ABSTRACT

SCHETZINA, CATHY ANNE. The Quest for the Mechanical Muse: Thomas Pynchon and Science. (Under the direction of Nick Halpern).

This thesis explores Thomas Pynchon's philosophy of science as evidenced by the thematic and literary role of science in *Gravity's Rainbow* and *Mason & Dixon*. His treatment of science in these novels amounts to a call for intellectual revolution on a grand scale, as Pynchon takes aim at the Western world's all-pervasive faith in the scientific enterprise, made dominant during the Enlightenment, which he associates with a blind reliance on binary oppositions, belief in cause-and-effect and faith in reason. Pynchon associates this cultural construction, which I refer to throughout the thesis as Science, with a range of abstract systems that, when imposed upon humanity, prove to be both oppressive and destructive. In *Gravity's Rainbow*, Pynchon depicts the destruction that has resulted from the use of science, creates a symbolic order that challenges the dominance of Science and urges traversal of the boundaries it dictates and subversion of the binary oppositions that characterize it. *Mason & Dixon* neatly enriches the symbolic order created in *Gravity's Rainbow*, having at its center an iconic representation of the Enlightenment enterprise and that of Science. Taken together, the novels provide both a critique and an apologia of the trajectory of science in the twentieth century, along with a symbolically articulated plea for revolution.

The Quest for the Mechanical Muse: Thomas Pynchon and Science

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BIOGRAPHY

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Introduction

Thomas Pynchon's *Gravity's Rainbow* begins with a quote asserting the power of science to inspire belief in immortality. For Pynchon, it appears also – or perhaps instead – to inspire literary creation. All of Pynchon's novels are riddled with references to science, mathematics and technology. As he employs these concepts in the service of literary art, they become essential to his narratives, assuming nonliteral values and meanings and becoming central to the – often futile – quest for answers to questions of life and mortality. *Gravity's Rainbow* and *Mason & Dixon* are singular among Pynchon's novels in that scientific endeavors additionally form the impetus for their narratives, making them ideal subjects for a study of the role of science in Pynchon's novels.

In *Gravity's Rainbow*, we follow Slothrop, -- a science experiment gone wrong – across war-torn Europe, surrounded by a cast of characters who seek to gain power through various uncoordinated scientific endeavors as their continent and countrymen fall down around them. The serpentine plot is filled with scientific theory and the novel's ultimate power product of human creation, the V2 rocket, is incessantly sexualized.

Mason & Dixon provides a glimpse of science and its seekers at the height of the Enlightenment, with the turbulent politics of the New World simmering as the novel's title characters' own scientific aspirations play out. Though questions of morality, religion and political power constantly challenge and offset the concept of scientific progress,

science forms the central impetus of the narrative and inspires the dialogue that embodies Mason and Dixon's intimate friendship.

This thesis explores Pynchon's philosophy of science as evidenced by the thematic and literary role of science in *Gravity's Rainbow* and *Mason & Dixon*. Various analyses of *Gravity's Rainbow* and, to a lesser extent, *Mason & Dixon*, have explored the presence of individual scientific theories in the novels. While many correlations have been noted, critics have been less forthcoming in addressing how the concepts from science and math function in relation to Pynchon's overall philosophy of science. In the current study I will be describing the parallels between science and literature and selectively cataloguing the presence and use of scientific theory in Pynchon's novels as a means through which to elucidate the significance of the interactions between scientific and alternate ways of knowing within *Gravity's Rainbow* and *Mason & Dixon*.

Pynchon's fascination with the interplay between science and literature is indicative of a deeper interest in epistemological boundaries and their traversal. Pynchon explores various scientific paradigms and strategies, making use of carefully chosen concepts from science and mathematics to illustrate their limitations, and make his arguments for possible alternatives.

