But I wonder why, if the novel's goal is solely to make the case for subaltern contributions to Western science, it goes about it in such a curious and self-defeating way, through a collation of history and fiction. I mean that there is actually evidence to support the claim that Ross received help in his research, as Ghosh very well knew. In fact, Ronald Ross's biographers struggled to make the opposite claim: that he went from being a very poor medical student to performing breakthrough research on malaria.[152] In Ross's own writings, he notes that he would not have noticed the *Anopheles* mosquito—the malaria vector—if an assistant had not brought the bug to his attention. This admission appears in his *Memoirs* (1923), a selective account of his discoveries in malaria in the form of letters, diary entries, and reflections:

> "[On] the 16 August, when I went again to hospital after breakfast, the Hospital Assistant (I regret I have forgotten his name) pointed out a small mosquito seated on the wall with its tail *sticking outwards* […] — the worthy Hospital Assistant ran in to say that there were a number of mosquitoes of the same class which had hatched out in the bottle that my men had brought me yesterday. Sure enough there they were: about a dozen big brown fellows, with fine tapered bodies and spotted wings, hungrily trying to escape through the gauze covering the flask which the Angel of Fate had given to my humble retainer! — dappled-winged mosquitoes."[153]

Though Ross attributes it to God, it is clear here that his knowledge of the connection between the Anopheles mosquito (the "dappled-winged mosquitos" he speaks of) and malaria comes in fact from an assistant working in his laboratory. Unnamed, because

---

[152] See W.F. Bynum and Caroline Overy (eds.), *The Beast in the Mosquito: the Correspondence of Ronald Ross and Patrick Manson*, Amsterdam: Rodopi, 1998, p. x. When Ross begins his research on malaria, Bynum and Overy note that he was "badly equipped for the task he had set himself." He had passed only one of the two medical exams that are standard for practicing doctors, and had to bribe his way into his first post as a ship's doctor. He did not know about different types of mosquitos, and had not read the latest malarial research.

[153] See Ronald Ross, *Memoirs: With a Full Account of the Great Malaria Problem and its Solution,* p. 221.

Quoted in Chambers, Claire. 2003. Postcolonial Science Fiction: Amitav Ghosh's *The Calcutta Chromosome*. *Journal of Commonwealth Literature* 38 (1):57-72. Chambers' article makes the fascinating point that the novel actually uses direct quotes from Ross's *Memoirs*, and interprets the novel as fictionalizing (creating a story around) the science of Ronald Ross.

Ross did not consider him important enough to remember his name, the assistant is excised from Ross's later accounts of his path to his Nobel Prize discovery, in which it becomes all about God benevolently revealing the world to him. But this early account remains available as evidence for those who wish to make the case for subaltern contributions to colonial science.

This passage about the hospital assistant from Ross's *Memoirs* actually appears in *The Calcutta Chromosome* but in such a way that undermines its evidentiary power. Murugan quotes it in the conversation he has with Antar in 1995, but in such a way that it is impossible to tell that this is a quote at all. In this conversation, which takes place before Murugan leaves for Calcutta, Murugan is trying to convince Antar of his theory that Ross was helped in his research by a subaltern group working undercover. Antar and Murugan's other coworkers think Murugan is out of his mind. "The way Ronnie tells it," Murugan begins, before giving voice to the quote: "'Next morning, August 16, when I went again to the hospital after breakfast...'" (78). Though this quote from *Memoirs* is placed within quotation marks and attributed to "Ronnie," it appears alongside exchanges that are completely imagined by Murugan which receive the same treatment, such as this one: "'Eureka,' [Ross] says to his diary, 'the problem is solved.' 'Whew!' says Lutchman, skimming the sweat off his face. 'Thought he'd never get it.'" (77). The intermingling of this quote from Ross's *Memoirs* with Murugan's own theorizing of what he thinks might have happened makes it impossible to tell the quote, with its evidence of colonial subjects contributing to colonial science, from Murugan's overactive imagination. Even the name Murugan gives to his theory undermines his attempt to persuade—he calls it the other minds theory, the idea that "other minds" led Ross to his discovery. If at first the novel seemed striking because of its claim that subaltern subjects led Ross to his discoveries, what's more surprising, reading it alongside *Memoirs,* is the extent to which this claim could be substantiated by the historical record.

Ghosh's mixing of actual facts with fictional characters and storylines and unreliable narrators such as Murugan, it seems to me, indicates that he's not as interested as scholars have thought in establishing the *fact* of subaltern contribution: that subaltern subjects contributed to Ross's discovery. If so, why conceal the evidence in Murugan's unreliable narration, which makes us question it? Why introduce fictional characters when there are people in the historical record like the hospital assistant to substantiate this claim?

II. An Infrastructure for Subaltern Recognition

The most obvious answer is that the historical record does not extend to someone like Mangala. If she existed, this woman who cleaned Ross's laboratory and whose surreptitious placement of slides shaped his insights, her presence would not be noted as the trained laboratory assistant's was, nor would her actions be considered intentional (did she merely displace the slides while cleaning? Was it a stroke of luck, or divine guidance?) In other words, I argue that Ghosh is interested in the limits of the historical record—what doesn't make it into the vat of facts that become knowledge—and what fiction can do about these limits.

Scholarly interpretations of the novel's project as recovering the role that colonial subjects played in colonial science struggle to account for these fictional additions—Mangala, Farley, and the subaltern group's project of immortality. If the unnamed and unacknowledged assistant forms a gap within the Western historiography, Ghosh's second project, it seems to me, is to tease out from this gap not only the assistant but also a force of worlding. Pheng Cheah writes that "world" is "a *temporal process* that brings all beings into relation," and "holds them together as a whole" (108-109). Capitalist globalization worlds by creating a teleology, a way of viewing events as driven by ends. But this worlding destroys indigenous notions of world, leaving an impoverished understanding of all that world could be. Thus to world, Cheah writes, is "transfor[m] a given country from a subordinate part of the homogeneous abstract space of the global capitalist system into a place of belonging where local populations and groups can freely thrive."[154] In postcolonial regions where imperialism and capitalist expansion has effected degrees of erasure, engaging with pre-colonial traditions and practices and acts of storytelling can help communities to recover and to forge alternative temporalities with which to resist the capitalist teleology of progress, and to imagine future that is self-determined.

What the fictional additions of Mangala, Farley, and the subaltern group make palpable is the presence of projects, trajectories, and histories other than the colonial that give shape to what happens. Mangala, who is syphilitic, discovers that the biological equivalent of the human soul, "the Calcutta chromosome," can be transmitted by malaria. She figures that it may be possible to use malaria for the transmigration of souls and personalities into new bodies. That is to say, there aren't just colonial subjects who made significant contributions to malarial research, but rather that there are other projects that animate activity, such as Mangala's treatment of syphilis patients, and the subaltern

[154] Cheah, Pheng. *What Is a World? On Postcolonial Literature As World Literature*. Duke University Press, 2016, p. 13.

group's quest for immortality. Indeed, these additions enable the novel to suggest that Western scientific progress—represented by Ross's discovery, which received the Noble Prize—is only a moment in the larger, subaltern project of immortality. Believing that "to know something is to change it" (105), the group guides Ross to discover the Anopheles mosquito as a carrier of malaria in order to bring about a mutation in the parasite that allows them to accomplish their project of immortality.[155] And they succeed—Antar discovers that Mangala and Laakhan have reincarnated many times in the 20th-century: Mangala is also the actress Sonali Das, the journalist Urmila, Murugan's landlord Mrs. Aratounian, and Antar's neighbor Tara; and Laakhan is also the wealthy developer Romen Haldar, and Lucky who sells Antar his daily paper. Ghosh narrates a gap in colonial history into the subaltern project for immortality, a project that, as it turns out, has shaped the world of the novel in the present. In Ghosh's telling, the present has come into being through not only forces of imperialism and capitalist expansion, but through subaltern forces and attempts to change the world.

For Cheah, the imagination is important because we cannot see the whole world. Therefore when we think "world," we are necessarily calling up an *imagination* of the world—of what there is and how everything relates. This imagination of the world is also our world model: it shapes what we are able to know about and to do in the world. Thinking in these terms, I'd like to suggest that the novel is not so much interested in establishing historical fact but rather in enriching the historical imagination. Ghosh's

---

[155] This idea—that malaria can be used to transmit personality traits, and therefore to create a kind of immortality—is the only in the novel that is not supported by the scientific establishment. It's what makes the novel science fiction, as Patrick Parrinder understands it—it is the "impossible premise" within an otherwise realistic universe that allows the plot to move into the realm of the speculative. Why is it here—and why does Ghosh choose the genre of science fiction? I suggest that it gives the subaltern group an end-goal for their project—what Cheah would call a force of worlding, an end towards which activity is directed—that is different from Ross's own, and that is different from the colonial project.

choice of imaginative embroideries over plausible history suggests that he is not as interested in working within the realm of history but rather in what makes it into history and what doesn't, the limits of the knowable, and what fiction can do with these limits.

Ghosh points repeatedly to *a fictive space prior to knowledge*—narratives and tropes that shape what can become knowledge by shaping the questions that are asked. Knowledge often needs to be imaginable before it can be known. Things cannot be scientifically known without first being imagined as possible, in order that they may be tested. The passage below, for example, explores this idea through an account of the different attempts to explain the malaria parasite and its emissions:

> 'You remember I mentioned a guy called W. G. MacCallum – a doctor and research scientist who made one of the big breakthroughs in malaria in 1897? OK, listen to this: what this guy did was he showed that the little "rods" that Laveran had seen, coming out of the parasite's hyaline membrane, weren't flagellae, like the great man thought. In fact they were exactly what they look like – that is, spunk – and what they did was what spunk does, which is make babies. You wouldn't think it would take a Galileo to figure that out: I mean what did they look like, for Pete's sake? MacCallum was the first to get it. He wasn't the first to see it, but he *was the first to figure it out.* Laveran saw it before him, but he didn't get it: guess Lav-the-Man didn't exactly have sex on his mind. Ronnie Ross saw it about a year before MacCallum did and he thought he'd seen his father. No kidding; he thought the flagella was a kind of soldier, going out to war, like Pa Ross on his white horse. I mean, think about it: Ronnie sees this thing that looks like a prick; it goes swimming across his slide and starts humping an egg, and what does Ronnie make of it? He thinks it's the charge of the Light Brigade. The moral is: just because you take a boy out of Victoria's England, doesn't mean you've got her out of the boy.'"[156]

This passage playfully works out the idea that in the interpretation of scientific phenomena, explanations need to be imagined before they can be verified.[157] When it

[156] 119.

[157] I am not making the point that science is completely shaped by culture, but that the set of possible explanations for observed phenomena may be. These explanations still have to be verified by empirical tests to count as scientific knowledge. As Stephen Jay Gould writes, "[s]cience is rooted in

comes to the malaria parasite's rod-like emissions, those who do not imagine it within the context of sexual reproduction are unable to figure out what it is doing. It takes MacCallum, "stuffed full of pumping red-blooded hormones" and with "sex on his mind" to see that they were the malarial equivalent of sperm. In emphasizing that many before him had seen the parasite's emissions, but not understood what they were—"he wasn't the first to see it, but he was the first to figure it out"—Ghosh draws attention to the space of explanations that precedes knowledge and makes it possible.

Gayatri Spivak makes a related point about the recognition of subaltern agency in her 2004 talk "The Trajectory of the Subaltern in My Work." Revisiting the example of Bhuvaneswari Bhadhuri and the way that her agency could not be read despite her efforts to make it known, Spivak reflects that a kind of "infrastructure" is missing through which subaltern agency could be recognized. She does not explain what she means by infrastructure, only that she does not mean "infrastructure in the Marxist sense"—that is, the base, the economic system and the means of production. But if we consider the function that this unelaborated notion of "infrastructure" is supposed to perform—making possible the recognition of subaltern agency—we might observe that The Calcutta Chromosome performs such a function. The novel, which opens with Antar's skepticism about Murugan's theory that a covert, subaltern group no one has ever heard about interfered with Ross's research, ends with his recognition not only that the subaltern group exists but that they are all around him, that they are a part of the world he lives

---

creative interpretation. Numbers suggest, constrain, and refute; they do not, by themselves, specify the content of scientific theories. Theories are built upon the interpretation of numbers, and interpreters are often trapped by their own rhetoric. They believe in their own objectivity, and fail to discern the prejudice that leads them to one interpretation among many consistent with their numbers." *The Mismeasure of Man*, Harmondsworth: Penguin, 1981, p. 74.

in.[158] Characters we meet in the novel's present turn out to be reincarnations of members of the subaltern group: Tara, Antar's neighbor, is Mangala; Lucky, the man who sells Antar's newspapers, is Laahkan. The novel as it develops teaches readers to recognize the impact of the activity of this subaltern group in the present. I suggest we read this novel to see how it makes this possible this recognition of subaltern agency, as a way of asking what infrastructure might look like in a literary form. In the next sections, I will discuss the elements of the novel that enable this group to emerge as shapers of the world.

I have argued for a shift in our interpretation of *The Calcutta Chromosome* away from how it makes a historical case for the contributions of colonial subjects to colonial science, and to its exploration of how subaltern agency can be made imaginable and recognizable. Concealing the evidence that an assistant played a significant role in Ross's malarial research in Murugan's narration so that readers first write it off, only to find it is indeed the case, has the effect of making us question the basis of our beliefs. In doing so, Ghosh raises interesting questions about what makes some ideas imaginable and others not, and the mechanisms that take an implausible idea into plausibility, that makes an idea thinkable as the explanation behind phenomena, and therefore that take that idea into the realm of the knowable. When the idea that is made plausible is the idea that a subaltern group has shaped Western science, making it plausible means making possible the knowledge of subaltern agency. It means making palpable a world ("quivering

[158] The convergence of seemingly unrelated stories, as Claire Chambers has described the novel's progression, where stories of the past explain and merge into the realities of the novel's present, is another way that the novel stages a sense of the group's influence over the present. Chambers writes of the novel: "Most chapters start with a leap to a new temporal and spatial location, allowing unrelated stories to be juxtaposed. Over the course of the novel, connections between the stories become increasingly apparent. At the end of the novel, the interconnected stories dramatically converge." Chambers, Claire. *In The Relationship Between Knowledge and Power in the Work of Amitav Ghosh.* 2003, p. 225.

beneath the surface of the world") in which a community of actors outside of Western capitalism and imperialism have shaped the present and can continue to shape it.[159] In the next section, I examine how the idea is made plausible that an illiterate cleaning woman could rival a leading scientist in her knowledge of the field of microscopy. I show that it is made plausible by borrowing an imagination of self and world from mathematical discourse. I will also uncover where this mathematical language comes from and how it came to be endowed with such transformative powers.

III. Making Mangala Imaginable: "The mathematician down in Madras":

To imagine that this subaltern group could have existed and shaped the course of Western science, it must first be possible to imagine Mangala, the group's mastermind, and how she could have acquired such knowledge and power. What allows such an imagination of this woman who cleans Ross's laboratory—what figures her in this way? What makes it possible to imagine that someone like Mangala, this cleaning woman working in Ronald Ross's laboratory, could have known about malarial research beyond what Ross knew*?* Looking at moments in the novel that grapple with this imagining, I suggest that the novel turns to a discourse of mathematics to imagine the subaltern woman as knowing and agential. Mathematics—in particular, an imagination of self and world that is carried in mathematical language—is one way that Mangala is made imaginable in the novel.

In the passage where Farley observes Mangala at work in the laboratory, he sees that Mangala knows and understands how malaria works, but he cannot fathom *how* she

[159] Cheah 309

knows: how she came by this knowledge. If he had not seen it, he would not have been able to imagine it, for even seeing it he cannot make sense of what he sees. “How had a woman, and an illiterate one at that, acquired such expertise?” he asks. This is a question that courses through the novel, cropping up again a hundred years later when Murugan goes to Calcutta to investigate the subaltern group’s influence on Ross’s work. Murugan suggests that to address this question, we must think in the paradigm of mathematicians. Looking closely at this moment in the novel, I want to show that mathematical discourse appears in order to introduce another way of imagining the relationship between self and world, one that that ripples into the novel’s worlding. The passage begins with one way of imagining self and world, and ends with another in which there is a wider sense of possibility and agency.

This time, the question is asked by Urmila, a local woman Murugan is trying to enlist to help him in his investigation. First he must convince her that Mangala could have played a shaping role in Ross’s research. “Farley,” Murugan explains to Urmila, “saw things happening in the lab that left him in no doubt that [Mangala] knew a whole lot more about malaria than Cunningham could ever have taught her.” But Urmila finds this hard to believe.

> “Really?” said Urmila, her forehead wrinkling in disbelief. “Is it possible that she could have taught herself something as technical as that?”

Like Farley, Urmila wonders how Mangala could have been able to access this knowledge when she was not trained by Cunningham or Ross, and when, being illiterate, she could not have learned it on her own through manuals and textbooks. In asking this question—“Is it possible that she could have taught herself something as technical as that?”—Urmila conveys the belief that someone or something other than Mangala herself—i.e. instructors, institutions, references—is necessary to learning. She suggests that this has to do with the "technical" quality of microscopy, underlining the practical and mechanical qualities of the field as opposed to the abstract or theoretical. Urmila understands a person's knowledge to emerge in relation to their surroundings and other people. That is, people become who they are through their environment—it shapes them, opening up particular paths and closing off others. But this understanding of the relationship between knowledge, self, and world, is about to change.

Murugan makes the case for the idea that Mangala could have "taught herself" microscopy by making an analogy to mathematics:

> "Similar things have been known to happen," he said. "Think of Ramanujan, the mathematician, down in Madras. He went ahead and reinvented a fair hunk of modern mathematics just because nobody had told him that it had already been done..." (245).

Murugan starts by asking Urmila to consider something that seems unrelated to the topic at hand. "Think of Ramanujan, the mathematician," he suggests, introducing into their conversation the biography of Srinivasa Ramanujan, a well-known Indian mathematician who made significant contributions to 20th century mathematics, in particular in the field of number theory.[160] Ramanujan was born in 1887 to a poor Brahmin family, and showed talent for mathematics at a young age. He received training in Indian mathematics from his mother, and in arithmetic, algebra and geometry in school. Although he did not receive training in pure mathematics, he had access to textbooks and articles on it, and he worked in a period where higher education in mathematics was emerging in Indian universities. In his twenties, he sent a notebook of his mathematical

[160] Major discoveries in mathematics in the 20th century have been made from attempts to make sense of the results in his notebooks. In the 1960s, Jean-Pierre Serre formulated Galois theory from results in Ramanujan's notebook, which Andrew Wiles then used in the 1990s to prove Fermat's last theorem, a centuries-long unsolved problem in the field. *This is another parallel between Mangala and Ramanujan, that he ends up shaping the trajectory of "European" mathematics—is it relevant to my reading?*

ideas to G.H. Hardy, the leading British mathematician at the time, who was impressed with his work. Hardy arranged for Ramanujan to study in Cambridge in 1914, where he stayed until shortly before his death in 1920.

In this moment, mathematics infuses into the novel on the level of content in that we are now thinking of Ramanujan instead of Mangala. But it also enters the novel on the level of form, for the language now mimics the language of mathematical proof. The phrase—"Think of Ramanujan"—performs a gesture of opening an imaginative space not unlike how mathematical proofs direct readers to imagine a world and what it would mean to dwell in that world. Mathematical proofs, writes Brian Rotman, a semiotic scholar of mathematical language, start by asking the reader to consider something other than what is present in the moment, for example "Consider the set of all even numbers," or "consider Hausdorff space."[161] In particular, they direct the reader to consider a set of objects that have been mutually defined, and rules associated with these objects. To take an example, to "consider Hausdorff space" is to imagine a space where all points are separated by a particular distance, so that it is possible to make a little neighborhood around each point such that the neighborhoods never overlap. That is to say, mathematical proofs begin by directing the reader to consider a kind of domain, with objects (points, neighborhoods) and rules associated with these objects (the rule of separation). They then direct the reader to imagine what is possible in that world, to think about what can follow from these mutually defined objects and rules. In this passage, "Think of Ramanujan" mimics the operations of mathematical proof in that it directs the reader to conjure up in their imagination a world that is different from the world at hand, in which the objects to think with are Ramanujan the mathematician and cultural

[161] Rotman, Brian. *Mathematics As Sign: Writing, Imagining, Counting* (2000).

narratives of his life, in order to consider what is possible, what can happen, in this world. In the suggestion that what is possible for Ramanujan's mathematical discoveries is also possible to Mangala and microscopy, the passage performs perhaps the most significant operation of mathematical proof, that it directs the reader to imagine herself as an actor in that world where she is not herself in all her specificity but rather sheds all physical, historical, and cultural coordinates.[162]

Where does thinking of Ramanujan lead us? Ramanujan, described here as someone in India who comes up with ideas from modern European mathematics, makes it possible to imagine that people can know things unrelated to their cultural and material contexts. Not only was context unnecessary to Ramanujan's mathematical work, in this telling it is his *ignorance* of his own temporal and historical situatedness that enables his work in mathematics (he "reinvented it… just because nobody had told him it had already been done"). Ramanujan's story functions to open up the possibility that Mangala, illiterate and untrained, could be an expert in malaria. "Similar things have been known to happen," says Murugan, propping open the possibility that Mangala could have taught herself everything with the idea that Ramanujan had done so.

What had been unimaginable within the field of microscopy becomes imaginable when the field is imagined to be mathematics. Of course, Ramanujan's work in mathematics cannot actually evidence Mangala's knowledge of mathematics, not least because these are not analogous fields. But within this imaginative space of analogy, where microscopy becomes mathematics, it becomes possible to imagine Mangala could

---

[162] While arguably novels also direct readers to imagine themselves in another world, I would say that mathematical language directs readers to imagine in a different way because it interpellates them as devoid subjects devoid attributes of gender and race, and of historical and cultural contexts. If readers of novels are directed to imagine themselves as someone else, readers of a mathematical proof are directed to imagine themselves as no one.

have known everything that she did. Questions of access, institutions, and contexts—as Urmila had asked about earlier—no longer seem relevant. By the end of the passage, the idea that Mangala taught herself microscopy has been accepted, and Murugan and Urmila move to tackle other aspects of their understanding of the workings of this subaltern group. What is it about mathematics that enables this kind of imagination—this expansion of what it is possible to believe that Mangala can do?

A closer look at Ghosh's portrayal of Ramanujan, through which mathematics enters into the novel, can help us to answer the question of what about mathematics enables this transformation. The novel's portrayal of Ramanujan, which closely mirrors major biographies of Ramanujan's life, introduces into the text what seems to be a very different way of understanding the relationship between self and world in mathematical knowing. Biographies of Ramanujan tend to emphasize the idea that a man from a poor family in a "far-flung corner of the British Empire" could have come up with key theorems in 19th century European mathematics by himself.[163] In these biographies, Ramanujan's poverty and the remoteness of his place of birth from the center of empire ("down in Madras," as Murugan puts it) is important because it suggest a lack of access

[163] In *Rediscovering Ramanujan* (2008), Momin Meraj Malik performs a critical assessment of Ramanujan's life as it has been written by diverse group of biographers including Indian nationalist writers, postcolonial critics, popular biographers, and professional mathematicians. He finds that underpinning these very different accounts is the idea of mathematical realism—that mathematical objects are eternal truths existing beyond human experience (Mathematical realism is the "ontological position [that] holds that mathematics is something independent of and prior to human conception, existing universally and eternally," p. 10). Ramanujan's contributions to mathematics are explained through his relationship and connection to this universal and eternal realm of mathematical forms in these biographies. This account of Ramanujan's life appears in Hardy, Littlewood, Kanigel, Nandy, and Ranganathan's biographies of Ramanujan, and also and in articles and websites on Ramanujan (11). For Indian nationalist biographers, "When they claim that Ramanujan's mathematics originated from a supernatural source, they identity mathematics with the ontological properties of the supernatural source. Mathematics, like the supernatural, is universal, eternal, and prior to the physical realm" (39). Contrary to these accounts, Malik makes the case that Ramanujan's mathematical skills and knowledge come not from his communion with the realm of mathematical ideas but rather from his relationship with an emerging mathematical community in India.

to education, and to a European mathematical tradition.[164] This lack of access is interpreted as evidence that Ramanujan arrived at his mathematical discoveries on his own. As the novel puts it, Ramanujan comes up with these theorems that appear in 19th century European mathematics independently, because "nobody told him it had been done."[165] The idea that Ramanujan—working in a different time and place from European mathematicians and without contact—could come up with the same theorems as these European mathematicians suggests an *ontological* view of mathematics called mathematical realism, in which mathematical ideas are understood as existing in a universal and eternal realm outside of experience.[166] In this view, mathematicians engage directly with this realm of ideas in mathematical knowing—mathematical knowledge is

---

[164] This is not entirely true. Though Ramanujan's family was poor, he learned traditional Indian mathematics from his mother, and arithmetic, algebra, and geometry in colonial schools. And though Madras is far from England, Ramanujan had access to European mathematical textbooks and articles circulating in university circles in the late 19th century (See Malik 20-64 on the emergence of a network of Indian mathematicians in this period). Though Ramanujan had not been trained at Cambridge, he had access to texts that Cambridge students used to prepare for mathematical exams and competitions.

[165] "He had no real teaching at all; there was no one in India from whom he had anything to learn," G.H. Hardy, the leading British mathematician of his time, said in one of his 1936 lectures on Ramanujan, published in *Ramanujan: Twelve Lectures on Subjects Suggested by his Life and Work* (1999). "The thought created in the West had not even been disseminated in the country [India]. Everything had to be done and discovered by him *de novo*," writes S.R. Ranganathan in *Ramanujan: The Man and the Mathematician* (1967). "Ramanujan did not have this good fortune [that European mathematicians had] in formal university training. He became a mathematician before anyone could think of training him. […] Ramanujan was a self-taught genius. He could dispense with all the technical elaborations of the 18th and 19th century mathematics and still have much to say," V. Krishnamurthy wrote in his 1987 paper in the *Srinivasa Ramanujan Centenary.* Quoted in Malik 35-36.

[166] Malik 6, 61. This telling of Ramanujan's story supports the idea that mathematics exists independently of the human and prior to human experience (mathematical realism, following from Plato's theory of the forms) rather than the idea that mathematical knowledge, like knowledge in the sciences, is the product of one's time, place, and community (social constructivism). For if mathematics is constructed—that is, if humans created mathematics and it did not exist prior to this—then how could it be that the European mathematicians and Ramanujan came up with the same mathematics? This suggests that mathematics pre-exists the human, and that humans are discovering—rather than creating—mathematics. These mathematical truths are eternal and universal: they remain the same across time and space, and can be accessed by individuals from different periods and cultures.

As Littlewood puts it: "If the architect of the Taj Mahal had designed a different tomb for Arjumand Banu, the most beautiful building in the world to-day would not have come into existence. But if Euclid had not discovered that the number of prime numbers is infinite, nevertheless that same theorem would have been discovered long ago by somebody else."

Another term for accounts of mathematical development that understand it to happen through geniuses working in isolation is "internalist" (activity takes place within individuals), as opposed to externalist (activity takes place in the relationship of individuals to their environment).

not routed through the real world. To summarize, then, through the introduction of Ramanujan the mathematician, the novel introduces a way of understanding how selves come to know things that is radically different from the paradigm of microscopy. Unlike the sciences, mathematics introduces into the novel the idea of a *contextless knowledge*: knowledge that can be accessed by anyone anywhere with their mind alone. It can be accessed by the mathematician working alone in her room, wherever her room is, and even if there is no room.[167]

One point we might think Ghosh is making is that mathematical ideas are universals that can be contextualized from a multiplicity of contexts, in particular that Ramanujan comes by his discoveries partly through traditional Indian mathematics. Indeed, Ghosh has pointed out in interviews that Ramanujan had the particular advantage of bridging two different mathematical ontologies. The novel however is curiously silent

[167] The imagination of mathematical knowledge as contextless is not limited to biographies of Ramanujan but rather exists more broadly within popular culture. The idea of the mathematician as a genius working in isolation to discover eternal mathematical truths can be found, for example, in the way that mathematicians are represented in films. In the 1997 film *Good Will Hunting,* for example, 20-year old William Hunting is a janitor at MIT who finds problems left on the blackboard and, despite having no mathematical education, is able to solve them. (Ramanujan gets a mention in this film: "Ever heard of Ramanujan? […] This boy is just like that." Ramanujan, it seems, is the most readily available coordinate in contemporary culture for the idea of the isolated genius, for whom knowledge is inborn rather than produced in their engagement with the world. The classical reference point for this is Plato's *Meno*, in which a boy who comes up with a theorem on his own in response to Socrates's questions, where this knowledge is understood to be inborn. Ian Hacking usefully summarizes the relevant parts of the dialogue: "As reported by Plato in *Meno*, the boy who invents a proof of a theorem did not experiment on the physical world, but used only his mind in response to Socratic questions. Hence he must have had inborn knowledge of the proof and he must have got this knowledge in a previous incarnation."

This ontology and epistemology of mathematics—this imagination of mathematics as eternal truths that can be discovered by the mathematician—makes its way into the novel **not** from its classical and (as I will discuss later) Cartesian origins, but rather from the biography of Ramanujan's life. In this way, the novel shows something about how this ontology and epistemology of mathematics is made available in contemporary culture: that it is secured in films such as *Good Will Hunting* that figure of the mathematician as an isolated genius working to access these eternal mathematical truths.

The story of Ramanujan's life, Malik suggests, is appealing both because it is the story of an individual who overcomes his origins and because it evidences an ontological understanding of mathematics as universal and eternal. (These two go together—as they follow from each other.)

Daston writes that we believe the world to be (the object of knowledge) be shapes how we imagine the subject who knows, and vice versa. But also, as we see here, the narratives that we use to write about a person's life produces the ontological status of objects in the world and vice versa.

when it comes to mathematics in India. Instead, there is this imagination of mathematical knowing as purely a relationship between the self and an imagined world of mathematical ideas. I will suggest later in the chapter that Ghosh does not frame Mangala and the subaltern group within an established Indian tradition in order to encourage a non-nationalist interpretation of Mangala and the subaltern group.

Why is mathematical knowledge imagined in this way, as emerging independently of context? This has to do with the understanding that mathematical objects—what mathematicians work with—are *ideas* rather than *things*, argues historian of mathematics Andrew Warwick. The imagination of mathematics as contextless, Warwick suggests, comes from our inability to imagine how mathematical ideas—abstract and theoretical as they are—are rooted in historical and material contexts. The theoretical nature of mathematical work makes it much more difficult to do material studies of mathematics. When the tools of the field are "readily transportable mathematical techniques and abstract theoretical concepts," there is very little in the way of "site-specific instruments, techniques, and materials" that can be analyzed. For this reason, mathematical work is still treated as the work of isolated individuals developing in an unrelated fashion to other individuals and their surroundings.[168] Another place where disconnect can emerge between mathematical ideas and historical and material contexts, Malik suggests, is in biographies of mathematicians. Biographers are often not mathematicians themselves, and in these cases do not completely understand their subject's mathematical work. This, Malik suggests, is perhaps why some biographers refrain from making connections between the mathematician's life and her work—from

---

[168] Warwick, Andrew. *Masters of Theory: Cambridge and the Rise of Mathematical Physics.* University of Chicago Press, 2003, p. 11.

explaining how her work arises out of her life. If the mathematician offers her own account of how she arrived at her ideas and what inspired them, this is sometimes left intact within the biography. As a result, there are two disconnected accounts of the mathematician: one of her life (written by the biographer), and one of her mathematical work (written by the mathematician—if at all). But Brian Rotman suggests that mathematicians themselves are unable to talk about their work in relation to contexts, even if they wanted to, because of the way that mathematical language operates. In his semiotic analysis of mathematical language, he finds that there is one language for the mathematician to discuss her motivations for a proof, and another language for carrying out the proof, and no translation between these two discourses.[169] Rotman, Warwick, and Malik articulate the unique way that mathematical knowledge erases its tracks in the real world, that is, makes it difficult to trace how persons came to know what they know in relation to a sociohistorical context. "Mathematics," as Malik puts it, "is locked inside a black box of intuition and incomprehensibility," and at the same time mathematicians are imbued with a sense of "mystique" and "an aura of genius."

---

[169] Brian Rotman suggests in *Mathematics As Sign: Writing, Imagining, Counting* (2000) that mathematics is an imagination machine—a technology for imagining—controlled by writing:

"Doing mathematics constitutes a kind of waking dream or thought experiment in which a proxy of the self is propelled around imagined worlds that are conjured into intersubjective being through signs…"

Mathematical texts direct the mathematician to imagine a world where there are objects and rules (i.e. the set of all evens, or a two dimensional plane), and to imagine what it would mean to dwell in that world. What necessarily follows? What connections can be made? As dwellers in this world, the mathematician is an abstract and reduced version of herself-in-the-real-world—transcultural, trans historical, and disembodied... This reduction, this shedding of the self, also contributes to the difficulty of tracing mathematical ideas to their real world contexts…

Rotman suggests that mathematicians themselves are unable to talk about their work in relation to cultural context, even if they wanted to, because of the way that mathematical language operates: there is one language for the mathematician to discuss the motivations for a proof, and another language for carrying out the proof (what he calls the "code," what I've been referring to simply as "mathematical language"), and no traffic between these two discourses ("No description of [the mathematician, of what they are doing] is available to the Subject within the Code," p. 19).

In *The Calcutta Chromosome,* this quality of mathematics where it erases its tracks in the real world becomes useful as a way to imagine subaltern subjects as authoritative figures. The inability to imagine the contextual coordinates of mathematics in the real world gives way to the imagination of a particular ontology and epistemology of mathematics (which I will call "onto-epistemology" for short): that mathematical truths exist outside of human experience (ontology) and are accessible to every individual (epistemology). The imagination of contextless knowledge makes it possible to imagine that Mangala, lacking in training, access to textbooks, and education, could have come to know what she does. The contextless nature of mathematical knowledge works with the marginalized position of the subject: Mangala lacks all these forms of access, but mathematical knowledge requires none. In the idea of knowledge as produced solely in the interaction between a thinking mind and a realm of ideas, it is also possible to resist forms of thinking that dismiss the idea that individuals could know based on their gender, race, or class. To Farley's question of how a woman could have acquired such expertise, the answer could simply be: why *couldn't* a woman like Mangala know what she does? What does being a woman have to do with it? In the novel, the ontoepistemology of mathematics makes it possible to imagine subjects in marginalized positions—by race, class, or gender, for example—in positions of authority and power.

Historically, however, the idea of contextless knowledge played a very different role: to marginalize and to imagine people as irrational and as unknowers.[170] Sara Hottinger traces the idea of mathematical knowledge as independent of context to the

---

[170] Postcolonial approaches to the history of science have explored how technological development (and notions of technological superiority) and the sciences of ethnography and anthropology have served to justify the imperial cause. But what is often not discussed is how mathematical objects fit in this overall shaping of the imperial subject. Here, I attempt to sketch what this might look like.

Enlightenment. She notes that the first modern histories of mathematics, emerging in the 18th century, "understood mathematical knowledge and truth in the Platonic sense, as existing outside of human concern and experience." In these histories, mathematics is understood as "an axiomatic, deductive system inherited from the Greeks," a system "brought into the modern world by Descartes, who developed standards for exactness of reasoning."[171] Mathematical thinking, understood to be axiomatic (beginning with a set of assumptions) and deductive (working from these assumptions to the conclusion), becomes a way of grounding the idea of reason, where reason is understood as a set of processes that supposedly allows access to "knowledge in the strongest sense, knowledge that can under no circumstances possibly be false."[172] Developing axiomatically and deductively, mathematical thinking was understood to be uniquely able to instruct individuals to reason—that is, to distinguish between what is necessarily true and what has been affected by their own personal prejudices and biases.[173] This imagination of a kind of knowledge—arrived at through reason—that could "under no circumstances be false" is an imagination of contextless knowledge. It supports the idea that an individual could, by following the process of reasoning, produce knowledge that transcends her subjective position—knowledge that is objectively true. This idea of objective knowledge acquired through reason made it possible for individuals to universalize their own values

---

[171] See Hottinger, Sara N. *Inventing the Mathematician Gender, Race, and Our Cultural Understanding of Mathematics.* Albany: State University of New York Press, 2016.

[172] Richard H. Popkin and Avrum Stroll, *Philosophy*, Oxford: Made Simple, 1993, p. 239.

[173] Jones, Matthew L., "Descartes's Geometry As Spiritual Exercise." *Critical Inquiry* 28.1 (2001): 40-71. Matthew L. Jones, a historian of mathematics, writes: "Descartes assumed all real knowledge could come only from a reason common to all humans. The universality of the knowing thing and the processes of knowing make this Cartesian subject a transcendental one. Above all*, mathematics, with its proof techniques, and formal thought, modeled on mathematics, exemplify those things that can be intersubjectively known by individual but importantly similar subjects.*" For Descartes, the belief that everyone had the capacity to reason is what makes possible the imagination of knowledge, understood as what can be "intersubjectively known," what is arrived at through "reason common to all humans." The idea that everyone had the capacity to reason is essential to the imagination of objective knowledge.

and conclusions as objective truth through the claim that they arrived at them through reasoning. As Aimé Césaire writes in *Discourse on Colonialism,* without it, scientists, ethnographers, and sociologies could not have made the claims that they did for the inferiority of (soon to be) colonized subjects: “These gentlemen, in order to impugn on higher authority the weakness of primitive thought, claim that his own is based on the firmest rationalism.” James Mill in History of India (1811), for example, points to what he called “the irrational and superstitious nature of Indian thought” as evidence for “the ‘low state’ of the subcontinent’s development.” “The Indians’ cultivation of mathematics and astronomy exclusively for ‘wasteful and mischievous’ and ‘irrational’ pursuits such as astrology, he argued, rather than would serve utility, ‘infallibly denotes a barbarous nation.’” Michael Adas explains in *Machines as the Measure of Man* that the belief that the British surpassed Asians and Africans in their knowledge of and approach to the natural world “was central to the… colonizers’ sense of themselves and their mission in overseas societies…. they had the right to rule and the duty to… transform.” Taken together, Cesaire, Mill, and Adas show how the idea of contextless knowledge was used to make the claim that colonial subjects—or soon to be colonial subjects—were unknowers. Historically, contextless knowledge led to the inability to recognize—or the active dismissal of—other forms of knowing, and was used to justify imperial expansion and the subjugation of people across the globe.

This history of reason and contextless knowledge, however, runs in contradiction to an idea at the heart of Enlightenment thinking: that mathematics is understood as the ground for reason because it is something that can be known by everyone. Ghosh once said in an interview that “language is not just a discourse but also contains within itself certain political perceptions, certain metaphysical perceptions." In this section, I have been trying to show that with the mathematician comes this onto-epistemology—this idea of contextless knowledge—that has historically given agency to the male imperialist. But in the novel, this relationship between mathematics, agency, and the male imperialist is rewritten to give agency to the female subaltern. The novel calls up this discourse of mathematics as contextless knowledge and transforms it by applying it to new subjects.

Given this history, we might still wonder why Ghosh uses mathematics, and its imagination of contextless knowledge, to make Mangala imaginable. There are other ways of explaining how Mangala could have acquired her knowledge of microscopy: for example through what she might have learned as a worker in Ross's laboratory; what she could have known from lived experience (in interviews, Ghosh describes knowledge about malaria as part of folk knowledge);[174] or through her access to alternative non-Western epistemologies through which knowledge of the world can be acquired.[175] That is, it is possible to root Mangala's access to knowledge to a material context other than laboratory training and English-language textbooks. Why doesn't Ghosh take this approach instead?

---

174 Strangely, Ghosh excludes from the novel explanations for how Mangala could have come to know about malaria that he gives elsewhere, for example that malarial knowledge was a part of folk knowledge: "Clearly local people were well ahead of Ross in their knowledge of malaria." See https://ttdlabyrinth.wordpress.com/2013/08/27/reprint-an-interview-with-amitav-ghosh/). "[Ross's] real achievement then, lay in translating folk knowledge into the language of science. Clearly local people were well ahead of Ross in their knowledge of malaria. But would they have directed research in the way I present? Look at it this way: Ross made a major breakthrough in science based upon a very partial acquaintance with folk knowledge. It follows, surely, that someone who was better acquainted with that knowledge would do even better, especially if they happened to pick up a fluency in the language of science."

175 In interviews, Ghosh suggests that Ramanujan's strength comes from the fact that he approached mathematics from two ontological perspectives—that he understood both the British approach to mathematics and "an understanding of numbers from his mother who was a traditional numerologist." Yet this explanation is left out of the novel, with the effect that Mangala's capabilities are not linked to any particular tradition.

I think another reason Ghosh uses mathematics in his description of Mangala is to create a kind of purposeful obscurity about her and the subaltern group. In other words, mathematics appears in the place of an explanation for how Mangala knows what she knows and for the operations of the subaltern group. What the novel does is open up another trajectory of development in which Ross's Nobel Prize discovery is a node, unfurling this trajectory of development from the seeming void—the silences within the Western historiography of science. And yet even as it opens this up, it keeps things indecipherable. It seems to me that mathematics is used to describe Mangala—and also a boy on the train—and their abilities and possibilities, almost as a way to keep things blank, to register the opening of a space without filling it. In the next section, I explore why silence might be desirable in a story about subaltern subjects and how mathematics might enable such silence.

IV. Mathematics in the Writing of Subalterneity and World Literature

IV.1 The Narration of Subalterneity: "Only Signs, Nothing More"

Of the subaltern group, Murugan says that "Silence is [their] religion." Indeed, the group seems always to elude the grasp of those who try to figure them out. Those who attempt to write down an account of the group, such as Phulboni the Bengali writer, and Farley, the American scientist, are punished by being made to disappear.

Why might silence be desirable in a story about subaltern subjects? Gayatri Spivak's well-known 1985 essay "Can the Subaltern Speak?" can help us to answer this question because it thinks about problems arising from attempts to write about the subaltern and their potential for revolution.[176] When Spivak says “no,” the subaltern cannot speak, she means in particular that neither French theorists thinking about a global working class alliance nor postcolonial intellectuals working on recovering a history of peasant uprisings in India can accurately construct a voice for the subaltern subject, and that in their attempt to they make it harder for actual subaltern subjects to gain a voice. For Spivak, this is because the historian imposes their paradigm of understanding, imperial and patriarchal, onto the subject that is studied, so that what is represented is not the subaltern’s views but the views of the historian (82). She gives the example of how the subaltern woman has been interpreted throughout history through the act of *sati,* or widow-sacrifice. By the British, it was seen as a backwards tradition from which native women needed to be liberated, but for the Hindu elites, the woman was expressing her true desire to die after the death of her husband. In this example, the desire of the woman cannot be accessed; rather, “woman” stands in by turns for the interests of the colonial system and the indigenous patriarchal system. Thus Spivak warns that in attempting to construct a voice for the subaltern—a subjectivity and a consciousness—we are only representing ourselves, our paradigm of understanding. This applies not only to the French theorist who expands to think about global working class alliance without considering third-world realities but also to postcolonial intellectuals working from their insights (they must understand, she writes, that “their privilege is their loss. They are in the paradigm of intellectuals”).