As I will illustrate in detail, Pynchon's treatment of science in the novels replicates the structure of scientific revolutions as described by Thomas Kuhn in his 1962 book of the same name. Kuhn argues that the majority of scientific endeavors fall into the category of what he calls "normal science," the function of which is to confirm and articulate the reigning paradigm of the relevant scientific discipline. Scientific research is

generally designed to produce a result that is anticipated in advance, and those endeavors that fail to produce the expected result are generally viewed as failed attempts. As Kuhn explains, "[O]ne of the things a scientific community acquires with a paradigm is a criterion for choosing problems that, while the paradigm is taken for granted, can be assumed to have solutions. To a great extent, these are the only problems that the community will admit as scientific or encourage its members to undertake" (37). Thus the scientific enterprise as described by Kuhn tends to exclude those areas of inquiry that cannot reasonably be explained by the given paradigm.

Despite the very non-revolutionary operations of normal science, scientific revolutions do, of course, take place, and these begin with the awareness of anomaly, "with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science" (53). Anomaly then sometimes inspires crisis, which in the most extreme cases results in production and adoption of a new paradigm.

Pynchon's treatment of science in *Gravity's Rainbow* and *Mason & Dixon* amounts to a call for intellectual revolution on a grand scale. Pynchon seeks not to challenge merely *a* scientific paradigm, he takes aim at *the* scientific paradigm, which I will refer to throughout the thesis as Science. Pynchon identifies Science with the cultural understanding of the scientific enterprise, made dominant during the Enlightenment, which he associates with a blind reliance on binary oppositions, belief in cause-and-effect and faith in reason, to the exclusion of anything that is not amenable to

investigation by the scientific method[1]. Pynchon's version of Science, as such, is a cultural construction, but one which informs the worldview of his scientist and non-scientist characters alike. Pychon takes aim at this classical, Newtonian understanding of the universe and illustrates how deeply embedded Science is in Western culture and thought, despite potential challenges raised by twentieth-century science proper and physics in particular. Pynchon associates Science with a ranges of abstract systems, most menacingly, the military-industrial complex depicted in *Gravity's Rainbow*, that, when imposed upon humanity, prove to be both oppressive and destructive. While Pynchon demonstrates a knowledge of the changes in physics and cosmology that occurred through the second half of the twentieth century, the Science he identifies with the military-industrial complex and in which he argues Western thought is entrenched is essentially identical to that depicted in *Mason & Dixon.*

Pynchon turns his attention to the boundaries and limitations of Science and highlights entire realms of human experience that it simply ignores. While many have cautioned against the expectation that scientific principles will hold when applied to social and moral problems, Pynchon's work insists on such application to the extent that the failure of scientific principles to remain valid in a social context suggests a failure of science and dictates knowledge boundaries that Pynchon is keen to traverse. Pynchon seeks a way of knowing that will prove equally valid when expressed mathematically as when applied to matters of the human heart. In the absence of such an epistemology, Pynchon launches an all-out attack on the overarching scientific paradigm that has

[1] Pynchon's critique of Science and identification of its characteristics with those of the Enlightenment project shares some basic ideas in common with postmodern philosophy and deconstruction, and the work of Jacques Derrida in particular.

dominated Western culture since the Enlightenment despite the presence of anomalies and theories that challenge it.

Kuhn's description of the structure of scientific revolutions describes how scientific change occurs. In seeking to invalidate Science, Pynchon mimics the structure of scientific revolutions as defined in Kuhn, just as he makes use of metaphors created using ideas from science and math. In other words, Pynchon uses science in his efforts to debunk Science, which illustrates a deep ambivalence about the scientific enterprise.