Ghosh’s *The Calcutta Chromosome* is susceptible to Spivak’s critique because it portrays a kind of subaltern revolution where a group of subalterns not previously known

[176] Spivak, Gayatri Chakravorty. "Can the Subaltern Speak?" In *Colonial Discourse and Post-colonial Theory: A Reader.* Edited by Patrick Williams and Laura Chrisman. London: Routledge, 1995

about turns out to have shaped the course of Western history. In its interest in rewriting the subaltern back into histories that have omitted their presence, it is similar to the project of the subaltern studies group that Spivak is thinking with in her critique, with the exception that Ghosh is writing fiction rather than history. How does Ghosh grapple with Spivak's warning that writing about the subaltern may erase the actual voices of subaltern subjects? It may be argued that because the novel is fiction, it cannot be understood as inscribing/speaking for the subaltern, that unlike history, it makes no claims to truth. But it is important to remember that for Spivak, what obscures the subaltern are paradigms of understanding—these can be secured and circulated in fiction as well as history. Does Ghosh's representation of subalterns in the novel commit the kind of epistemic violence that Spivak describes? Is Ghosh a postcolonial intellectual speaking for actual subaltern subjects? Or does Ghosh help to form that much needed infrastructure Spivak spoke of in a 2004 lecture—infrastructure that allows subaltern resistance to be read?

In its portrayal of Mangala and the subaltern group, the novel resists the problems that Spivak outlines for speaking for the subaltern through its use of mathematical language and more broadly the language of proof and multi-disciplinary paradigms of explanation. Spivak makes three critiques of the attempt to find a voice for the subaltern subject. First, she suggests that the paradigm of thinking about class revolution and overthrow inherited from Foucault and Deleuze is not appropriate for an analysis of global revolution given the complexities of capitalism on "the other side of the international division of labor," as she puts it. Second, she warns that in the attempt to speak for the Other—that is, to understand the Other's desires—existing paradigms of understanding will speak for and over the persons or groups being studied. For the investigator, the "clamor of his or her own consciousness (or consciousness-effect, as operated by disciplinary training)" becomes ventriloquized as the "voice" of the peasant (82). In particular she points to the way that the woman is figured in psychoanalytic criticism, and the peasant in Marxist criticism, where they operate as "a pointer to an irretrievable consciousness" that invites the investigator to supply their own narration. Third, she observes that in the subaltern studies group's attempt to recover a subaltern consciousness—in Guha's work up to that point— they have left women out of their analysis to focus on male peasant rebels. For these three reasons, she opposes the way that the subaltern studies group is going about their project of constructing a voice for the subaltern.

In Ghosh's portrayal of the subaltern group, the woman is not forgotten, but rather imagined as the head of the group. The novel's portrayal of Mangala does not impose a vision of the subaltern onto subaltern subjects because it is so fundamentally unclear. Mangala is only glimpsed twice in the novel, once by Farley as she is working in the backroom of the laboratory, and the second time by Sonali, who sees her in her next reincarnation as Ms. Aratounian performing a ritual in a broken-down house. Neither character through which the scene is focalized fully grasps the significance of what they are seeing, as Suchitra Mathur notes, nor does the reader at this point, as Vescovi observes in his narratological analysis of the text. Of the three main characters in the subaltern group—Mangala, Laakhan, and a young boy—only Laakhan, the trained laboratory assistant, is seen with relative clarity, presenting information to Ross and Farley. He is also the only one who appears in some form in colonial history—he is the laboratory assistant who worked for Ronald Ross and appears in his *Memoirs*. Mangala's role is only guessed at: “Mangala remains a shadowy figure in the background whose controlling hand (in directing Laakhan, and by implication, Ross) is more guessed at than proven” (134).[177] While the woman is at the center of the subaltern group, this center is made more obscure. The further away we move from the historical record, it seems, the more shadowy the descriptions become. The young boy, who is also not in the historical record, is also described through mathematics. The boy is introduced by Sonali as someone Romen met on the train, where “he played mathematical tricks for the rush-hour commuters” (98). The idea of mathematical knowing as an ahistorical and contextless process helps to negotiate a kind of shadowy presence where the subaltern woman is not forgotten but also not inscribed. The difficulty of translating from mathematical activity to things that have human meaning becomes useful, allowing for a form of description—a description of activity—that does not circumscribe the person being described in a meaningful way.

In addition, the novel’s use of mathematical language, and more broadly of multiple disciplinary discourses, allows it to perform a “displacing gesture” where interpretive paradigms become distinguishable from the position of the subaltern. Earlier I discussed one moment in the novel that focuses on Mangala, in which Murugan asks Urmila to understand her abilities and powers by “think[ing]… of the mathematician.” I argued that mathematics infuses into the novel on the level of form as well as content. This phrase mimics the form of mathematical proof, which opens up an imaginative space and asks readers to imagine what it what mean to be in that space. We are not

[177] Vescovi, Alessandro. "Emplotting the Postcolonial: Epistemology and Narratology in Amitav Ghosh’s the Calcutta Chromosome." *Ariel: A Review of International English Literature* 48, no. 1 (2017): 37-69

Mathur, Suchitra. "Caught Between the Goddess and the Cyborg: Third-World Women and the Politics of Science in Three Works of Indian Science Fiction." *The Journal of Commonwealth Literature* 39, no. 3 (2004): doi:10.1177/0021989404047050.

thinking of Mangala anymore, but of Ramanujan, and not of microscopy or malaria, but mathematics. In other words, we are no longer in the world of the novel, but a world of theory—or perhaps speculation is a better word—a world in which Ramanujan and mathematics help us to understand what "may be" for Mangala and the subaltern group in the novel's world. Here, I argue that in borrowing the language of mathematical proof, that asks readers to posit for a moment another world with different objects and different rules, the novel underscores that what is being produced is not Mangala herself but a theory of her, the attempt on the part of two people, Murugan and Urmila, to understand her. In other words, the analogy that is made from Mangala to Ramanujan operates as a "displacing gesture," that marks out the explanatory paradigm from the subject from whom explanation is sought. Elsewhere in the novel, the idea of the Calcutta chromosome—the soul in biological form, a chromosome by analogy, that can be transmitted from one person to another through the malaria virus (250)—again works to present the novel as a whole as the *talk around*—rather than the talk from—the subaltern group.[178] But perhaps mathematics, which presents the idea of not trafficking at all in the real world, is the clearest first articulation of this point. In the novel as a whole, the interdisciplinary nature of the text—biological, mathematical, mystical, religious—foregrounds the various "disciplinary effects" at play in the attempt to understand Mangala and the subaltern group, to make them out. In a way, the novel performs various different ways that agency can be imagined to appear, from the mathematical to the spiritual to the biological. The plurality of paradigms makes visible

[178] That is to say, it appears in the form of rumor and of theory that Murugan and others use in the attempt to understand the group's activities, rather than as speech that comes directly from the subaltern group.

each paradigm as paradigm, rather than as actuality. Altogether, they form an infrastructure through which subaltern agency may be recognized.

IV.2 Worlding Without End: The Novel as World Literature

As I have argued, mathematics allows for an imagination of agency without disclosing its contexts. In particular, the analogy to Ramanujan operates to make Mangala's knowledge and ability plausible without articulating her situatedness in real world contexts. This lack of specificity as to the origins and contexts of the subaltern group also helps the novel to function as world literature. World literature, under Cheah's radical redefinition, is not literature that registers the emergence of a globe made increasingly coherent through capitalist expansion, but rather literature that can "world otherwise," that enables the imagination of a world other than the worlding of capitalist globalization. Literature has the power to world, according to Cheah, because "world" has always been a narrative concept, one that has to do with the way that narrative can lock space and the past into a vision of what should be in the present. Worlding comes from Spivak's description of the way that imperialist discourse inscribed the geography of the colonies as land that was uninhabited and open for the taking. Literature can "world otherwise" through an engagement with the precolonial past, in which a sense of self, community, and purpose can form through a feeling of having been that contests the worlding of global capitalism in which postcolonial areas are inscribed as timeless, unproductive space. Thus one form of world literature—literature that worlds—is the revolutionary novel, which imagines "the destruction of a world where the colonized subject cannot develop as autonomous subjects and the creation of a new common world where they can be at home." But this form of worlding is often problematic for a variety of reasons, ranging from the inaccessibility of some precolonial traditions, the co-optation of revolution, or the undesirability of nationalism. Thus Cheah articulates the importance of cohering a sense of community and direction (as well as hope and futurity) in the present without working from a particular pre-colonial historical tradition, and without presenting yet another end—revolution—to counter the capitalist teleology of progress.

In the novel, this project of worlding without an end in revolution is carried out by the description of the subaltern group through mathematical language in the sense that the imagination of mathematics as contextless knowledge allows their potential to be fleshed out but also made nonspecific. Though Ramanujan's knowledge of mathematics comes in part from a rich tradition of Indian mathematics, and through his mother's work in numerology, Ghosh omits this information from the pages of the novel, so that the capabilities of the group are not located in any way in a specific national or religious tradition. Ghosh is able to do this because there is a discourse of mathematics as a universal capacity—something that anyone, anywhere is able to do and to know—as I have shown. This nonspecificity of the origins and powers of the group also allows it to become an expanding community across national boundaries, from Calcutta to Egypt to New York. In this way, the novel participates in world literature in the second sense of the term, literature that worlds by adding to the world as a web of meaningful connections. Moreover, in aligning mathematical discourse with local spiritual traditions[179] as ways of figuring agency into being, the novel embeds alternative

[179] The woman priestess who performs rituals and the cult of silence, Banerjee writes, is not a part of classical Hindu mythology, but rather is "more similar to the subjugated tribal cultures" (Banerjee 60).

ontologies within mathematical ontology, and makes room for these alternative ontologies within the present.

IV.3 The Novel as An Interdisciplinary Genre

The genre of the novel is key to its ability to bring about subaltern recognition. Earlier, I argued that the novel's use of multiple disciplinary discourses—from the biological to the mathematical to the spiritual—is important because it allows for a kind of "displacing gesture" where interpretive paradigms become distinguishable from the position of the subaltern, as the *talk around* rather than the *talk from* the subaltern subject. These shifting interpretive paradigms create a sense of vibrancy and activity around the subaltern that cultivates attentiveness. In other words, it is through engaging with different disciplinary discourses that the novel creates an infrastructure through which subaltern agency may be detected without fixing it in a particular way. In my argument, the genre of the novel is key: the novel is able to bring about subaltern recognition because it is able to absorb and bring together different disciplinary discourses into one space. For these discourses can only be engaged with in this way in a space where their norms are not the norm, and where their unique ways of carving out the world and actors become visible. Here I draw on an understanding of the novel from Mikhail Bakhtin's work, that it is able to manage different discourses without integrating them into one worldview.

In the novel, mathematical language is likened to mystical language as another way of imagining how forces and agency can emerge from the void.

For Bakhtin, the novel is “an artistic organization of social speech types” and individual voices.[180] Bakhtin understood this first in terms of the relationship between characters’ speech and narration in the novel. Characters’ voices are not merged into the narrating voice, but rather each character’s voice is distinct.[181] For Bahktin, language is always “ideologically saturated,” so that a character’s voice carries her values and how she sees the world, what he calls her “worldview.” Beyond characters’ voices, there are “official languages” such as the language of the church and the law that similarly carry ideology, and individuals must express themselves in these languages as social beings. Novels bring these different languages together in one place, which makes it possible to see their differences—the different ideologies they carry, different ways of seeing the world—and to realize that the languages we use not only convey the meanings we intend but also shape selves and worlds. This can be empowering because it allows readers to see languages in a new light and as resources for self-fashioning, trying on different discourses to see in which they appear and can make the best case for themselves.[182]

---

[180] “The primary stylistic project of the novel,” he writes, “is to create images of languages”: “the novel can be defined as a diversity of social speech types (sometimes even diversity of languages) and a diversity of individual voices, artistically organized” (366, 262)

[181] Bahktin refers to this quality of the novel as “polyphonic,” meaning multiple voices, and fleshes out this out in *Problems of Dostoyevsky’s Poetics* (1929), describing the way that in Dostoyevsky’s novels, there is no single voice that speaks for the characters but rather “a plurality of independent and unmerged voices and consciousnesses”—that is, the voices and perspectives of each of the characters are considered valid, and retained in the novel.

“A plurality of independent and unmerged voices and consciousnesses, a genuine polyphony of fully valid voices is in fact the chief characteristic of Dostoevsky’s novels. What unfolds in his works is not a multitude of characters and fates in a single objective world, illuminated by a single authorial consciousness; rather a plurality of consciousnesses, with equal rights and each with its own world, combine but are not merged in the unity of the event.” (6)

Language and voice in Bahktin carries ideology, are “ideologically saturated.” So when he says that there are multiple voices and that each character’s voice is represented, he means that each character’s perspective and values, different from those of the others, are kept intact, are not resolved under the narrating consciousness.

[182] Bahktin describes this process in which an awareness of the languages in which one participates as carriers of worldview, as tools not only for communication but for worlding, enables a peasant woman to actively manage her social representation:

Bahktin goes as far as to say that the novel takes *languages* as its objects of representation.

While Bahktin focuses on discourses of church and law, I have been interested in the way that *disciplinary* discourses also have different ways of making self and world that has the potential to widen the world of the novel—its "worlds of verbal perception," as Bahktin puts it. In this chapter, my argument is that the novel takes on mathematical language and its assumptions about the self, world, and knowledge to imagine the subaltern subject at the center of knowledge production and as a force of worlding. Through an analogy to mathematics, Mangala is capable of knowing about microscopy and has shaped Ross's research and the community Antar finds himself in in the present. What makes this possible is the ability of the novel to absorb and entertain—to "try on"—different discourses, to mix together literary, mathematical, and historical discourses in the same space. The novel is able to bring about subaltern recognition because it brings mathematical language—cultural narratives about mathematical geniuses, which make accessible the interpellation of a disembodied, ahistorical speaking subject and a world of objects within mathematical language itself—into the world of the novel. By taking on the forms of mathematical language that I discuss here, the novel makes the self-world relationship contained within them—the idea of contextless

---

"Thus an illiterate peasant, miles away from any urban center, naively immersed in an unmoving and for him [or her] unshakable world, nevertheless lived in several language systems: he [or she] prayed to God in one language [Church Slavonic], sang songs in another, spoke to his [or her] family in a third and, when he [or she] began to dictate petitions to the local authorities through a scribe, he [or she] tried speaking yet a fourth language [the official-literate language, 'paper' language]. All these are *different languages*, even from the point of view of abstract socio-dialectological markers… As soon as a critical interanimation of languages began to occur in the consciousness of our peasant, as soon as it became clear that these were not only various different languages but even internally variegated languages, that the ideological systems and approaches to the world that were indissolubly connected with these languages contradicted each other and in no way could live in peace and quiet with one another—then the inviolability and predetermined quality of these languages came to an end, and *the necessity of actively choosing one's orientation among them began*."(295-96) knowledge, that anyone anywhere could have access to knowledge—available to our imagination of subaltern subjects. The notion that a cleaning woman could simply have all of this knowledge, which would otherwise seem a wishful fantasy, is a sensible statement within the mathematical realism where mathematicians commune directly with an imagined world of mathematical objects, and anyone can acquire mathematical knowledge. Therefore mathematical language works as a way of making a valid (rather than wishful) argument for subaltern potentiality.[183] Mathematical language when it is used in the novel effects a transformation on the world of the novel, taking the idea of Mangala and the subaltern group into plausibility.

Mathematical language is transformed in turn. For while the idea of contextless knowledge should apply to everyone, this way of thinking about the self and world in mathematical knowing has historically only applied only to Western subjects. In the novel, Ghosh applies this way of thinking, secured by cultural biographies of the genius and mathematical language itself, onto subaltern subjects, appropriating the universalizing standpoint for subalterns so that they may bring about their own worlding. By applying mathematical language and cultural biographies of the mathematical genius to colonial, postcolonial, and female subjects to whom they have not historically been applied, the novel transforms the very mathematical discourses that it employs. Scholars of mathematics and science understand mathematics as a field of study secured by the

[183] When I say "valid," I am thinking of the way that discourses, as Foucault understood it, define what is a sensible statement and what doesn't parse at all. Michel Foucault, *The Archaeology of Knowledge, Pantheon Books,* 1972, p. 61. "General Grammar [the study of discourse] defines a domain of validity for itself (according to what criteria one may discuss the truth or falsehood of a proposition); how it constitutes a domain of normativity for itself (according to what criteria one may exclude certain statements as being irrelevant to the discourse, or as inessential and marginal, or as non-scientific); how it constitutes a domain of actuality for itself (comprising acquired solutions, defining present problems, situating concepts and affirmations that have fallen into disuse)."

circulation of academic and cultural texts—in this sense, we may think of the novel as creating and circulating a different and subaltern mathematics.

By activating different discourses and their modes of worlding—from the mathematical to the biological to the spiritual—the novel creates the effect of an interpretive structure through which the subaltern subject may appear, a space before knowledge that makes it possible. Within these different discourses, mathematical discourse initiates this creation of infrastructure by conjuring up a world detached from the real world/present reality. World, as Eric Hayot puts it, is never the whole world, but the expression of a desire for the world in all its diversity, a totem of responsibility to a world that cannot ever be encompassed in all its diversity. In this novel, mathematical language plays a vital part in creating a kind of attentiveness to what *may be*—to sources of agency and worlding where we may not expect them—without fixing what it *is*.

In conclusion, *The Calcutta Chromosome* uses mathematics to imagine the potential for subaltern worlding without rendering it in a particular way. Mathematical language is useful to world literature with a postcolonial project (of re-centering the subaltern without speaking for the subaltern) because it is associated with the idea that anyone can access to knowledge and can act, and because of its oblique relationship to human meaning. In using mathematical language, the novel also revises these discourses about mathematics—about who is able to do mathematics and whose ability to know and act is enlarged by its ontoepistemology—by applying them to new subjects: women and subjects from South Asia in the colonial period and in the present. In this way, the novel transforms a vision of mathematics that lives within culture. Taking advantage of the interdisciplinary nature of the novel—that it does not have to work within a single disciplinary language but can reflect on the ways that languages carve out worlds and actors—the novel participates in the transformation of a cultural ontology of mathematics. It suggests, moreover, a connection between world literature and interdisciplinary thinking—that to think in a more worldly way may require thinking beyond categories and disciplines which are themselves legacies of imperialist epistemology and reproduce it in the present. This kind of thinking is uniquely suited to the novel as an interdisciplinary genre that can handle and cross-pollinate different disciplinary world views, and ways of rendering the world into language.

My next chapter continues this exploration of how minor authors transform imperial legacies of thinking about mathematics and the human by turning to Nnedi Okorafor's speculative trilogy *Binti,* where mathematics appears as the protagonist's special power.

CHAPTER 4: TRANCING IN THE NAMIBIAN DESERT: NNEDI OKORAFOR'S *BINTI* (2015-2018)

Nnedi Okorafor (1974-) is a Nigerian-American writer whose work imagines women in the African diaspora in empowering, cosmic universes. In her fiction and her prose essays, Okorafor celebrates the power that speculative fiction, detached from normative notions of the real, has to change what is real and what is possible. This chapter focuses on *Binti* (2015-2018), a trilogy that follows the galactic travels of a young girl from southwestern Africa who has a special, mathematical power. Okorafor portrays Binti's power as the power to escape from the actual world through the contemplation of mathematical equations. While the world of *Binti* is marked by violent racial and gender conflict, Binti's mathematical thinking seemingly allows her to resist these effects, and to experience other realms of self-making.

This chapter makes the argument that Okorafor draws on and remakes Enlightenment mathematical dreamworlds in her portrayal of Binti's power, turning them into a realm of imagining that empowers Binti. In making this argument, I draw on existing work on postcolonial science fiction that understands engaging with Western mathematics, science, and technology as a form of writing back and of remaking.[184] I contend that Okorafor foregrounds the fantastical aspects of this Enlightenment notion of mathematics, and extends our analysis by suggesting that Enlightenment mathematical

[184] As the Afro-Caribbean writer Nalo Hopkinson writes in the opening of *So Long Been Dreaming*, a volume of postcolonial science fiction: "To be a person of colour writing science fiction is to be under suspicion of having internalized one's colonization… [But science fiction stories] take the meme of colonizing the natives and, from the experience of the colonizee, critique it, pervert it, fuck with it, with irony, with emotion, with anger, with humour, and also, with love and respect for the genre of science fiction that makes it possible to think about new ways of doing things." Hopkinson, Nalo, and Uppinder Mehan. So Long Been Dreaming: Postcolonial Visions of the Future. Vancouver, B.C.: Arsenal Pulp Press, 2004, 8-9.

dreamworlds are virtual worlds, imagined worlds mediated by language that have shaped our thinking about the human. Highlighting the enduring presence of mathematical dreamworlds within contemporary thought, she suggests that the worlds of speculative fiction, likewise realms of imagining detached from the real, could have just as significant an effect on our thinking about ourselves and the world.