Gravity's Rainbow's exploration of the changes wrought in science in the Enlightenment period through the middle of the twentieth century, as well as the limits of such knowledge, is poignantly offset by *Mason & Dixon*'s more intimate and coherent depiction of Mason and Dixon's optimistic stargazing and boundary-making endeavors of the eighteenth century. In *Gravity's Rainbow*, Pynchon depicts the destruction that has resulted from the use of science and creates a symbolic order that challenges the dominance of Science and urges traversal of the boundaries it dictates and subversion of the binary oppositions that characterize it. *Mason & Dixon* neatly enriches the symbolic order created in *Gravity's Rainbow*, having at its center an iconic representation of the Enlightenment enterprise and that of Science. Taken together, the novels provide both a critique and an apologia of the trajectory of science in the twentieth century, along with a symbolically articulated plea for revolution.

In seeking to dethrone the reigning scientific paradigm of Western thought, Pynchon assumes a certain authority that strict disciplinary boundaries would deny him. While disciplinary purists may scoff at investigations of parallels between science and

literature, links between major changes in modern physics' conception of the universe and corresponding changes in literary form have been noted by various critics (among them Alan J. Friedman, Carol C. Donley and N. Katherine Hayles). The correlations between the development of relativity theory, thermodynamics and quantum mechanics in physics and the changes in literary and artistic form in modernism and postmodernism in the twentieth century are persuasive. The dramatic change in worldview represented by these advances in physics theory is evident in a broad range of literature and even in the writing of authors who, unlike Pynchon, know very little of science[2].

Consequently, discussions of parallels across disciplines should not be based on a premise of influence that necessarily assumes a causal relationship between scientific and literary changes. Rather, the simultaneous evolution of parallel concerns and ideas in diverse disciplines suggests a cultural mechanism in which "different disciplines base the theories they construct on similar presuppositions because these are the assumptions that guide the constitution of knowledge in a given episteme" (Hayles, *Chaos xi*). The intellectual and social concerns present within a culture at a given time give rise to similar developments across disciplines; this effect is intensified by the developing global culture and information explosion that has arisen during Pynchon's lifetime, and which is a recurring theme in his novels.

In addition, however, to falling within the general realm of postmodernism, the indeterminacy of which suggests comparison to contemporary physics theory, Pynchon's novels are the products of a formidable intellect and perhaps the broadest knowledge of

[2] For example, Virginia Woolf, D.H. Lawrence and Vladimir Nabokov knew relatively little about science, yet the presence of concepts parallel to those of modern physics theory are evident in their novels. Woolf's *The Waves*, for example, structurally mimics the wave-particle duality concept of quantum theory.

science and mathematics of any contemporary non-genre novelist. His use of scientific theory is extensive, carefully-designed, and central to the narratives of *Gravity's Rainbow* and *Mason & Dixon*.

Although notoriously little is known of Pynchon's personal history, the available facts illustrate an early and persistent oscillation between his interest in science and literature. Pynchon graduated from high school as salutatorian and was presented with an award for attaining the highest average in English studies. He then entered Cornell University with a scholarship and matriculated in Engineering Physics, but later transferred to the College of Arts and Sciences and graduated with a degree in English (Winston 258). Pynchon spent only one year as an Engineering Physics student and, while some critics have assumed his knowledge of mathematics and science was acquired in the brief course of that formal training, Cornell records suggest that "in his studies of mathematics, physics, and technology, what really mattered to him he learned largely on his own" (Schachterle, *Pynchon* 136).

This fact is significant in light of Pynchon's interest in the dangers of science when filtered through and co-opted by institutions. In *Gravity's Rainbow*, Science inextricably linked to the oppressive power structure. As Kuhn explains in a discussion of the culture of science, the scientific community has a stake in maintaining the reigning theoretical paradigm, enforcing its rules and, at least initially, ignoring anomaly. Pynchon has attained his scientific knowledge in relative isolation, not only from public life, but, barring a brief stint as an engineering aide at Boeing, from the influence of educational or corporate entities. He has no officially-sanctioned scientific authority and

therefore no responsibility to conform to the dictates of the scientific community. His power as a commentator on science comes, instead, from his success in blending scientific and artistic ways of knowing. Pynchon appears to have set up permanent base camp at the border and seems intent, through calculated raids across the boundaries, on fostering the sort of intellectual anarchy that he argues is essential to the advancement of human knowledge.