Following a brief introduction to Okorafor's work, I begin the chapter with an account of Binti's power in "I. Entering *Binti*" and "II. Trance." "I. Entering *Binti*" considers Binti's mathematics in relation to the plot of the trilogy as a whole, to show that Binti's math is a formidable power that she can use to reconfigure what is possible and to shift her relationship to the world. While section I focuses on *what* Binti's power does, "II. Trance" takes a closer look at moments in which Binti's mathematical thinking is described in order to build an understanding of *how* Binti's mathematical power does this. These close readings show that Okorafor portrays Binti's mathematics as *a realm of imagining brought about by mathematical language*, highlighting the peculiarity of this imagined experience—that its imagined objects do not refer the thinker back to the actual world—through the language of "trance." This presentation of mathematical thinking is not far from how mathematicians describe mathematical thinking. While literature that engages with mathematical and scientific ideas are often thought to fictionalize, misunderstand, or otherwise embellish these fields of knowledge, my readings here suggest that Okorafor's engagement with mathematics in fact reveals the phenomenological dimensions of mathematics that have thus far escaped disciplinary study and bear closer examination.

"III. Enlightenment" re-reads Enlightenment mathematics through Okorafor's notion of mathematics to show that it could, indeed, be described as a kind of power. While Descartes begins with the belief that certain knowledge inheres only in mathematical objects, through his conception of mathematical training in rationality, he writes into being the possibility of certain knowledge of the world. In other words, Okorafor's presentation of Binti's power foregrounds the fantastic—and potentially science-fictional—aspects of Enlightenment thinking about mathematics. This section prepares the ground for the sections that follow, which analyze how Okorafor remakes Enlightenment notions of dreamworld into an imagining that empowers Binti.

Building on the insight of "II. Trance," "IV. Bodily Experience" further elucidates the workings of Binti's mathematical power by showing that Binti's experiences in the imagined realm of mathematics *produce effects on her body*. It is through her body that Binti's mathematical thinking can act in the actual world, *as a realm of experience that counters the effects of racial and gendered experience* on the body. This section completes the chapter's exploration into how Binti's power works, and my argument that Okorafor reconfigures Enlightenment notions of dreamworld into a realm of imagining that empowers Binti.

At the end, "V. Happy Endings and Okorafor's Theory of Speculative Fiction" discusses the parallels that Okorafor draws between mathematical thinking and speculative fiction, as realms of imagining, detached from the real, that shape bodies and subjectivities.

Nnedi Okorafor's work, which she calls "Africanfuturism," can be understood as a part of the emerging genres of Afro-Futurism and postcolonial science fiction.[185] Her stories take on themes of black futurity, technology, and liberation common to Afro-Futurist literature, and are postcolonial in their approach, centering on non-Western perspectives and indigenous cosmologies. Okorafor has received the 2018 Wole Soyinka Award for Literature in Africa, as well as numerous science-fiction awards, including the Hugo and Nebula awards. Her fiction has tremendous reach: her novel *Who Fears Death* (2010) and trilogy *Binti* (2015-2018) have been picked up for production into television series by HBO and Hulu, respectively.[186] Beyond the novel genre, Okorafor has worked on issues of *Black Panther,* including the series *Wakanda Forever* (2018), about the Dora Milaje, women warriors who serve King T'Challa, and *Shuri* (2018), about T'Challa's sister Shuri, a tech genius who develops new inventions for Wakanda. She has become a central figure in what has been called the rise of African speculative fiction in the past two decades, both in her fictional works and her non-fictional prose essays, which seek to define this genre.[187]

This chapter focuses on Okorafor's *Binti* trilogy, as its imagination of Binti's mathematics makes it relevant for this dissertation's investigation into mathematical dreamworlds as they appear in literature by marginalized authors. Published in

---

[185] Okorafor, Nnedi. "Africanfuturism Defined," October 19, 2019. "http://nnedi.blogspot.com/2019/10/africanfuturism-defined.html" (accessed May 1, 2020). Africanfuturism, like Afrofuturism, is interested in the imagination of futures and centering black people in that imagination, but also re-centers on African cultures outside of the West. ("The difference is that Africanfuturism is specifically and more directly rooted in African culture, history, mythology and point-of-view as it then branches into the Black Diaspora, and it does not privilege or center the West.")

[186] Okorafor made the announcement on Twitter: https://twitter.com/Nnedi/status/1217120553817051136.

[187] As of 2019, she has published *The Shadow Speaker* (2007), *Long Juju Man* (2009), *Who Fears Death* (2010, adult), *Akata Witch* (2011), *Iridessa and the Secret of the Never Mine* (2012), *Kabu Kabu* (2013, adult), *Lagoon* (2014, adult), *The Book of Phoenix* (2015, adult), *Binti* (2015, adult), *Binti 2: Home* (2017, adult), *Akata Warrior* (2017), *Binti: The Night Masquerade* (2018, adult), and *Black Panther* series *Long Live the King* (2017-18), *Wakanda Forever* (2018), and *Shuri* (2018-).

novella-length installments in 2015, 2017, and 2018, *Binti* is the first-person narrative of Binti, a "mathematical genius and heroine," as N.K. Jemisin describes.[188] *Binti* (2015) received both the Hugo and Nebula awards in 2016. Binti is a young Himba girl with the special power of mathematical thinking, which helps her to make her way in a world that is marked by racial and gender power dynamics.

The text is set in southwestern Africa, in an ambiguous future time after alien contact. The region is segregated. The Khoush live in the cities, and are a light-skinned people and the dominant group of humans on Earth; they have a large military and monopolize resources such as water and technology. In the desert, the Himba live in villages, where the roads to the city are poorly maintained. Racial conflict persists along colonial lines. In space, there is interspecies conflict between the Khoush and the Meduse that mirrors the dynamic of racial prejudice. The Himba are described as a patriarchal society, where decisions for the community are made by a committee of men. The text, focalized through Binti and also narrated by her, foregrounds how Binti perceives and interacts with the world, and the landscapes, imagined and actual, that she interfaces with and that limit and enable her. In the spaces of her family home, the Khoush city, and the spaceship, Binti encounters racialized and gendered discourses.

In creating the setting of *Binti*, Okorafor draws inspiration from the histories of the region, but also deviates from them. The Himba are a real people, many of whom are semi-nomadic livestock farmers who live in a subsistence economy in the desert region of Northern Namibia. Namibia was first colonized by Germany and then by South Africa,

---

[188] Okorafor, Nnedi. Binti. New York: DAW, 2018. Jemisin's "Foreword" appeared on 2018 reprint of the first book of *Binti.* An excerpt from it can be found at "https://www.tor.com/2018/04/30/nnedi-okorafor-binti-trilogy-hardcover-editions-cover-reveal/" (accessed May 1, 2020).

achieving independence in 1990. A 2002 Minority Rights Group International publication reports extreme economic disparity, as minority communities have been disadvantaged through colonial history of violence, dispossession of land, segregation, and detrimental "development" policies.[189] The report suggests also that Himba communities, compared to their neighbors, have been relatively shielded from colonial violence. German colonization established itself to the south, in present-day central and southern Namibia.[190] Under South African rule (1917-1989), the Himba did not bear the brunt of the land policies that allowed white South Africans to claim native lands, as their territories were outside of the "police zone" set aside for settlement.[191] If so, these realities may contribute to the fact that they have preserved traditional cultural forms of dress and ways of life—as Okorafor puts it, "They have maintained their culture so deeply in the midst of modernity."[192] In *Binti*, the Himba follow traditional forms of dress and the use of red clay, or *otjize*, to cover the skin. They are not depicted as nomadic or livestock farmers, however, but rather creators of advanced technological devices. While Okorafor depicts the Himba as a patriarchal society, the social

---

[189] Suzman, James. *Minorities in Independent Namibia*. London: Minority Rights Group International, 2002.

[190] A map of German colonial activity from 1904-1906 shows settlements to the South, in central Namibia. (Steinmetz, George, and Julia Hell. "The Visual Archive of Colonialism: Germany and Namibia." Public Culture 18, no. 1 (2006), p. 160.) See also Bley, Helmut. *Namibia under German Rule, 1894-1914*. Windhoek: Namibia Scientific Society, 1996. In the most violent period of German rule (1904-1907), German military forces committed genocide against the Herero and Nama people living in central Namibia, in Watenberg and the Omaheke Desert to the East. (See Hull, Isabel V. *Absolute Destruction: Military Culture and the Practices of War in Imperial Germany.* Ithaca: Cornell Univ. Press, 2006.)

[191] Wolputte, Steven Van. "Subject Disobedience: The Colonial Narrative and Native Counterworks in Northwestern Namibia, C.1920–1975." History and Anthropology 15, no. 2 (2007), p.156. Minority Rights Group International reports that "It is noteworthy that some ethnic communities, such as the Himba, Kavango, and Owambo peoples, escaped any substantial alienation of their traditional territories during the colonial period."

[192] *Wired* interview.

organization of the Himba is complex as they practice dual descent.[193] Most recently a series of images of Himba women, bare-chested, has appeared in the Western media that describes the Himba as a timeless, unmodern people. Okorafor counters this representation by portraying the Himba to be technologically advanced. By portraying Binti as Himba and centering her in this imagination of the future, Okorafor attempts to imagine forms of futurity that are centered in non-Western cultures and that would unfold outside of Western histories of development.[194]

As in her other works, *Binti* imagines young women in the African diaspora in empowering roles in cosmic universes. Okorafor's first novel, *Zahrah the Windseeker* (2005), incorporated West African folklore in a story about a thirteen-year-old girl who grows her own floral computer. *Who Fears Death* (2010) tells the story of a young girl in post-apocalyptic Africa who is born with magical powers. "Part of why I started writing," Okorafor has said, "was that I wanted to tell stories of women and girls—African women and girls.… I wanted to tell the narratives of the women I grew up with. I wanted to empower them… I wanted to give them more agency."[195] In other words, Okorafor describes the goal of empowering particular identities as central to her work, and

---

[193] Although communities are organized around patri-households, the Himba practice dual descent, in which a "combination of matri- and patrilineal descent is used to establish social, economic, and moral/ritual identity." See Halstead, Narmala, Eric Hirsch, and Judith Okely. Knowing How to Know: Fieldwork and the Ethnographic Present. New York: Berghahn Books, 2008. Note: It is difficult for me to say more about the accuracy of Okorafor's representation of the Himba people as there is a dearth of scholarship and some of what I have found seems to take on problematic ethnographic assumptions.

[194] "This is the cultural conversation in Binti. She's constantly asking herself, 'Who am I? What am I?', but always while maintaining that she is Himba. And the Himba people are constantly grappling with this issue, too. Can one move into 'modernity' with her culture? What does 'modernity' mean? Most of the time it just means assimilating to Western cultures and ideals so you can enjoy technology. What is lost? Who is in control of the direction of 'modernity'? Must it always be this way? If not, how? This is an issue I know Africans on the continent and in the Diaspora will have to face in the future, if not already." Okorafor, Nnedi. "Interview with Nnedi Okorafor." March 2017. "http://www.lightspeedmagazine.com/nonfiction/interview-nnedi-okorafor/" (accessed May 1, 2020).

[195] Okorafor, Nnedi. "WIRED Book Club: Nnedi Okorafor Finds Inspiration Everywhere—Including Jellyfish." February 2017. "https://www.wired.com/2017/02/wired-book-club-nnedi-okorafor-interview/amp" (accessed May 1, 2020).

understands a relationship between the empowerment of identities in fiction and in actual life. This chapter considers this aspect of her work, which has so far not received critical attention.[196] Okorafor's statements raise questions about the relationship between fictional and actual empowerment, and also about how mathematics could be a kind of power. These questions are intimately related.

Binti's mathematical power is described as the ability to think about abstract mathematical ideas, entering into a "mathematical trance."[197] In this trance, she experiences realms beyond the actual world. In some moments, it is clear that Binti's mathematical trancing has changed the environment in a way that enlarges her ability to act, and yet in other moments, her mathematics is described as merely a way of escaping the present. In portraying Binti's mathematics as a kind of power, Okorafor suggests that imaginative spaces are powerful.

I. Entering *Binti*

I begin with an overview of the three volumes of *Binti*, followed by an analysis of Binti's mathematical power in relation to the trilogy as a whole. This analysis reveals that

---

[196] As Okorafor's work is relatively new, a small corpus of scholarship on it began to emerge in 2015. Thus far, this scholarship has tended to focus on Okorafor's postcolonial representations of place. Hugh O'Connell contextualizes Okorafor's Lagoon within mainstream representations of Nigeria in *District 9,* arguing that Okorafor presents a corrective vision of Lagos as a site of potential and futurity. Others have explored how Okorafor uses the relaxed mimetic constraints of speculative fiction to re-imagine place, from the imagination of a post-apocalyptic Africa that is also free of neoliberalism in her early novels (Joshua Yu Burnett), to the utopian, cosmopolitan spaces of Lagoon and Binti (Dustin Crowley). Melody Sue extends these studies of Okorafor's treatment of place to her work with the natural environment, arguing that Okorafor's representations of aliens in Lagoon as coral reefs and Mami Wata devices blends indigenous cosmologies and technological development. This emerging body of scholarship articulates the vibrant ways in which Okorafor's fiction revises colonial and neocolonial worldview through its work with place. But they miss a central aspect of Okorafor's *oeuvre* that is at the heart of her writing and of her popularity with fans and critics: her creation of female heroines. That is, inseparable from and influencing her re-imagination of place is her goal of empowering particular identities within that space ("giving them more agency"). This chapter takes on this aspect of her work, exploring what Okorafor means by empowerment in her portrayal of Binti's mathematical abilities.

[197] Okorafor, Nnedi. *Binti.* New York: Tor Press, 2015, p.41.

Binti's mathematics is quite a formidable power: throughout her galactic adventures, Binti uses mathematics to reconfigure what is possible, and to shift her relationship to the world.

Binti (2015-2018) follows Binti as she embarks on a galactic journey that sparks transformations within her and also in the world around her. In the first book, *Binti* (2015), Binti finds out that she is accepted to Oomza University due her high score on the mathematics entrance exam. Her mathematical abilities are described as coming partly from her father, who uses mathematics to create current that powers *astrolabes*, small cellphone-like communication devices,[198] and partly from her mother, who gives her the "gift of mathematical sight," a protective power that involves communing with nature.[199] Binti decides that she wants to attend Oomza, but is pressured not to by her family, as it violates traditional cultural and gender norms, and by the Khoush, as her acceptance challenges their belief in their superior intellect. Binti goes into a mathematical trance to distance herself from these views and to manage their interpellatory effects. Binti catches a ride to Oomza University on a large fish (called the "Third Fish") that swims through space. On her journey there, the spaceship is attacked by the Meduse, who kill everyone on board. Only Binti survives, protected by a small metal object, an *edan*, that she realizes she can activate through mathematical thinking and use to communicate with the Meduse. Learning that the Meduse plan to attack Oomza to obtain their chief's stinger,

[198] "My father passed me three hundred years of oral knowledge about circuits, wire, metals, oils, heat, electricity, math current, sand bar. And so I had become a master harmonizer by the age of twelve. I could communicate with spirit flow and convince them to become one current. I was born with my mother's gift of mathematical sight. My mother only used it to protect the family, and now I was going to grow that skill at the best university in the galaxy." (Okorafor 2015, pp. 31-32).

[199] This side of Binti's power is less developed in the text, and only becomes fleshed out in the third volume. "My mother, she sees the math in the world, she was born with it. That's where the sharpness of my gift comes from. She was never trained, though. She just used it to protect the family during storms, to fortify the house, sometimes to heal you if you were sick." Okorafor, Nnedi. *Binti: The Night Masquerade.* New York: Tor Press, 2018, p. 154.

violently severed during a Khoush-Meduse war and housed in a museum there, Binti persuades them to let her negotiate with Oomza on their behalf for its return. Not believing that she could advocate for them in her human form, the Meduse sting Binti so that she becomes half-Meduse—this is the first of a series of transformations that Binti undergoes in her journey. Against all odds, Binti succeeds in her negotiation with Oomza, and the stinger is returned to the Meduse without further bloodshed.

If Book One is about Binti finding a wider universe beyond Earth, Book Two is about finding the universe on Earth, and deep in the desert, its "primitive" regions. Book Two, *Binti: Home* (2017), opens at Oomza University, where Binti is excelling in her mathematics studies. But she struggles with her now half-human identity, and the lingering trauma of the Meduse attack, often using mathematical trances to manage her anxiety. Binti returns to Earth for the annual Himba pilgrimage, accompanied by Okwu, a Meduse student. On Earth, they travel to Binti's family home, where she is taken away by the Enyi-Zinaryia, a group of people who have deeper skin than the Himba and live in caves deeper in the desert. Although her father is Enyi-Zinaryia, their family, like other Himba families, consider the Enyi-Zinaryia to be primitive, and associate the discontinuous movements that they make with their arms with disability and illness. But Binti discovers that her own talent at mathematics comes in part from her own heritage as an Enyi-Zinaryia through her father. The Enyi-Zinaryia, moreover, are more technologically advanced than the Himba — they have gold organisms running through their blood that allow them to use movement to communicate with people who aren't there, without the aid of an external device. These gold organisms are the gift of an alien species—the Zinaryia, or "gold people"—who landed near their village long ago. In her second transformation, Binti activates the zinaryia in her blood so that she, too, can communicate in this way, moving her arms to send messages by pressing buttons in the air.

In Book Three, *Binti: Night Masquerade* (2018), the Khoush-Meduse conflict, foreshadowed in the earlier books, comes to a head. The Khoush have attacked Binti's family in an attempt to find and kill Okwu. Binti races home through the desert, accompanied by an Enyi-Zinaryia boy named Mwinyi. Binti successfully uses her mathematical abilities to persuade the Khoush and Meduse leaders to call a truce, but she is killed in the process. Mwinyi takes her body away from Earth on a spaceship that is Third Fish's baby, where she comes back to life, her third transformation, revitalized by the microbes of the baby fish. They stop by the rings of Saturn, where the Zinaryia live. The trilogy ends with Binti at Oomza University.

From this summary, we see that Binti's mathematics is quite powerful and expands her world in many ways, which I will enumerate below.

In the very beginning of the trilogy, mathematics functions as a way of setting Binti apart from other characters—of writing her as "special," as Okorafor puts it.[200] For although Binti's mathematical prowess come from her parents, her abilities outstrip both of theirs ("I was the best in the family").[201] It also leads to her offer of admission at Oomza: "I had scored so high on the planetary exams in mathematics," she reflects, "that the Oomza University had not only admitted me, but promised to pay for whatever I

---

[200] "With Binti, I knew she would be a girl, and that she would not be your typical badass heroine who could kick ass and do all those things. I knew she would have other qualities that would make her special." *Wire* interview.

[201] Okorafor 2015, 30. The idea of being the "best" is emphasized in the story: Binti is "the best" in her family and also among her people. As she represents to Okwu: "I am the best of the best. I can create harmony *anywhere*" (56).

needed in order to attend."[202] In this moment, mathematics in *Binti* is understood as a field of knowledge that is shared across cultures. Binti, who is described as never having communicated with any other peoples or cultures, nevertheless does the same mathematics that they do. The idea of math as universal—a part of how people from all cultures think—plays an important role in the text, because it is what allows someone like Binti, who is from an isolated people, to excel at a field of knowledge that is her own and that is also shared by other human groups. As the first Himba to be accepted into Oomza, Binti's mathematics opens up spaces beyond those that she is expected to occupy. However, it does so in quite a banal way, replicating standardized testing and admissions exams in the real world.

As the trilogy progresses, Binti's power takes on more marvelous functions. In moments when her agency is restricted and/or she is under threat, Binti goes into a mathematical trance with the effect that, after the trance, the calculus has shifted, and her agency widens. That is to say, Binti's math is a power in the very real sense that she can use it to change the circumstances in which she finds herself and/or her ability to act in the world. We can categorize her mathematics as functioning in two main ways: 1) in creating new experiential environments, and 2) in the creation of current that manipulates things in the world.

In this first category are moments where Binti enters into mathematical thinking with the state of trance itself being the end goal. In situations of stress, Binti enters into a mathematical trance that papers over the actual world with a realm of imagined, mathematical objects, which keeps her from fully perceiving what is happening and/or replaces it with another perception. After an alien species invades the spaceship and

[202] Okorafor 2015, p. 13.

murders her friends, for example, Binti, frozen in shock, enters into such a trance ("My mind cleared as the equations flew through it, opening it wider, growing progressively more complex and satisfying. V-E + F = 2, a^2 + b^2 = c^2"), in which she is momentarily protected from the traumatizing effect of what has happened and can gather herself into a protective position ("I thought. I knew what to do now," she thinks in the trance, remembering to gather food before locking herself in her room[203]). This is powerful because it allows her to delay and to manage the *effects* of the circumstances in which she finds herself, when she is unable to change the circumstances themselves.

The second category includes moments when Binti directs her mathematics outward and at the world. This use of her mathematics builds on her identity as a Himba harmonizer, who uses mathematical trancing to create electrical current that unites unlike things, creating "harmony" between unharmonious entities.[204] Learning this from her father, Binti attempts to extend these powers of harmonizing to warring groups, although the mechanism by which her current can act on people is unclear. For example, in the climactic war council between the Khoush and Meduse, Binti uses mathematical thinking to call up *deep current*, a Himba power, to persuade these long-warring groups to end the galactic conflict.[205] In this universe of warring species and centuries-long histories of conflict, this is significant—Binti's math is able to re-shape what is possible, and what happens.

---

[203] Okorafor 2015, 32.

[204] "My people are the creators and builders of astrolabes. We use math to create the currents within them. The best of us have the gift to bring harmony so delicious that we can make atoms caress each other like lovers." Okorafor 2015, 62.

[205] Curiously, in the description of this moment, the significant event is cast not as the truce-making itself but Binti's realization prior to it that she can make it happen herself without the help of the Himba council who were not coming. ("I awoke," "I knew the destiny of my people depended on me in that moment." This is an internal transformation rather than an external one: "my world remained as it was… because it was already expanded" Okorafor 2018, p. 113-115.)

II. Trance

This section undertakes close readings of moments in which Binti's mathematical thinking is described in order to build an understanding of the text's notion of mathematical thinking. Binti's mathematical power stems from her contemplation of mathematics, which brings about a state of remove from the external world, described as a "trance":

> My shoulders relaxed as I calmed. Then my starved and thirsty brain dropped into a mathematical trance like a stone dropped into deep water. And I felt the water envelop me as down down down I went….[206]

Her math is powerful because in this state of remove, she can conjure currents that transform the ontological universe. In other moments, it is this state of remove itself that she is after, where the ability to be at a remove from one's surroundings is conceptualized as a kind of power.

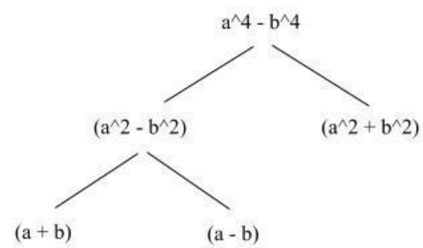
Throughout the trilogy, Binti's trances are brought about by thinking about mathematical equations and numbers:

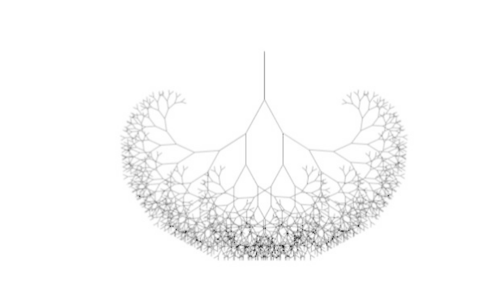
> Imagine the most complex equation and then split it in half and then in half again and again. When you do math fractals long enough, you kick yourself into treeing just enough to get lost in the shallows of the mathematical sea.[207]

Here, the trance state seems to be brought about by factoring mathematical equations ("splitting [them] in half"). In factoring, one considers how an equation can be expressed as the product of two smaller equations, and then, how each of these equations can be further split into even smaller equations, and so on ("in half again and again"). This

[206] Okorafor 2015, 22.
[207] Okorafor 2015, 41.

repetitive activity, thinking about and with mathematical objects, initiates an experience that Binti calls "treeing." As a description of activity, "treeing" is synonymous with "trancing." When Binti trees, she is no longer aware of her physical surroundings. Her attention is on mathematical objects—these terms of her equations: she is "lost… in the mathematical sea." "Treeing" also describes the pattern that her process of factoring leaves behind (see left), a fractal pattern that takes a tree-like appearance (see right).[208] "Treeing" is "the splitting and splitting [of] fractals of equations."[209]





What kinds of mathematics does Binti engage with? Binti's mathematics is the activity of thinking about things that do not exist in the actual world (i.e. circles, triangles, numbers) and their relationships to each other. When Binti factors an equation, she does not seek to establish a relation between the equation and the external world. She does not ask: does this equation describe something in my immediate physical environment?

[208] Note on the images:
Left: To factor an equation means to see it as the product of two terms, often expressed through the diagram on the left.
Right: Fractals are patterns that build on themselves, repeating recursively. The appearance of a fractal depends therefore on the starting pattern. I selected this mathematical fractal because it begins with a similar pattern to that of the factoring diagram (a pattern of branching out) and gives a sense of how the diagram could look if carried out many more steps ("in half again and again," as Binti puts it). This image is in the common domain: https://commons.wikimedia.org/w/index.php?curid=73877448

[209] Okorafor 2017, 130.

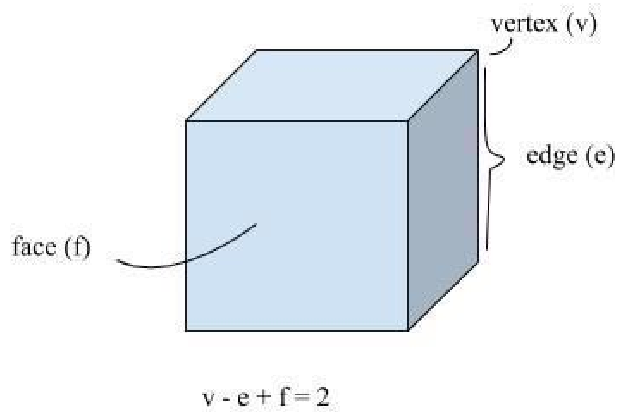
Rather, she asks about relationships that exist between the terms of the equation. Factoring is the process of asking the question: can I express the relationship between these terms differently, as a product of terms rather than as a sum? Her mathematics therefore tends towards "pure" math, which seeks to understand the relationship between mathematical ideas, their properties and rules, rather than "applied" math, which seeks to use mathematical rules to describe or manipulate the world. More broadly, Binti's mathematics spans the fields of algebra and geometry, fields of pure math that study, respectively, the inherent relationships between mathematical symbols, and between mathematical shapes. This distinction between pure and applied mathematics is important because it speaks to the relationship between Binti's imaginative activity and the actual world. As pure mathematics, Binti's imaginative activity is relatively closed to the external world.

To put it in linguistic terms, in Binti's math, mathematical language (these equations that initiate her trances) does not "represent" or "describe" the actual world, but rather "presents" an idea (or "represents" a mental object). In considering the relationship between mathematical and literary language, Baylee Brits writes that mathematical language is not "representational"—there is no object "out there" that it represents—but rather "presentational"—it is both the sign and the thing itself.[210] This is true for some fields of mathematics, but not all. For Binti, it is true when she is factoring: the algebraic variables she thinks with (a, b, x) do not represent or "stand in" for anything beyond their place in the relationship that the equation sets forth. But when Binti thinks about equations about geometry, the terms of the equation do "stand in" for something,

---

[210] Brits, Baylee. Literary Infinities: Number and Narrative in Modern Fiction. Bloomsbury Publishing USA, 2017.

although not something that exists in the external world. When Binti thinks about the geometric equation “v - e + f = 2,” for example, the variables of the equation (v, e, f) represent the geometrical imagination of different parts of the polyhedral object: its vertices, edges, and faces.[211] The cube is an example of a polyhedron:



Thinking about the equation requires that she call to mind the idea of the polyhedron, an abstract concept of a three-dimensional object with straight edges and faces. In general, for Binti’s algebra and for her geometry, we can say that her mathematical equations are “texts” that direct her to think about abstract objects that do not exist in the physical world, whether these are signs or geometric objects. Indeed, her power is described at times as the ability to focus on these objects even in the presence of her physical environment: it is the ability to see things that are “not there.”[212]

Binti engages with a Western history of mathematics, as the four equations that she thinks about (v - e + f = 2; a^2 + b^2 = c^2; e^{i × π} + 1 = 0; z = z^2 + c) are recognizable as the equations of Euler, Pythagorus, and Mandelbrot. This is likely because Okorafor was inspired in her creation of Binti’s mathematics by her experience

---

211 Okorafor 2015, 32-33.
212 Okorafor 2018, 17.

of mathematical work in secondary school in Illinois. When asked about Binti's trance-like, mathematical power, she says:

> I know how I came up with that. When I was growing up, the subjects that I was best at were math and science. And I was best at them when I would not think about it, when I would kind of fall into a meditative state and the answer would come quickly. But if I focused directly on it, I would lose it, it would all fall apart.

Okorafor's description of Binti's mathematical thinking is not far from how mathematicians describe mathematical thinking. In depicting Binti's mathematical practice as a process of reading mathematical equations that call to mind mental objects and also as a state of trance, Okorafor renders the strange dimension of mathematical practice in which "mental mathematical entities are experienced as actual objects, more or less clearly or obscurely perceived, that have their own properties," as Reuben Hersh writes, something that she likely encountered in her own mathematical studies. While Hersh writes that this phenomenon has thus far eluded disciplinary study—falling outside of the disciplinary projects of history of math and the philosophy of math—Okorafor reveals and draws attention to this dimension of mathematical practice in her fiction.[213] Her work suggests that literature can help us to understand mathematical fields, fields considered objective, and can reveal similarities between the "two cultures" that might otherwise remain invisible.

---

[213] In a study of these narrative accounts of mathematical experience, Hersh writes that "[w]hat some mathematicians say they are doing" includes finding their way through a "labyrinth," "landscape," or "geography of mathematical reality." "There is no 'furniture' or 'labyrinth' in any literal sense… [they] are encountering mental mathematical entities. These mental mathematical entities are experienced as actual objects, more or less clearly or obscurely perceived, that have their own properties, which the mathematician may struggle for a long time to ascertain" (95). Hersh notes that these aspects of mathematical experience, emerging from practitioner accounts, have not received serious attention. See Hersh, Reuben. "Experiencing Mathematics: What Do We Do, When We Do Mathematics?" American Mathematical Society (2013): 92-95.

III. Enlightenment

This section re-reads Enlightenment mathematics through Okorafor's notion of mathematics as a power to show that it could, indeed, be described as a kind of power. In the process, I explore how her portrayal of Binti's math as a trance and as a power draws on and extends the analysis of the strange and fantastical qualities of mathematics in "Part 1: Mathematical Dreamworlds: Enlightenment." In particular, I ask: could mathematical dreamworlds in the Enlightenment be understood as a power like the powers that characters hold in fantasy and speculative fiction? Power in fantasy fiction (i.e. telekinesis, mind-reading) is usually understood as an ability that is superhuman or beyond what is understood to be humanly possible.[214] Binti's math is more subtle than that: it is a power not so much because it is understood to be an ability beyond the human (others can do math) but because of its effects, how Binti uses it to shift the calculus of possibility. Could Enlightenment math be considered a "power" in this sense?

This is a particularly interesting question to ask of Enlightenment thinkers who are in their work defining the human in the sense of establishing the scope of human ability. Descartes' works are preoccupied with the question of whether humans have the ability to know the "world" (described variously as: the question of certain knowledge, the scope of human knowledge, or the foundations of modern knowledge).[215] Within

[214] I struggled to find theorizations of power in fantasy fiction within literary studies, and am relying here on a notion of power as it is discussed (although not specifically defined) in Andre Carrington's *Speculative Blackness,* in particular in his reading of Storm's power. See Carrington, André M. Speculative Blackness : The Future of Race in Science Fiction. 2017

[215] In taking this interpretation of Descartes' corpus, I draw on the work of Peter Machamer and J.E. McGuire, who understand Descartes to be preoccupied with questions of epistemology (how do we know the world?) from his early works (*Rules*) to his late works (*Meditations*, *Passions*). Other scholars, such as Daniel Garber, see his career as to evolving from epistemological to metaphysical concerns, with his late works taking up questions such as: What exists? What is the nature of the world that we seek to know? And how does that understanding then inform epistemology? The difference between these two approaches to his thought, Gary Hatfield writes, is whether the primary emphasis is given to epistemology

postcolonial and literary studies, Descartes is associated with the Cartesian plane and other forms of mathematics applied to the world in the production of knowledge—knowledge that is reductive and, at heart, an attempt to control. Such readings of Descartes' work are reductive, as he was acutely aware of the limits of mathematics in the production of knowledge. At the same time, they elide the more fantastical ways in which he tried to make the argument for certain knowledge, anyway—despite these limits.

In Descartes' works that make the case for the human ability to know the world, he begins not with applied mathematics but with abstract mathematical objects, like the ones that Binti thinks with.

It is in *Discourse on the Method* (1637) that Descartes first sets out his argument that humans are able to know the world. There, he argued that it was possible to come up with a method of acquiring certain knowledge of the world that was modeled after mathematics. This math is not applied mathematics. Rather, Descartes describes mathematics as a realm of knowledge in which it is possible to be certain that the things we think to be true are actually true (where "demonstrations" of truth are possible). As he writes:[216]

> I had no great difficulty in deciding which thing to begin with, for I knew already that it must be with the simplest and most easily known. Reflecting, too, that of all those who have hitherto sought after truth in the sciences, mathematicians alone have been able to find any demonstrations—that is to say, *certain and evident*

---

or metaphysics. Both highlight his concern, throughout, in establishing the human-world relation—what the world is, what humans are, and whether humans can know this world.

[216] It is possible to say that something is true in the sense that there are proofs, and also in the sense that Descartes was simply convinced that mathematical ideas were self-evident, they could not be denied, they naturally followed from what was presented (see his discussion of the triangle in Meditations, Cress 88).

> *reasonings*—I had no doubt that I should begin with the very things that they studied.

In other words, Descartes understands mathematics as the realm of certain, self-evident truth, as Lorraine Daston writes.[217]

Starting with mathematics as a realm of certain truth, Descartes begins to refashion it:

> From this, however, the only advantage I hoped to gain was to accustom my mind to nourish itself on truths and not to be satisfied with bad reasoning. Nor did I have any intention of trying to learn all the special sciences commonly called 'mathematics'. For I saw that, despite the diversity of their objects, they agree in considering nothing but the various relations or proportions that hold between these objects. And so I thought it best to examine only such proportions in general, supposing them to hold only between such items as would help me to know them more easily…. I suppose [these relations and proportions] to hold between lines, because I did not find anything simpler, nor anything I could represent more distinctly to my imagination and senses. I thought it necessary to designate them by the briefest possible symbols. In this way I would take over all that is best in geometrical analysis and algebra, using the one to correct the defects of the other.[218]

He begins by refashioning mathematics, paring away its relations to the external world. He first excludes mathematics that is applied to the world as a way of describing natural phenomena. By mathematics, he does not mean "all of the special sciences commonly called 'mathematics'"—these would refer to astronomy, music, and optics. Rather, he focuses on the "general" rules that hold between these fields of study ("relations and proportions… in general"). He abstracts from these fields of applied mathematics the

[217] Daston, Lorraine, Things That Talk: Object Lessons From Art and Science. New York: Zone Books, 2004. "On the other hand, there is self-evidence: *res ipsa loquitur*, the thing speaks for itself. It does so in mathematics, law, and religion. Geometric self-evidence comes in the form of axioms and postulates about spatial magnitudes too blindingly obvious to require (or admit of) demonstration: for example, the whole is greater than the part."

[218] Descartes, René, and John Cottingham. The Philosophical Writings of Descartes. Cambridge University Press, 1985.

rules that hold between them ("relations and proportions… in general"). In the process of moving from mathematical fields to general rules, he pares away the real-world referents of mathematical ideas, stripping mathematics of its descriptive function. Second, he re-represents the general rules that hold between these fields as geometrical relationships between lines ("I suppose these [relations and proportions] to hold between lines"). The reason for this paring away and this re-representing, he writes, is to maximize the simplicity of mathematical ideas and therefore the ease with which we apprehend them. Paring away real-world referents makes these ideas simpler and allows him to "know them more easily"; re-representing these general rules as relationships between lines makes them easier to visualize ("I suppose [these relations and proportions] to hold between lines, because I did not find anything simpler, nor anything I could represent more distinctly to my imagination and senses"). That is to say, Descartes refashions mathematics as a purely mental activity that involves engaging with mental objects (i.e. abstract lines).

Descartes turns mathematical thinking into a purely mental activity because he believed that only mental objects can be clearly and distinctly known. In what would become known as his mind/body dualism, Descartes understood the mind and the body to be two separate substances. There is a fundamental incompatibility between our minds, made up of mental content, and the world that we seek to know with it, made up of extra-mental content. For Descartes, this suggested that it is only in intellectual activity that does not involve the senses that we can be sure of the truth of our ideas. He takes this position to the extreme in *Meditations*: in his methodical doubt, he doubts any truths that involve the senses, understanding the senses to introduce confusion and error. There, the first truth that he establishes—"cogito, ergo sum"— is a truth established by the mind: "clearly and distinctly perceived" by the intellect.[219] In *Discourse*, Descartes begins his epistemology with mathematics as an example of clear and distinct knowledge. He therefore wrests it from the senses, and from the realm of sense perception, paring away its associations with the fields of astronomy, music, and optics, in which thinking about mathematics is always a way of thinking about the night sky, sound, and sight. By re-representing the rules that come from these fields as relationships between abstract lines, he eliminates aspects of mathematics that might otherwise invite the senses into intellectual activity. But this leaves open the question: If certain truth is only possible in mathematics as a field of intellectual objects, how could truth in this sense help to define truth in the external world?

Although Descartes separates body from mind, and the senses from intellect, he returns repeatedly to the body and the senses in his description of the method. Mathematics, refashioned as a realm of mental objects, he writes in *Discourse*, acts on the thinking self: "From this, however, the only advantage I hoped to gain was to accustom my mind to nourish itself on truths and not to be satisfied with bad reasoning." With words such as "nourish" and becoming "accustom[ed]," Descartes' "mind," echoing Binti's "starved, thirsty brain," is a second body that consumes and remembers experiences and can become accustomed to them.

As he elaborates in *Rules for the Direction of Mind* (1628), we can use mathematics as a training ground for the mind. The simplicity of mathematical ideas make them a kind of starting point for the mind, a first exercise, so to speak:

---

[219] Descartes, René, 1596-1650. Discourse on Method; And, Meditations on First Philosophy. Translated by Donald A Cress. Indianapolis: Hackett Pub, 1998, p. 63-64.

> We must not take up the more difficult and arduous issues immediately, but must first tackle the simplest… It is surprising how much all of these activities exercise our minds, provided that we discover them for ourselves and not from others… they present us in the most distinct way with innumerable instances of order, each one different from the other, yet all regular. Human discernment consists almost entirely in the proper observance of such order.
>
> We must therefore practice these easier tasks first, and above all methodically, so that by following accessible and familiar paths we may grow accustomed, just as if we were playing a game, to penetrating always to the deeper truth of things.[220]

Considering mathematical ideas, these clear and self-evident things, and following them to their necessary conclusions, something happens to our minds that allows us to see truth more broadly (to "penetrat[e] always to the deeper truth of things"). This something is that we become "accustomed" to what seems to be the movement ("following accessible and familiar paths") and qualities of truth ("instances of order"). As he writes in *Principles*, "The study of these principles will accustom people little by little to form better judgments about everything they come across, and hence will make them wiser."[221]

Descartes makes the connection between the realm of mathematics, for whose simple and limited objects certain truth is possible, and the actual world, which makes no such guarantees, by conceptualizing math as an *experience*. Mathematical thinking presents the thinker with *experiences* of truths and reasoning. The conceptualization of mathematical thinking as experience is important because it means that from mathematical thinking, the thinker gets not only knowledge of specific mathematical truths, but an experience of truth that can be applied more generally. "The study of these principles will accustom people little by little to form better judgments about everything they come across, and hence will make them wiser," as he writes. These experiences act

---

220 CSM 36. *Rules* is an unpublished text that Descartes abandoned in 1628; he revisits the thinking in it in *Discourse.*

221 CSM 188.

on the thinker's "mind," where mind is described to function in an analogous way to the body. These experiences, accumulating on their minds-conceptualized-as-body, create the taste and the desire for other experiences of truth, which guides them to seek out and to recognize truth in the actual world.

In conclusion, despite the common understanding of math's centrality to the Enlightenment as a descriptive tool that encouraged faith in individual ability to know the cosmos, that notion of math did not ground the notion of the human. In seminal texts that lay out the case for human knowledge, Descartes dismisses the uses of mathematics to explain the physical universe. Aware of the incredible aptness of mathematical formulae to the description of the physical universe, Descartes nevertheless believed mathematics to be fundamental to epistemology in a different way: as a realm of objects to habituate the mind. For mathematics, as he understood, cannot explain the whole cosmos. While it can be used to describe the heavenly bodies, it cannot explain things that do not operate according to mathematical laws—things beyond the "mathematical world." Descartes refashions math as a way of training the self to recognize truth itself, understood as a sensation/effect on the mind. By turning mathematics into a training ground for the rational subject, he extends the uses of math to fields beyond the mathematical world. Although it would perhaps be anachronistic to refer to mathematics in Descartes as a superpower, it is accurate to say that mathematics as he understood it extends human ability. While he begins with the belief that certain knowledge inheres only in mathematical objects, by refashioning mathematics as the rational method, he writes into being the possibility of certain knowledge of the world. It is this transformation, this sleight of hand, that Okorafor's conception of mathematics as a power highlights, as I elaborate in my next section.

IV. Bodily Experience

This section builds on the analysis in "II. Trance" to further elucidate the workings of Binti's mathematical power. It shows that Binti's mathematical thinking produces effects on her body. Okorafor takes Descartes' notion of mathematics as acting on the mind-conceptualized-as-body and transforms it by portraying mathematical thinking as actually impacting Binti's body. In *Binti*, therefore, thinking with abstract, mental objects has bodily effects.

In her mathematical thinking, in focusing on objects that are "not there," she begins to experience their effects on her body. Focusing her attention on numbers in the desert, she begins to "see and feel" the numbers. These objects are not merely mental, but rather activate her bodily senses of feeling and sight. They do not remain in her mind: rather, her body finds itself situated within and among these objects, as I will elaborate.

Thinking about abstract, mathematical objects, she brings these objects into perceptual being. By bring into "perceptual being," I mean bring into being to her senses, not only to her mind, but also to her body. This is evidenced by the description of her mathematical development. Mathematical skill is described as the ability to bring mathematical objects to mind and to focus on them, even in the presence of one's physical surroundings. Finding this difficult as a child, Binti would leave her family home to practice mathematics: "I brought my small tent, set it up in the middle of the semicircle, and sat inside it while gazing out at the desert as I practiced equations, algorithms, and formulas for mathematical currents that I'd use in astrolabes I was making…. I'd needed the hard silence of the desert because I was still learning back then. This place was perfect."[222] The desert, with its relative emptiness (its "silence") compared to her home, allowed her the focus necessary for her mathematical activity, which is at heart about conjuring up concepts that are not already there.[223] Binti describes her attempt to bring these ideas into (visual and tactile) being by digging them into the sand: "When I practiced, I liked to dig my fingers in the sand and scratch circles, squares, trapezoids, fractals, whatever shapes I needed to visualize the equation."[224] These circles that Binti "digs," falling between representation and presentation, writing and drawing, can be understood as diagrams that help her in her thinking[225]. The relationship of Binti's math to the natural world (the desert) is described through the language of creation rather than description, *poeisis* rather than *mimesis*: she draws or writes on top of (superscription) the desert rather than delineating or describing it. As she improves, she no longer etches these objects into the sand, but rather sees them around her as she thinks: "circulating around you like the eye floaters you see on the surface of your eye if you pay too close attention."[226] The way that the signs and concepts surround Binti's body suggests immersion—that these concepts are not contained in her mind, as

---

[222] Okorafor 2017, 105-6.

[223] Elsewhere, Binti describes practicing mathematical thinking with fellow travelers in her room in the spaceship because it "was the emptiest," where the absence of solid things helps with the kind of abstract thinking that is required (Okorafor 2015, 22).

[224] Okorafor 2017, 105-6.

[225] Diagrams "have some of the attributes of representation, but is situated in the world like an object" (BM). "The perceived diagram does not exhaust the geometrical object… But the properties of the perceived diagram from a true subset of the real properties of mathematical objects. This is why diagrams are good to think with" (Netz, quoted in BM, 7).

[226] This ambiguity as to whether mathematical objects are actually, physical there (circulating around her) or only in her perception (like floaters on the surface of the eye) persists throughout the trilogy. This is a question about the status of the object: whether it is objective, belonging to the world, or subjective, belonging to the subject. For this reason, I say that Binti brings her mathematical objects into "perceptual being."

mental objects, but rather that she has become immersed within and among them, that they form an environment around her: a "mathematical sea."

The strange environments that mathematical thinking presents Binti can take on many forms—a rabbit-hole, numbers floating, a stone dropped into deep water—but they share in common their ability to affect Binti, acting on her body as experience. At times, mathematical thinking seems to usher in completely new environments, thickly and opaquely lacquered over the actual, physical world:

> I grabbed at Euler's identity, e^{i × π} + 1 = 0, and I went from plummeting to gently floating down a warm rabbit hole with soft furry walls and landing on a bed of pillows and flowers. When I looked up from this fragrant quiet place, the narrowed telescopic view made things above clearer.[227]

> I hummed, I let myself tree, floating on a bed of numbers soft, buoyant, and calm like the lake water. Just beautiful, I thought, feeling both vague and distant and close and controlled.[228]

While the objective status of these environments are in question, their effects on her are undeniable. Described with words such as "plummeting" and "floating," these environments have a magical, fantastical sensibility. These words hone in on how these environments inflect the body, the body's relation to the space, its speed of movement through it. They are descriptions that focus on her experience of the environment, how it made her feel ("I… fel[t] both vague and distant and close and controlled"), which may call up an earlier quote where mathematical thinking is described as the feeling of one's brain being dropped into deep water: "My shoulders relaxed as I calmed. Then my starved and thirsty brain dropped into a mathematical trance like a stone dropped into deep water. And I felt the water envelop me as down down down I went." Water and sea,

[227] Okorafor 2017, 43.
[228] Okorafor 2017, 86.

often present in these descriptions, suggest that mathematics presents her with a very different experience than her experiences of the actual world, plunging her into another medium: water rather than air.

Binti's mathematical environments—the spaces to which her thinking takes her—do not fit neatly into the traditional categories of spatial theory. In *The Production of Space*, Henri Lefebvre articulates social space by distinguishing it from mathematical or logical space.[229] Rather than a realm of mental objects, he redirects us to think about actual spaces and the ways in which they are produced by and produce social dynamics. But *Binti*'s mathematical environments show that spaces of abstract mathematical objects can similarly be, if not social space, then at least spaces of lived experience. In his analysis of Paris, Lefebvre articulates three forms of space: (1) physical or perceived space, (2) mental or conceived space, and (3) lived experience, which he described as a combination of the first two.[230] Yet in *Binti*, mathematical environments are at the same time mental spaces and spaces of lived experience, without ever becoming physical space. These spaces are mental spaces in that they involve thinking about ideas that she calls to mind through her equations (it is the space of ideas, of abstract concepts, of things conceived). But they are also spaces of lived experience, in that as she thinks about these ideas, she begins to perceive them, they become tangible to her, and she begins to experience their effects on her body. She relates to these environments as a being bound in time and space: herself within its space and its time. Binti's engagement with what Lefebvre calls a mathematical-logical space evidences that it is important to consider how

[229] Lefebvre, Henri. The Production of Space. Translated by Donald Nicholson-Smith. Oxford: Blackwell, 2007. p. 1.

[230] Lefebvre 40. See also Soja, Edward W. Thirdspace: A Journey Through Los Angeles and Other Real-and-imagined Places. Oxford; Cambridge (Mass.): Blackwell, 1996, p. 10, 22.

subjects interpret the spaces that they inherit, as Katherine McKittrick writes, and to include scales of body and mind—sites of "experience and interpret[ation]"—in the study of geography.[231]

As (lived) experience, Binti's math presents alternative experiences to her experience of the actual world. For Binti, who feels uncomfortable in the spaces of her home, the city, and the university, these mathematical spaces are a welcomed respite. Her mathematical thinking brings into play, in her imagination, objects and spaces that do not exist in the actual world. The question for Binti becomes: how to transport the wondrous environments of mathematical thinking, and the feeling of freedom and calm that she experiences within them, to the actual world? Is it possible?

For Binti, her body becomes the conduit between mathematical environments and the external world. Early in the trilogy, she finds herself under fire for her acceptance to Oomza University, both from her family and from the Khoush. While her family expresses their view that it would be unfitting for her as a Himba to leave home to attend Oomza, from the city, she receives:

> I was the first Himba in history to be bestowed with the honor of acceptance into Oomza Uni. The hate messages, threats to my life, laughter and ridicule that came from the Khoush in my city made me want to hide more. But deep down inside me, I wanted... I needed it. I couldn't help but act on it. The urge was so strong that it was mathematical. When I'd sit in the desert, alone, listening to the wind, I

---

[231] McKittrick, Katherine. *Demonic Grounds: Black Women and the Cartographies of Struggle*. Minneapolis: University of Minnesota Press, 2006. "Places and spaces are experienced subjectively, and interpretations of such discourses, locales and scales reflect this. Black women are not only defined according to white and patriarchal discourses, black cultural expectations, and class differences, they experience and interpret these cultural purveyors differently." McKittrick, Katherine. "'Black and 'cause I'm Black I'm Blue': Transverse Racial Geographies in Toni Morrison's 'The Bluest Eye'." *Gender, place and culture: a journal of feminist geography* 7 (2000): 125-142. "The place of black women in relation to various scales: in their minds, in their bodies, in their homes, in urban/rural centres, and in the nation."

> would see and feel the numbers the way I did when I was deep in my work in my father's shop. And those numbers added up to the sum of my destiny.[232]

Entering into mathematical thinking, however, she encounters another context (frame of reference, set of coordinates) for herself, that allows her to understand herself differently. Amongst the numbers that she sees and feels, she experiences an urge "so strong... I couldn't help but act on it." The urge "was mathematical": "those numbers added up to the sum of my destiny." Thinking with "numbers" and their "sum[s]" presents an experience of necessity that runs counter to her friends' assertion that her "destiny," as a part of the Himba people, is to stay on ancestral land, and as her father's daughter, to take on his work. Binti's mathematical thinking takes her to a realm in which her experiences affect and influence her just as events do in the real world. This alternative realm of experience opens her up to new forms of being, influencing the decision that she ultimately makes to leave home.

The text dramatizes how a person's experiences, in dreamworlds and also real life, modify the body, leaving marks that linger past the moment of experience. As Binti travels from her home in the desert to the city, she experiences the Khoush's racist reactions to her presence. On the bus into the city, people lean away, "face[s] pinched as if they smelled something foul."[233] In the city, and waiting to board the space ship, a woman pulls her hair and asks whether "[it is] even real?" "These dirt bathers are a filthy people," a woman remarks, referring to the Himba tradition of covering the body in sweet clay.[234] Onto her body—her hair, skin tone, and the ornament of clay that she wears, the Khoush attach assumptions of primitiveness, backwardness, and social otherness. There

---

[232] Okorafor 2015, 29
[233] Okorafor 2105, 10.
[234] Okorafor 2105, 16.

is a particular danger to this experience, which Binti senses, as she begins to "recognize" the "knowledge" that these people have of her, appearing in her shame. She "cast her eyes to the floor," and "felt her face grow hot." Binti's experiences in the city modify her body, how she carries herself, what Fanon would call her body schema—"the composition of my self as a body in the middle of a spatial and temporal world." Her thoughts mark the dissociation she experiences from her own view of herself earlier that morning, when she decided to travel to the station. "What am I doing [here]?" she asks (and then "What was I thinking?") Elsewhere in the trilogy, the lasting impact of momentary experiences on the body is figured through the conceit of multi-species becoming: Binti, in her encounters with other species, often becomes more than herself, acquiring some of their physical qualities. Encounters in real life as much as in dreamworlds, Binti shows, have effects on the body and on body memory.

Binti's experiences recall Fanon's writing about his first visit to Paris from the French Antilles. There, he writes of the way that experiences of racism linger on the body, shaping how bodies orient themselves in space.[235] Fanon reminds us that there is a phenomenological theory of race that understands experiences of racism to act on the body, to shape how people inhabit the world past the moment of experience. Curiously, mathematical dreaming appears as an alternative realm of experience that counters the lingering effects of racial experience on the body. At the launch port, smarting from the remarks of the Khoush, Binti fingers her *edan*, a small metal device that she keeps in her pocket with a geometric figure inscribed onto it. "I let my mind focus on it, its strange language, its strange metal, its strange feel."[236] This singular object re-orients her in the

[235] Fanon, Frantz, and Charles Lam Markmann. Black Skin, White Masks. London: Pluto, 1986.
[236] Okorafor 2105, 16.

space station. She had found it in the desert, and its origin and date are unknown. The geometric figure on its surface also does not date it. Contemplating its geometric surface takes her into the space of mathematical thinking, a timeless, placeless realm, as mathematical concepts are defined without the language of place and time. This realm of thinking becomes a realm of experience, as the concepts that she thinks about begin to appear, as objects that she can see and feel. In this context, this newly materialized frame of reference, she could be anyone, she is unlimited by the interpellation of other people, fixed onto her outward, physical form. Binti's mathematical dreamworld gives her another field of reference through which to interpret herself and her worth. "Those women talked about me," she notes, "the men probably did too. But none of them knew what I had, where I was going, who I was." In this realm, she reclaims her "I"—an "I" outside the normative construction of her body as gendered and racialized.

Binti's mathematical thinking, which presents to her environments beyond the actual world, cannot be turned into reality directly. Rather, these environments, called up and secured by language, affect her as imagined environments in her mind that become an experience on the body. These experiences remind her of alternative versions of self that do not transcend but rather exist in excess of racialized and gendered subjectivity.

In conclusion, this section extends the analysis of Binti's mathematics in "II. Trance" as a realm of imagining without reference to the actual world in order to consider how such an imaginative realm could produce effects in the real world. I have argued that Binti's mathematical dreaming affects her in the actual world as a realm of experience that acts on the body and counters the effects of racial and gendered experience on the body.

In *Binti*, there is the strange combination of violent, racialized, and gendered spaces with the feeling of relatively free movement through them. The spaces in *Binti* are stark: the Khoush maintain their dominance by restricting access, exerting their force on the micro scale, in social interactions such as the ones discussed, and also on a macro scale, through institutional force and violence, as when the Khoush military bombs Binti's family home, and when they ultimately kill Binti. And yet, these actions seem to have little lasting impact on Binti and her family, partly explained by mathematical powers. As Binti discovers, during the bombing, her mother "used her mathematical sight" to protect the family, sealing them into the earth, so that everyone survived.[237] When Binti is killed by a Khoush soldier, Mwinyi takes her onto a fish spaceship, where she is revived through the cells of the infant fish. As Amal El-Mohtar writes, "Right now, the fantasy in the *Binti* novellas, the fiction, isn't the jellyfish-aliens, the magical math or strange artifacts, but the ease with which travel is allowed black and brown people between planets, nations, lives."[238]

VI. Happy Endings, Virtuality, and Okorafor's Theory of Speculative Fiction

> Okorafor: Part of why I started writing was I wanted to tell stories of women and girls—African women and girls. Mind you, one of my favorite authors just passed, Buchi Emecheta. I was devastated about that, because this woman's work had such a huge impact on my own writing, on why I am a writer. She was writing honest, really hard-hitting stories about African women. She wrote over 20 novels, and I read them one after the other. It made me kinda crazy, because her stories, her narratives, often either didn't have a happy ending or they were really

[237] Okorafor 2018, 154.

[238] https://www.npr.org/2017/02/04/512042817/a-spacefarers-next-great-adventure-begins-at-home

> disturbing. You'd be sweating reading these books; you'd want to punch walls reading these books. Once I started writing, I knew I wanted to tell those kind of narratives too, the narratives of the women that I grew up with. I wanted to empower them, I wanted them to have different endings, I wanted to give them more agency.
>
> Interviewer: Is that part of why the ending of Binti is, for lack of a better word, so nice?
>
> Okorafor I like nice! Even though some people have accused me of the opposite—yeah yeah, some of my other books have gone dark. But I like happy too. Like, come on, can't we have one of those? Where everything goes well and it's nice and shiny? I mean, at the end of Binti, she is changed. She's gone through something horrible. But I wanted her to come out the way she did.[239]

I return to this quote with which I began the chapter because it captures the questions that I had when I first started writing: what is the point of reading things that are not true in actual life? What could be the value of reading happy endings, as Okorafor says in this interview? In this section, I suggest that this question is central to Okorafor's thinking about her own writing and about speculative fiction as a genre. Between the years 2008-2018, as a conversation was developing around African speculative fiction, Okorafor published a series of non-fiction prose pieces about the power of speculative fiction for marginalized audiences. Turning to these pieces, this section considers Okorafor's argument for the value of speculative fiction as the imagination of realms detached from the actual, real world in the light of Binti's mathematical power—the power to enter into such realms. Okorafor suggests that narratives can be understood as technologies for virtual experiences beyond one's experience in the actual real world; new narratives eschewing realist representational norms scaffold new experiences that alter how subjects can be formed, opening up new realms of possibility.

---

[239] *Wired* interview.

In recent years, there has been a surge of interest in reading, writing, and studying African speculative fiction. To say "the rise of African speculative fiction" is not to imply that there was no African or African-American speculative writing prior to 2000—indeed, Amos Tutola's *My Life in the Bush of Ghosts* (1954) and W.E.B. DuBois's "The Comet" (1920) are clear examples of speculative fiction. In 2000, Sheree R. Thomas published the first anthology of speculative fiction from the African diaspora, *Dark Matter,* which was followed by *So Long Been Dreaming: Postcolonial Visions of the Future* in 2004. In 2009, the film *District 9* and Twitter controversy Racefail foregrounded the question of race and representation for popular audiences and readers of science fiction. In 2012, the first African SF magazine, *Omenana*, was established. In 2015, Okorafor's *Binti* won both the Hugo and Nebula awards for best sf novella. In 2016, The African Speculative Fiction Society launched at Nigeria's Aké Arts and Book Festival, and with it came the Nommo Awards, annual awards for best African speculative novel, novella, short story, and graphic novel. 2018 saw the release of the film *Black Panther*, which attracted a large audience, becoming the ninth-highest-grossing film of all time, and the third-highest-grossing film in the U.S. and Canada, as of this writing.[240]

Among writers of these emerging and vibrant bodies of work, there is a question. Speculative fiction, unlike realism, does not strive for realistic representations of the world. What does imaginative activity detached from the "real" world get us? Okorafor takes up this question in her essays. Anticipating criticism of speculative fiction as flights of fantasy and apolitical escapism, she insists on the value of speculative fiction for African audiences in a 2014 essay, "Is Africa Ready for Science Fiction?"

[240] Last checked on Jan. 2020.

Within literary theory, the political power of speculative fiction is understood to inhere in the way that enables readers to see reality anew. In "On the Poetics of the Science Fiction Genre," Suvin defines science fiction as literature that include a new element, a *novum*, different from the author and readers' empirical environment, while keeping many other things the same.[241] The effect is that readers recognize the textual world to be the real world, but at the same time find it unfamiliar, a state that he calls "cognitive estrangement." As a defamiliarized representation of the empirical world, science fiction allows readers to make connections that they cannot make about the real world, and this is the source of its power as social critique. In other words, although the worlds of science fiction appear different from the real world, they ultimately refer readers back to the real world, to consider how the fictional world is a reflection of their own, enjoining them to see their world differently. This understanding of where speculative fiction's political power comes from limits it to the writing of a set of worlds that serve as a lens onto the reader's world—everything else is fantasy, whose political power cannot be vouched for.

To this understanding, Okorafor adds several new elements. In the years leading up to the novel, she wrote a series of blog posts on speculative fiction that took on critiques of the genre as childish play or as flights of fantasy. "African audiences don't feel that science fiction is really concerned with what's real, what's present. It's not tangible. It's sport. Child's play," reads a 2009 post.[242] In response, however, she insists that art can be political and entertaining ("we will have to deliberately combine 'art as a

[241] Suvin, Darko. "On the Poetics of the Science Fiction Genre." *College English* 34, no. 3 (1972): 372-382, p. 374-5.

[242] Okorafor, Nnedi. "Is Africa Ready for Science Fiction," August 12, 2009. The Nebula Awards Blog. http://www.nebulaawards.com/index.php/guest_blogs/is_africa_ready_for_science_fiction/ (accessed January 31, 2019)

tool for social critique and commentary' and entertainment"). A 2014 post takes a stronger position: science fiction is a genre "practically made to redress political and social issues." Imaginative activity removed from the actual world, rather than being flights of fantasy, "carries the potential to change the world." She cites defamiliarization as a source of science fiction's social and political potential—"science fiction also triggers both a distancing and associating effect. This makes it an excellent vehicle for approaching taboo and socially relevant yet overdone topics in new ways." But also, she names other qualities of speculative fiction as important, such as the ability to *imagine new technologies* that are later made into actuality ("The concept of the very computer that I am using to type these words was first dreamed up in a science fiction novel"), and the quality of *being fun* ("Oh and, these narratives are a lot of fun, too"). And lastly, she writes, "the power of the imagination and narrative should not be underestimated." In writing *Binti*, Okorafor says, "I was inspired to write… because of blood that runs deep, family, cultural conflict, and *the need to see* an African girl leave the planet on her own terms."[243] That is, she speaks of the power of the imagination, and of the power of seeing something happen that did not happen to someone in the actual world, arguing that this itself is important and transformative. She also speaks of the power of pleasure and play. Speculative fiction is a genre that is fun to read, she notes, with this word "fun" highlighting the playful and inhabitory qualities of sf, that link it to fantasy and video games. She insists, however, that fun does not mean apolitical. As she writes, "we will have to deliberately combine 'art as a tool for social critique and commentary' and entertainment".

---

[243] Okorafor, Nnedi. "Sci-Fi Stories that Imagine a Future Africa." August 2017, 8:45, https://www.ted.com/talks/nnedi_okorafor_sci_fi_stories_that_imagine_a_future_africa.

What is the power of seeing something regardless of its relation to the actual world, regardless of whether it actually happened, or actually could happen? Okorafor explores this question through Binti's mathematical power. Binti's mathematical power, the power to enter into a realm of imagining detached from the real world, is a figure for the power of speculative fiction within the text. Like the worlds of speculative fiction, her mathematical dreamworlds are imaginative spaces detached from the "real" world and secured by language.

"Reading" (thinking with) numbers, she begins to "see and feel" them: they are layered over her immediate physical environment. They take her away from her physical environment, that is, the textual real world, just as readers of speculative fiction are taken into imagined worlds that do not resemble their immediate physical environments (what they think of as the real world). Portraying mathematical dreamworlds as an alternative realm of experience for Binti that acts on her body and that habituate her body memory, Okorafor suggests that regardless of the relationship between imagined world and real world, detached imaginative worlds are important because they are a real experience on the body, or as Deleuze would put it, they are actualized—they become actual—in the process of being experienced by the body.[244] If the body is a repository of how it has been treated, as Fanon argues, then virtual experiences offer new forms of shaping for the self, perhaps not beyond but in surplus of racialized and gendered experience. She suggests, by extension, that speculative fiction is itself a kind of virtual experience. That is to say, she presents a theory of fiction that understands fiction primarily as a way of erecting imaginative environments for readers to inhabit. Okorafor presents a theory for

[244] Deleuze, Gilles. Bergsonism. Translated by Hugh Tomlinson and Barbara Habberjam. New York: Zone Books, 1991.

the political power of speculative fiction that moves away from models of defamiliarization (how one "sees" the world) and towards models of embodied experience (how one is habituated to be in the world).

It becomes clear, perhaps, why a sense of fun and play are central to Okorafor's description of African science fiction. Her works, which act as virtual realities that are unleashed onto readers in the experience of reading, must be inhabited to take effect. They must be worlds that are dwelt in, that readers seek at the end of a long day of work, and that are returned to. Her theory of speculative fiction explains the significance of popular cultural objects like *Black Panther*, that are less about creating defamiliarizing lenses onto the real world than about creating and transforming the imaginative structures that we inhabit and that habituate our body memory. Moreover, this theory of speculative fiction that she presents—speculative fiction as a way of creating virtual worlds for subaltern subjects—links the virtual worlds of the novel to those of video games and across the high/low divide. And it gets at a question that is at the heart of literary study—why fiction?: what is the use of imaginative freedom in the face of material realities?—by drawing attention to the imaginative structures that shape our being in the world.

Using mathematical dreamworlds as a figure for speculative fiction, Okorafor highlights the enduring presence of a dreamworld of mathematics within Western thought. Okorafor, like Woolf and Ghosh, discloses the imaginative and aesthetic dimensions of mathematics, which are part of the experience of mathematical work, but are not recorded in mathematics as an academic field of study, or in the history of mathematics. Their work suggests that literature is a site where such qualities of mathematics, which give us a more complete picture of the field of study, are uncovered.

My project brings literary methods to mathematical and scientific thinking, thinking that is considered objective. I show that literary analysis as a mode of thinking is important to understanding other disciplines and how they have formed. Throughout this project, there is a question about how to engage with Enlightenment legacies of thinking. Rather than taking up Enlightenment mathematics to critique it—as Woolf and Ghosh do—Okorafor takes up this imagination as if she could have found it anywhere. For her it is a tool, a pre-made imagining of a realm without place or time, that the individual can access. She takes it as a tool for her imagination machine, intent on producing the imagination of someone like Binti who is at the center of the universe's activities. Virtual worlds must precede actual ones, writes Gloria Anzaldúa, for "Nothing happens in the "real" world unless it first happens in the images in our heads." In Binti, mathematical dreamworlds are a tool for the fashioning of virtual worlds, and by extension, the spaces in which we think about and become human.

Coda

This project began as an attempt to think about the relationship between mathematics and literature in more productive ways. In interdisciplinary work that revealed rich connections between literature and science, I found that mathematics was often left untouched. In Barbara Stafford's *Body Criticism*, for example, Stafford writes of the ways in which metaphors can allow us to see cross-disciplinary movements, and to forge "un-thought of connections."[245] Yet in her work, her own metaphors leave mathematics behind, in the realm of the objective, and as the opposite of literature: "For the geometrical spirit, metaphors were always a sort of an alien 'misfit' or gross monster of difference."[246]

I was interested in this phenomenon partly because of my own experience in mathematics, which showed me that mathematicians often talked about mathematical experience as a creative activity. But I was also interested because, as science scholars Lorraine Daston and Peter Galison have shown, what we produce as the objective world also produces us as the subject.[247] Daston and Galison uncover the way that scientific concepts and tools, in establishing a notion of what is, also and at the same time established a notion of the perceiver, the subjective, the human. Sylvia Wynter takes this one step further. Human society, she suggests, establishes itself through "descriptions" of the universe understood to be objective but are in fact "truths-for."[248] That is to say, the rules for a society are created and hidden in descriptions of the universe understood to be

---

[245] Stafford, Barbara Maria. *Body Criticism: Imaging the Unseen in Enlightenment Art and Medicine*. Cambridge Mass.; London: MIT Press, 1997. p. 8.

[246] Stafford 4.

[247] Daston, Lorraine, and Peter Galison. *Objectivity*. New York: Zone Books, 2007.

[248] Wynter, Sylvia. "Unsettling the Coloniality of Being/Power/Truth/Freedom: Towards the Human, After Man, Its Overrepresentation--An Argument." CR: *The New Centennial Review* 3, no. 3 (2003): 257-337

objective. This is an act of ventriloquism. Something that is *made* is passed off as something that *is*—fiction passes as science. Taken together, these thinkers suggested to me when something is clearly a creative act and passes as an objective one, it's important to look deeper.

These interests coalesced in a set of literary texts in which mathematics appears as a form of dreaming and as a form of becoming. I was drawn to these works by Virginia Woolf, Amitav Ghosh, and Nnedi Okorafor because they presented mathematics as an object of desire, and associated it with the desire to be universal. These authors are what Kandice Chuh calls minor subjects—those excluded from Enlightenment notions of the universal human.[249] In their work, they write as mathematicians characters who are, by dint of their race and gender, not associated with the Enlightenment figure of the mathematician and with the qualities of universality that such association bestows.

Rather than write these notions of mathematics off as part of the author's fantasy or misunderstanding of mathematics, I took them seriously. In reading these texts, I focused first on the textual presentation of mathematics, and then to move outward to the important cultural and historical research that could help me to contextualize that presentation. I did not want to impose onto the texts what I thought was literary or what was mathematical—what was "actually" mathematics, and what was the authors' embellishment. Such distinctions impose disciplinary boundaries where they may not exist.

This dissertation is a result of these interests, texts, and this methodology. It is well known that within liberal modernity, mathematics was understood as a training that

---

[249] Chuh, Kandice. *The Difference Aesthetics Makes: On the Humanities "after Man".* Durham: Duke University Press, 2019

could turn European man into the universal human, understood as the rational subject. In Part 1 of this project, I took a closer look at how mathematics was understood to operate on thinkers in readings of Descartes' *Discourse on the Method* (1637) and *Kant's Critique of Pure Reason* (1781). I showed that Descartes and Kant produced mathematical dreamworlds, writing that narrates pure mathematical thinking as an experience that takes place in a realm beyond the real, physical world. In the space of pure mathematical thinking—a sensible realm where all markers of time, place, culture, and history are absent—they understood the universal human to come into being. I then traced this Enlightenment dreamworld of mathematics to 19th-century British discourses on liberal education, where this space that trains the rational, universal subject becomes an important part of education that was understood to produce subjects with the authority to rule over empire.

These readings helped to set the ground for the literary texts that followed in Part II. Woolf, Ghosh, and Okorafor take up this notion of mathematical dreamworld to explore how it works for different subjects. In *Night and Day* (1919), Katharine uses mathematical thinking to inhabit an alternative realm to the real space of the drawing room, a realm without reference to the real world. In *The Calcutta Chromosome* (1996), Ghosh uses a notion of mathematics' universality to write Mangala—an illiterate, low-caste woman who cleaned the laboratory—as the leader of a global history of science. For Okorafor's *Binti*, a mathematical dreamworld appears to help Binti access a version of herself that is different from how she is interpellated as a woman within her traditional community and also by those who see her people to be primitive and underdeveloped. In each case, writers draw on this idea of mathematical dreamworld to explore its uses for subjects who are not European Man. In each case, they also show the very notion of mathematical thinking to be a kind of fantasy or dreaming, revealing the fantastical qualities undergirding the supposed rationality of Enlightenment thought.

From these chapters, I draw a few conclusions:

1) The timescale of mathematics as it appears in literary texts is not always as we think—in particular, references to mathematics are not always coming from contemporary developments in mathematics. From Descartes to Okorafor, surprisingly, there is an enduring notion of mathematics even as academic fields of mathematics undergo revolutionary changes.

2) The dreamworld of mathematics draws on cultural notions of mathematics that inhere in narrative. Woolf, as I have suggested, takes inspiration from Bertrand Russell's general audience writings in which he produces a narrative notion of mathematics as an escape from the real world into another realm. In Ghosh's *The Calcutta Chromosome,* a notion of mathematics is similarly carried into the text by narrative, this time in the form of popular biographies of the South Asian mathematician Srinivasa Ramanujan. For Okorafor, the situation is different: her notion of mathematics comes from her experience of doing it in school and the general value accorded to mathematics as evidenced in standardized exams, which play a significant role in the text. In this case, it is the language of mathematics itself that secures the qualities of mathematical experience, what semiotician Brian Rotman describes as a language that lacks deixis and yet asks the reader to engage and put themselves into relation to its concepts. Thinking with objects forged in this language creates the unusual experience of being in a realm where these coordinates are absent that mark one's place in the world as a situated subject.

3) Authors have something important to contribute to the study of mathematics and the history of mathematics. In their portrayal of mathematics in literature, they disclose dimensions of mathematical experience that have eluded disciplinary study. Woolf in *Night and Day* reveals a second, dream-like mathematics underlying Bertrand Russell's seemingly rational project of reducing mathematics to logic. Ghosh pays attention to math as a discourse. Okorafor pays attention to the virtuality of mathematical dreamworlds, and their demands on the imagination, not unlike those of speculative (narrative) fiction.

Reading these texts together, we can begin to trace a global history of thinking about the human from below through the idea of mathematical dreamworlds. In Woolf, Ghosh, and Okorafor, we see how authors excluded from notions of the universal human as European man respond to this notion of mathematical dreamworld, taking it on in their creative work. Reading these texts, which appear in the disparate literary fields of modernist, postcolonial, and speculative fiction, in this way also reveals continuities across generic and theoretical divides. The imagination of pure mathematics—as the desire to experience other forms of being with the understanding that forms of being are intimately linked to the spaces in which they exist—reveals continuities between modernist and postcolonial literature. Speculative fiction, moreover, is interested in the real, that is, in supplementing the real with the virtual—or, putting it differently, in creating virtual realms that are a part of what constitutes the "real."

I end with a few thoughts on how this project contributes to studies of world literature, speculative fiction, and interdisciplinary work.

In a period of global capitalist expansion, where numbers are increasingly used to describe people and the globe, the writers that I look at refuse to use mathematics to quantify the world/people. Instead, they use mathematical numbers and figures to elaborate other worlds and notions of value. These novels, by elaborating and circulating a notion of mathematics as a dreamworld rather than the far more ubiquitous notions of mathematics as a descriptive discourse of quantity and of geography, turn a descriptive tool of colonialism and capitalism into a tool for remaking and reimagining.[250] They replace capitalist notions of value with open spaces of dreaming. In this way, they show how a dreamworld of mathematics can be used in the making of a postcolonial world literature, which I understand, following Pheng Cheah, as literature that imagines worlds beyond the capitalist globe.[251] In their focus on mathematics as a dreamworld rather than

[250] The mathematics that is represented in these novels, and that I trace to Enlightenment thought, is in many ways the counterpart to the quantitative mathematics that Mary Poovey argues is prominent in social and economic discourses today. Since the early 19th century, she writes, quantitative mathematics has been understood as the language of fact, and facts the basis of knowledge. Poovey's history of the modern fact is a history of what Peter Dear describes as a transformation in the basis of knowledge production, from assumed universal commonplaces used to make an argument or point *evident*, to singular events that could be recorded and act as *evidence*. While Poovey's focus (quantitative mathematics) is enlisted in the persuasive force of an argument in the latter way, as evidence, my focus (mathematics as a deductive system of thinking) is enlisted in the former way—as a way of making evident through a commonplace. (Although we should note that the commonplace of mathematical thinking is not an experience of the real world assumed to be universal, but rather a realm made and effected as shared experience through the text itself. See Dear, Peter. *Discipline & Experience: The Mathematical Way in the Scientific Revolution.* Chicago: University of Chicago Press, 1995, p. 25. "The singular experience could not be evident, but it could provide evidence.") The novelists that I look at, when they elaborate mathematics as a way of thinking in an imaginative realm, hark back to an Enlightenment notion of mathematics to question the close relationship between quantitative mathematics and facts/reality.

[251] Definitions of world literature through circulation (Damrosch), world-systems theory (Moretti), and as international literary exchange (Casanova) are effectively definitions of "global" literature in the sense that they describe literary formations made possible by the emergence of a more interconnected globe through capitalist expansion. Cheah argues that these models for thinking about world literature do not fully capture the potential of literature to create a world, nor do they capture the meaning of the word "world." Drawing on Auerbach and Said's notion of "world" that includes all of the people, cultures, and histories within it, over and beyond a Western history of the world, Cheah defines world literature as literature that can more fully capture the world and make it palpable; that can open up such a world within

mathematics of quantity and geography, they elaborate alternative ontologies within colonial and capitalist mathematics that could form a basis for imagining more meaningful forms of being.

I use the term *speculative fiction* to describe writing that narrates mathematical activity as the experience of inhabiting another realm beyond the textual real world. And I show that this writing appears in literature, in these novels that I read, but also across and between disciplinary fields of literature, philosophy, and mathematics. In this way, I am suggesting that our definition of speculative fiction should be broader in scope than it is at the present—that we do not limit speculative fiction to literature but rather are attentive to how it may appear also in the sciences and more broadly in the production of an idea of reality—the world as it is without us.[252]

At the same time, I suggest a more precise definition of speculative fiction. In literary studies' global turn, the term "speculative fiction" has emerged as a useful organizing concept because it can be used to describe a more expansive group of texts than "science fiction." While "science fiction" has been used to describe a set of texts that engage a particular history of science and technology and a particular tradition of literature, the term "speculative fiction" can be used more loosely and expansively to

---

the homogenous empty present of capital. This involves the complex act of both understanding the way that capitalist and colonial systems shape selves and at the same time holding on to a separate sense of value and possibility that can be unfolded into the present.

[252] For Descartes, "all that can be formulated in mathematical terms can be meaningfully conceived as the properties of the object in-itself… the thing not only as it is with me, but also as it is without me," writes Quentin Meillassoux. Meillassoux, a speculative realist, is interested in using Descartes' work to advance his theory that mathematics gives access to a world and past where humanity and life are absent—a world prior to human access. I am not interested in making the case for the existence of an objective world, but rather in the way that mathematical contemplation is repeatedly conscripted—by Meillassoux, by Badiou, by Descartes, and by Kant—into the task of constructing a notion of the objective world that is knowable by an idea of the human. Meillassoux, Quentin. *After Finitude: An Essay on the Necessity of Contingency.* Translated by Ray Brassier. London: Bloomsbury Academic, 2017.

describe literature beyond this tradition and that engages not only with scientific ideas but supernatural and mystical notions. In these studies, a text is speculative fiction if it goes against some view of reality nebulously defined, a notion of reality that, some scholars have argued, can be traced to the Enlightenment. As an organizing concept that allows for greater inclusion, speculative fiction has the paradoxical effect of affirming a single tradition of thinking about reality. My approach to speculative fiction, which describes as speculative fiction texts that present a textual real world and an alternative realm that mathematical thinking opens up, offers a corrective to these tendencies because it does not depend on the assumption of an implicit, consensus notion of reality, but rather requires that the text itself presents a textual real world against which an alternative realm is juxtaposed. Moreover, this approach allows us to look more closely at how this consensus notion of reality is produced, to see how a speculative fiction of mathematics—the creation of a virtual world that is not the real, physical world—is at work in the production of Enlightenment reality (in Enlightenment philosophical arguments on whether and how we can know the real world).

Lastly, a thought about interdisciplinary work, which shaped my thinking throughout. It seems to me that science studies—under which histories of mathematics fall—could be more literary, and literary studies could be more mathematical. One of the questions that I started asking was about the social, cultural, and historical dimensions of mathematics, not mathematics as it is *applied* to capitalism or governance, but how mathematical thinking itself can have these dimensions. This is a difficult question because historians have long understood mathematics as the field of knowledge that is most removed from social, cultural, and historical contexts. My readings in this introduction suggest that literature should be at the center of this exploration. For it is literary narratives of mathematics that *world* mathematics—that place mathematics, a realm of contemplation detached from the real world, back into the real world. Narratives about mathematics can give us an idea of how mathematical ideas take on meaning (to mathematicians, and to a wider audience) even as they are framed, within mathematical discourse, to be devoid of such meaning. Through literature we can begin to understand how mathematical ideas take on social, cultural, and historical lives, and to pose questions about how the development of new ideas might be compelled by these dimensions of life.

At the same time, I suggest that literary studies could extend its scope to objects that are considered mathematical. Reading mathematics as a literary object in Enlightenment texts, as I do here, enables us to see how mathematics is not free of social or cultural meaning, but rather performs the very important social function of instating both the universal subject and reality *by being narrated as* a radically detached space from the real world. Drawing on ethnographic research that suggests that this formulation of mathematics may be unique to Europe,[253] I suggest that a more worldly way of reading would also be a more interdisciplinary one, that extends literary analysis to

[253] For example, Claudia Zaslavsky, an ethnomathematician focusing on northern Africa, writes that she found narratives about mathematics were indispensible to her understanding mathematical concepts in the region, for she found that mathematical knowledge was not configured as a separate area of study but rather embedded in stories, decorative art, and architecture. (Zaslavsky, Claudia. *Africa Counts: Number and Pattern in African Cultures.* Chicago, Ill.: Lawrence Hill Books, 1999). Closer to the material of this dissertation, Amitav Ghosh mentioned in an interview about *The Calcutta Chromosome*, that he believes that Ramanujan's mathematical insight came out of his access to two different traditions of mathematical knowledge: a Western one, and also an understanding of mathematics he inherited from his mother's numerology practices, where mathematics is intertwined with the religious and spiritual resonances. More recently, the singer-songwriter Lila Downs noted that for indigenous groups in Mexico, practices of mathematics are interwoven with artistic and narrative practices.

mathematical objects, and that decouples disciplinary methods from their privileged objects of study. Disciplinary methods are ways of knowing about the object *and also* ways of limiting what can be known about it—a way of shaping the world that can be known into disciplinary categories that are themselves legacies of the Enlightenment.

BIBLIOGRAPHY

Adas, Michael. *Machines As the Measure of Men: Science, Technology, and Ideologies of Western Dominance*. Ithaca, NY: Cornell University Press, 1990.

Albright, Daniel. *Quantum Poetics: Yeats, Pound, Eliot, and the Science of Modernism*. Cambridge, UK: Cambridge University Press, 1997.

Appadurai, Arjun. *Modernity at Large: Cultural Dimensions of Globalization*. Minneapolis, MN: Univ. of Minnesota Press, 2010.

Ascher, Marcia. *Ethnomathematics: A Multicultural View of Mathematical Ideas*. Pacific Grove, CA: Brooks/Cole, 1991.

———. *Mathematics Elsewhere: An Exploration of Ideas Across Cultures*. Princeton, NJ: Princeton University Press, 2002.

Bachelard, Gaston. *The Poetics of Space*. Trans. Maria Jolas. 1958. Boston, MA: Beacon Press, 1994.

Bakhtin, M. M., and Michael Holquist. *The Dialogic Imagination: Four Essays*. Trans. Caryl Emerson. Austin, TX: University of Texas Press, 2010.

Banerjee, Suparno. "The Calcutta Chromosome: A Novel of Silence, Slippage, and Subversion." *Science Fiction, Imperialism and the Third World: Essays on Postcolonial Literature and Film*. Ed. Ericka Hoagland and Reema Sarwal. Jefferson, NC: McFarland & Co., 2010.

Banfield, Ann. "L'Imparfait De L'objectif: The Imperfect of the Object Glass." *Camera Obscura* 8, no. 3 (24) (1990): 64-87.

———. *The Phantom Table: Woolf, Fry, Russell and the Epistemology of Modernism*. New York: Cambridge University Press, 2007.

———. "Tragic Time: The Problem of the Future in Cambridge Philosophy and to the Lighthouse." *Modernism/modernity* 7, no. 1 (2000): 43-75.

Bangura, Abdul Karim. *African Mathematics: From Bones to Computers*. Lanham, MD: University Press of America, 2012.

Basalla, George. "The Spread of Western Science." *Science* 156, no. 3775 (1967): 611-622.

Bates, David William. *Enlightenment Aberrations: Error and Revolution in France*. Ithaca, NY: Cornell University Press, 2002.

Baucom, Ian. *Specters of the Atlantic: finance capital, slavery, and the philosophy of history*. Durham, NC: Duke University Press, 2005.

Bender, John, and Michael Marrinan. *The Culture of Diagram*. 1st ed. Stanford, CA: Stanford University Press, 2010.

Benveniste, Émile. "Subjectivity in Language," in *Problems in General Linguistics* vol. 1, 223-230. Miami, Florida: University of Miami Press, 1971.

Brits, Baylee. *Literary Infinities: Number and Narrative in Modern Fiction*. New York: Bloomsbury Academic, 2017.

Burnett, Joshua Yu. "The Great Change and the Great Book: Nnedi Okorafor's Postcolonial, Post-Apocalyptic Africa and the Promise of Black Speculative Fiction." *Research in African literatures* 46, no. 4 (2015): 133-150.

Burstall, Sarah A. "The Place of Mathematics in Girls' Education." *The Mathematical Gazette* 6, no. 96 (1912): 203-213.

Carrington, André M. *Speculative blackness: The Future of Race in Science Fiction*. Minneapolis, MN: 2017.

Césaire, Aimé. *Discourse on Colonialism*. 1955. N.p.: NYU Press, 2001.

Chakrabarty, Dipesh. "The Muddle of Modernity." *The American Historical Review* 116, no. 3 (2011): 663-675.

———. *Provincializing Europe: Postcolonial Thought and Historical Difference*. Princeton, NJ: Princeton University Press, 2000.

Chambers, Claire. "Postcolonial Science Fiction: Amitav Ghosh's *the Calcutta Chromosome*." *Journal of Commonwealth Literature* 38, no. 1 (2003): 58-72.

———. "The Relationship Between Knowledge and Power in the Work of Amitav Ghosh." PhD diss., University of Leeds, 2003.

Cheah, Pheng. *What Is a World? On Postcolonial Literature as World Literature*. Durham, NC: Duke University Press, 2016.

Chuh, Kandice. *The Difference Aesthetics Makes: On the Humanities "After Man"*. Durham, NC: Duke University Press, 2019.

Connor, Steven, Nicola Bown, Carolyn Burdett, and Pamela Thruschwell. "Afterword," in *The Victorian Supernatural*. Cambridge, UK: Cambridge University Press, 2004.

Corelli, Maria. *Woman, or— Suffragette? A Question of National Choice*. London: Pearson, 1907.

Corpis, Duane. "Introduction to 'A Correspondence on Provincializing Europe'." *Radical History Review* 83, no. 1 (2002): 143-145.

Crowley, Dustin. “Cosmos and Polis: Space and Place in Nnedi Okorafor’s SF.” *Science Fiction Studies* 46, no. 2 (2019): 268-288.

Csicsery-Ronay, Istvan, Jr. “What Do We Mean When We Say ‘Global Science Fiction’? Reflections on a New Nexus.” *Science Fiction Studies* 39, no. 3 (2012): 478-493.

Cuddy-Keane, Melba. “World Modelling: Paradigms of Global Consciousness in and Around Virginia Woolf,” in *Virginia Woolf’s Bloomsbury: International Influence and Politics*. Ed. Lisa Shahriari and Gina Potts. Vol. 2. London: Palgrave, 2010.

D’Ambrosio, Ubiratan. “Ethnomathematics and Its Place in the History and Pedagogy of Mathematics.” *For the Learning of Mathematics* 5, no. 1 (1985): 44-48.

Daston, Lorraine. “On Scientific Observation.” *Isis* 99, no. 1 (2008): 97-110.

Daston, Lorraine, and Peter Galison. *Objectivity*. New York: Zone Books, 2007.

Davis, Philip J, Reuben Hersh, and Elena Anne Marchisotto. *The Mathematical Experience*. Study ed. Boston, MA: Birkhäuser Boston, 2012.

Dear, Peter. *Discipline & Experience: The Mathematical Way in the Scientific Revolution*. Chicago, IL: University of Chicago Press, 1995.

———. “What Is the History of Science the History Of? Early Modern Roots of the Ideology of Modern Science.” *Isis* 96, no. 3 (September, 2005): 390-406.

Dear, Peter Robert. “The Mathematical Principles of Natural Philosophy: Toward a Heuristic Narrative for the Scientific Revolution.” *Configurations* 6, no. 2 (1998): 173-193.

Deleuze, Gilles. *Bergsonism*. Trans. Hugh Tomlinson and Barbara Habberjam. New York: Zone Books, 1991.

Dery, Mark. “Black to the Future: Interviews with Samuel R. Delany, Greg Tate, and Tricia Rose,” in *Flame Wars: The Discourse of Cyberculture*, 179-222. Durham, NC: Duke University press, 1994.

Descartes, René. *Reguale Ad Directionem Ingenii—Rules for the Direction of the Natural Intelligence: A Bilingual Edition of the Cartesian Treatise on Method*. Trans. George Heffernan. 1628. Amsterdam: Rodopi, 1998.

———. *Discourse on Method; And, Meditations on First Philosophy*. Trans. Donald A Cress. Indianapolis, IN: Hackett Pub, 1998.

———. *The Geometry of René Descartes: With a Facsimile of the First Edition*. Trans. David E. Smith and Marica L. Latham. New York: Dover Publications, 2012.

———. *Oeuvres De Descartes*. Vol. 6. Paris: J. Vrin, 1957.

———. *Oeuvres De Descartes*. Vol. 9. Paris: J. Vrin, 1957.

———. *The Philosophical Writings of Descartes*. Vol. 1. Trans. John Cottingham, Robert Stoothoff, and Dugald Murdoch. Cambridge, UK: Cambridge University Press, 1984.

DeWitt, Anne. *Moral Authority, Men of Science, and the Victorian Novel*. New York: Cambridge University Press, 2013.

Duplessis, Rachel. "Feminist Narrative in Virginia Woolf." *NOVEL: A Forum on Fiction* 21, no. 2/3 (1988): 323-30.

Dyhouse, Carol. "Good Wives and Little Mothers: Social Anxieties and the Schoolgirl's Curriculum 1890-1920." *Oxford Review of Education* 3, no. 1 (1977): 21-35.

Eglash, Ron. *African Fractals: Modern Computing and Indigenous Design*. New Brunswick, N.J.: Rutgers University Press, 1999.

Fanon, Frantz. *Black Skin, White Masks*. Trans. Charles Lam Markmann, London: Pluto, 1986.

Feder, Rachel. "The Poetic Limit: Mathematics, Aesthetics, and the Crisis of Infinity." *ELH* 81, no. 1 (2014): 167-195.

Felski, Rita. *The Gender of Modernity*. Cambridge, MA: Harvard University Press, 1996.

Fendt, Julia. "The Chromosome As Concept and Metaphor in Amitav Ghosh's *The Calcutta Chromosome*." *Anglia* 133, no. 1 (2015): 172-186.

Foucault, Michel. *The Archaeology of Knowledge*. New York: Pantheon Books, 1972.

———. "Of Other Spaces," in *Heterotopia and the City: Public Space in a Postcivil Society*. Ed. Michiel Dehaene and Lieven de Cauter. New York: Routledge, 2008.

———. *The Order of Things: An Archaeology of the Human Sciences*. New York: Vintage, 1994.

———. "What Is an Author?" in *Language, Counter-Memory, Practice: Selected Essays and Interviews*, 113-138. Ed. Donald F Bouchard. Trans. Josué Harari. Ithaca, NY: Cornell University Press, 1977.

Galison, Peter. *Things That Talk: Object Lessons From Art and Science*. Ed. Lorraine Daston. New York: Zone Books, 2004.

Gaonkar, Dilip Parameshwar. "On Alternative Modernities." *Public Culture* 11, no. 1 (1999): 1-18.

Gay, Peter. *The Enlightenment: An Interpretation*. New York: Knopf, 1967.

Ghosh, Amitav. *The Calcutta Chromosome: A Novel of Fevers, Delirium & Discovery*. New York: Perennial, 2001.

———. *The Circle of Reason*. New York: Mariner Books, 2005.

Gilroy, Paul. *The Black Atlantic: Modernity and Double Consciousness*. London: Verso, 1993.

Gray, Jeremy. *Plato's Ghost: The Modernist Transformation of Mathematics*. Princeton, NJ: Princeton University Press, 2008.

Green, Martin Burgess. *Dreams of Adventure, Deeds of Empire*. London: Routledge & Paul, 1980.

Hacking, Ian. *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. New York: Cambridge University Press, 1983.

Halstead, Narmala, Eric Hirsch, and Judith Okely. *Knowing How to Know: Fieldwork and the Ethnographic Present*. New York: Berghahn Books, 2008.

Hansen, Mark B.N. *New Philosophy for New Media*. Cambridge, MA: The MIT Press, 2006.

Haraway, Donna Jeanne. *Simians, Cyborgs, and Women: The Reinvention of Nature*. New York, NY: Routledge, 1991.

Hardy, Godfrey Harold. *A Mathematician's Apology*. 1940. Cambridge, UK: Cambridge University Press, 2005.

Hartmann, Ivor W. *AfroSF: Science Fiction by African Writers*. N.p.: Story Time, 2012.

Henderson, Andrea. "Math for Math's Sake: Non-Euclidean Geometry, Aestheticism, and 'Flatland'." *PMLA* 124, no. 2 (March, 2009): 455-471.

Henry, Holly. *Virginia Woolf and the Discourse of Science: The Aesthetics of Astronomy*. Cambridge, UK: Cambridge University Press, 2003.

Hersh, Reuben. *Experiencing Mathematics: What Do We Do, When We Do Mathematics?* Providence, RI: American Mathematical Society, 2013.

Hopkinson, Nalo, and Uppinder Mehan. *So Long Been Dreaming: Postcolonial Visions of the Future*. Vancouver, B.C.: Arsenal Pulp Press, 2004.

Hottinger, Sara N. *Inventing the Mathematician: Gender, Race, and Our Cultural Understanding of Mathematics*. Albany, NY: State University of New York Press, 2016.

Hull, Isabel V. *Absolute Destruction: Military Culture and the Practices of War in Imperial Germany*. Ithaca, NY: Cornell University Press, 2006.

Jenkins, Alice. “George Eliot, Geometry, and Gender,” in *Literature and Science*. Ed. Sharon Ruston. Cambridge, UK: D.S. Brewer, 2008.

Jones, Claire. *Femininity, Mathematics and Science, 1880-1914*. London: Palgrave Macmillan, 2009.

Jones, Matthew L. “Descartes's Geometry as Spiritual Exercise.” *Critical Inquiry* 28, no. 1 (2001): 40-71.

Jue, Melody. “Intimate Objectivity: On Nnedi Okorafor’s Oceanic Afrofuturism.” *Women's Studies Quarterly* 45, No. 1/2 (2017): 171-188.

Kant, Immanuel. *Critique of Pure Reason*. Trans. Paul Guyer and Allen W Wood. Cambridge, UK: Cambridge University Press, 1998.

Katz, Victor J. *A History of Mathematics: An Introduction*. Boston, MA: Addison-Wesley, 2009.

Kerslake, Patricia. *Science Fiction and Empire*. Liverpool, UK: Liverpool University Press, 2010.

Kline, Morris. *Mathematics in Western Culture*. Oxford, UK: Oxford University Press, 1964.

Kuhn, Thomas. “Mathematical vs. Experimental Traditions in the Development of Physical Science.” *The Journal of Interdisciplinary History* 7, No. 1 (1976): 1-31.

Kurnick, David. “Abstraction and the Subject of Novel Reading: Drifting Through Romola.” *NOVEL: A Forum on Fiction* 42, no. 3 (2009): 490-496.

Latour, Bruno. “Visualisation and Cognition: Drawing Things Together.” *AVANT. Pismo Awangardy Filozoficzno-Naukowej* 3 (2012): 207-257.

Latour, Bruno, and Steve Woolgar. *Laboratory Life: The Construction of Scientific Facts*. Princeton, NJ: Princeton University Press, 1979.

Lefebvre, Henri. *The Production of Space*. Trans. Donald Nicholson-Smith. Oxford, UK: Blackwell, 2007.

Lowe, Lisa. *The Intimacies of Four Continents*. Dunham, NC: Duke University Press, 2015.

MacClintock, Ann. *Imperial Leather: Race, Gender and Sexuality in Colonial Context*. New York: Routledge, 1995.

Malik, Momin Meraj. “Rediscovering Ramanujan.” Undergraduate thesis. Harvard University, 2008. https://www.mominmalik.com/malik_undergrad2009.pdf.

Marcus, Jane. "Britannia Rules *The Waves*," in *Hearts of Darkness: White Women Write Race*. New Brunswick, NJ: Rutgers University Press, 2004.

Massey, Doreen. *Space, Place and Gender*. Cambridge, UK: Polity, 1994.

Mathur, Suchitra. "Caught Between the Goddess and the Cyborg: Third-World Women and the Politics of Science in Three Works of Indian Science Fiction." *The Journal of Commonwealth Literature* 39, no. 3 (2004): 119-138.

McKittrick, Katherine. "'Black and 'Cause I'm Black I'm Blue': Transverse Racial Geographies in Toni Morrison's 'The Bluest Eye'." *Gender, Place and Culture: A Journal of Feminist Geography* 7, no. 2 (2000): 125-142.

———. *Demonic Grounds: Black Women and the Cartographies of Struggle*. Minneapolis, MN: University of Minnesota Press, 2006.

———. "Mathematics Black Life." *Black Scholar* 44, no. 2 (2014): 16-28.

Meillassoux, Quentin. *After Finitude: An Essay on the Necessity of Contingency*. Trans. Ray Brassier. London: Bloomsbury Academic, 2017.

Mendlesohn, Farah. *Rhetorics of Fantasy*. Middletown, CT: Wesleyan University Press, 2008.

Mignolo, Walter D. "Delinking: The Rhetoric of Modernity, the Logic of Coloniality and the Grammar of De-coloniality." *Cultural Studies* 21, no. 2-3 (2007): 449-514.

Mill, James. *The History of British India*. 4th ed. Vol. 2. 1817. London: James Madden and Co., 1858.

Moses, Michael Valdez. *The Novel and the Globalization of Culture*. Oxford, UK: Oxford University Press, 1995.

Nelson, Diane M. "A Social Science Fiction of Fevers, Delirium and Discovery: 'The Calcutta Chromosome', the Colonial Laboratory, and the Postcolonial New Human." *Science Fiction Studies* 30, no. 2 (2003): 246-266.

O'Connell, Hugh Charles. "'We Are Change': The Novum As Event in Nnedi Okorafor's Lagoon." *Cambridge Journal of Postcolonial Literary Inquiry* 3, no. 3 (2016): 291-312.

Okorafor, Nnedi. "Africanfuturism Defined." (October 19, 2019). http://nnedi.blogspot.com/2019/10/africanfuturism-defined.html.

———. "African Science Fiction Is Still Alien." (January 15, 2014). http://nnedi.blogspot.com/2014/01/african-science-fiction-is-still-alien.html.

———. *Binti*. New York: Tor, 2015.

———. *Binti: Home*. New York: Tor, 2017.

———. *Binti: The Complete Trilogy*. New York: DAW, 2019.

———. *Binti: The Night Masquerade*. New York: Tor, 2018.

———. "Is Africa Ready For Science Fiction?" (August 12, 2009). http://nnedi.blogspot.com/2009/08/is-africa-ready-for-science-fiction.html.

Oziewicz, Marek. "Speculative Fiction." In *Oxford Research Encyclopedia of Literature*. (March 2017). https://oxfordre.com/literature/view/10.1093/acrefore/9780190201098.001.0001/acrefore-9780190201098-e-78

Plato. *Meno and Phaedo*. Ed., David N. Sedley and Alex Long. Trans. Alex Long. Cambridge, UK: Cambridge University Press, 2010.

Plofker, Kim. *Mathematics in India*. Princeton, NJ: Princeton University Press, 2010.

Poovey, Mary. *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society*. Chicago, IL: University of Chicago Press, 1998.

Price, Katy. *Loving Faster Than Light: Romance and Readers in Einstein's Universe*. Chicago, IL: University of Chicago Press, 2012.

Priest, Ann-Marie. "Between Being and Nothingness: The 'Astonishing Precipice' of Virginia Woolf's Night and Day." *Journal of Modern Literature* 26, no. 2 (2003): 66-80.

Rahman, Zia Haider. *In the Light of What We Know*. New York: Picador, 2015.

Richards, Joan L. "The Art and the Science of British Algebra: A Study in the Perception of Mathematical Truth." *Historia Mathematica* 7, no. 3 (1980): 343-365.

———. "God, Truth and Mathematics in Nineteenth-Century England." *Theology and Science* 9, no. 1 (2011): 53-74.

———. *Mathematical Visions: The Pursuit of Geometry in Victorian England*. London: Academic Press, 1988.

Rieder, John. *Colonialism and the Emergence of Science Fiction*. Middletown, CT: Wesleyan University Press, 2008.

Rodal, Jocelyn. "Patterned Ambiguities: Virginia Woolf, Mathematical Variables, and Form." *Configurations* 26, no. 1 (2018): 73-102.

———. "Virginia Woolf on Mathematics: Signifying Opposition." In *Contradictory Woolf: Selected Papers from the Twenty-first Annual International Conference on Virginia Woolf, University of Glasgow, 9-12 June 2011*. 202-208.

Rosner, Victoria. *Modernism and the Architecture of Private Life*. New York: Columbia University Press, 2005.

Ross, Ronald, and Patrick Manson. *The Beast in the Mosquito: The Correspondence of Ronald Ross and Patrick Manson*. Ed. William F Bynum, and Caroline Overy. Amsterdam: Rodopi, 1998.

Rotman, Brian. *Mathematics as Sign: Writing, Imagining, Counting*. Stanford, CA: Stanford University Press, 2000.

———. "The Technology of Mathematical Persuasion." In *Inscribing Science: Scientific Texts and the Materiality of Communication*, 55-69. Ed. Timothy Lenoir. Stanford, CA: Stanford University Press, 1998.

———. "Thinking Dia-Grams: Mathematics, Writing, and Virtual Reality." In *Mathematics, Science and Postclassical Theory*, 389-415. Ed. Arkady Plotnitsky and Barbara Herrnstein Smith. Durham, NC: Duke University Press, 1997.

Russell, Bertrand. *Introduction to Mathematical Philosophy*. London: George Allen & Unwin, 1919.

———. *Mysticism and Logic and Other Essays*. New York: Longmans, Green and Co., 1918.

———. *Our Knowledge of the External World*. London: George Allen & Unwin Limited, 1922.

Schalk, Sami. *Bodyminds Reimagined: (Dis)ability, Race, and Gender in Black Women's Speculative Fiction*. Durham, NC: Duke University Press, 2018.

Semmelhack, Elizabeth. *Heights of Fashion: A History of the Elevated Shoe*. Toronto: Bata Shoe Museum, 2008.

Seshagiri, Urmila. *Race and the Modernist Imagination*. Ithaca, NY: Cornell University Press, 2010.

Shabel, Lisa. "Kant's Philosophy of Mathematics." In *The Cambridge Companion to Kant and Modern Philosophy*. Ed. Paul Guyer. New York: Cambridge University Press, 2006.

Sharpe, Christina. *In the Wake: On Blackness and Being*. Durham, NC: Duke University Press, 2016.

Snow, C.P. "The Two Cultures." *New Statesman*, November 1956.

Soja, Edward W. *Thirdspace: A Journey Through Los Angeles and Other Real-and-Imagined Places*. Cambridge, MA: Blackwell, 1996.

Spivak, Gayatri Chakravorty. "Can the Subaltern Speak?" in *Colonial Discourse and Post-colonial Theory: A Reader*. Ed. Patrick Williams and Laura Chrisman. London: Routledge, 1995.

———. *A Critique of Postcolonial Reason: Toward a History of the Vanishing Present*. Cambridge, MA: Harvard University Press, 2003.

———. "Three Women's Texts and a Critique of Imperialism." *Critical Inquiry* 12, no. 1 (1985): 243-261.

Steinmetz, George, and Julia Hell. "The Visual Archive of Colonialism: Germany and Namibia." *Public Culture* 18, no. 1 (2006): 147-184.

Suvin, Darko. "On the Poetics of the Science Fiction Genre." *College English* 34, no. 3 (1972): 372-382.

Suzman, James. *Minorities in Independent Namibia*. London: Minority Rights Group International, 2002.

Taylor, Melanie Benson. *Disturbing Calculations: The Economics of Identity in Postcolonial Southern Literature, 1912-2002*. Athens, GA: University of Georgia Press, 2010.

Thomas, Sheree R. *Dark Matter: A Century of Speculative Fiction From the African Diaspora*. New York: Warner Books, 2000.

Thrall, J.H. "Postcolonial Science Fiction?: Science, Religion and the Transformation of Genre in Amitav Ghosh's the Calcutta Chromosome." *Literature and Theology* 23, no. 3 (2009): 289-302.

Vescovi, Alessandro. "Emplotting the Postcolonial: Epistemology and Narratology in Amitav Ghosh's *The Calcutta Chromosome*." *Ariel: A Review of International English Literature* 48, no. 1 (2017): 37-69.

Walkowitz, Rebecca L. *Cosmopolitan Style: Modernism Beyond the Nation*. New York: Columbia University Press, 2006.

Warwick, Andrew. *Masters of Theory: Cambridge and the Rise of Mathematical Physics*. Chicago, IL: University of Chicago Press, 2003.

Whewell, William. "Thoughts on the Study of Math as Part of a Liberal Education." In *On the Principles of English University Education*. London: J. W. Parker, 1838. 135-189.

Whitworth, Michael H. *Einstein's Wake: Relativity, Metaphor, and Modernist Literature*. New York: Oxford University Press, 2001.

Wolputte, Steven Van. "Subject Disobedience: The Colonial Narrative and Native Counterworks in Northwestern Namibia, c.1920–1975." *History and Anthropology* 15, no. 2 (2007): 151–173.

Woolf, Virginia. *The Diary of Virginia Woolf*. Ed. Anne Oliver Bell and Andrew McNeillie. San Diego, CA: Harcourt, Brace Jovanovich, 1984.

———. *Night and Day*. Ed. Frank Kermode and Suzanne Raitt. Oxford, UK: Oxford University Press, 2009.

Wynter, Sylvia. "On Disenchanting Discourse: 'Minority' Literary Criticism and Beyond." *Cultural Critique* 7 (1987): 207-244.

———. "Unsettling the Coloniality of Being/Power/Truth/Freedom: Towards the Human, After Man, Its Overrepresentation—An Argument." *CR: The New Centennial Review* 3, no. 3 (2003): 257-337.

Zaslavsky, Claudia. *Africa Counts: Number and Pattern in African Cultures*. Chicago, IL: Lawrence Hill Books, 1999.

Zweig, Paul. *The Adventurer*. London: Basic Books, 1974.