From the inception of his writing career Pynchon has stood out as a renegade disciplinary boundary crosser, seemingly equally at ease with differential equations and Maxwell's demon as he is with *Duino Elegies* and Jewish mysticism. Among Pynchon's early published literary efforts, the short story "Entropy" stands out as an obvious early attempt to integrate science and literature, and one which Pynchon characterizes as being sabotaged by a naive reliance on scientific theory alone as the basis for his narrative. As Pynchon states in *Slow Learner* "[I]t is simply wrong to begin with a theme, symbol or other abstract unifying agent, and then try to force characters and events to conform to it" (12).

In the novels, and particularly in *Gravity's Rainbow* and *Mason & Dixon*, Pynchon makes the relations between science and humans a major thematic focus and develops the theme through skillful integration. Rather than crushing these narratives with the weightiness of the scientific principles he incorporates and "short-chang[ing] the humans in the story," Pynchon's characters here suffer for making the same mistake Pynchon claims to have made in "Entropy." Their interaction with the world is mediated and determined by the scientific principles that were designed to enable description of the

world. The mandated obsession with categorization and analysis -- the abstract unifying thrust of Science -- compels them to force the world to conform, thereby advancing the goals of the power structure and ignoring the alternate ways of knowing that could disrupt those plans.

In section one of the thesis I outline some of the major developments in physics the eighteenth, nineteenth and twentieth centuries and generally establish their relevance to the novels and their relationship to the paradigm of Science that Pynchon is seeking to dismantle. Sections three and four of the thesis examine the function of these and other scientific concepts in *Gravity's Rainbow* and *Mason & Dixon*, respectively. Through examination of a series of shared features in the novels, I illustrate how Pynchon defines and attacks Science by illustrating its shortcomings and arguing for alternate ways of knowing. In each section, I explore Pynchon's use of narrative form, scientist and non-scientist characters, and individual concepts from science and math to challenge the intellectual dominance of Science in Western thought and culture. I further examine Pynchon's efforts to break down the rigid boundaries of Science by examining the permeable boundaries he creates between living and dead, animate and inanimate. In section four, I discuss the relationship between the two novels and the relevance of this relationship to Pynchon's ideas about Science and the prospects for attaining the sort of intellectual and cultural revolution he demands.

I. The Revolutions in Physics

Prior to launching into a discussion of the individual novels, it is useful to review some of the major cosmological and related developments in science and math that are central to the structure of Pynchon's texts. I will address scientific theories that are applicable to individual metaphors on a smaller scale in *Gravity's Rainbow* and *Mason & Dixon* within the section devoted to each novel.

For ease of analysis, Alan J. Friedman usefully groups the theories relevant to Pynchon's novels into three scientific paradigms, to which I have added a fourth, twentieth-century cosmology. Thus, the major changes I describe below are grouped generally into the following paradigms: eighteenth-century Newtonian mechanics, nineteenth-century statistical mechanics, twentieth-century cosmology and twentieth-century quantum physics. These paradigms are presented for ease of reference and none should be considered synonymous with the concept of Science that Pynchon seeks to dismantle, although there is some notable overlap. The tenets of eighteenth-century mechanics are generally those which define Science and which have remained prevalent in Western intellectual thought, despite the challenges of twentieth-century cosmology and quantum physics.

The theories I will describe were generally the result of the contributions of numerous scientists over a span of time, culminating in breakthroughs that come to be identified with the accompanying cultural and scientific paradigm shifts. Because we are primarily interested in the paradigm shifts themselves, and only secondarily interested in

the scientific particulars associated with them, in the interest of simplicity I will follow Friedman in applying these generalized designations to each period.

Eighteenth-century Newtonian mechanics and the worldview associated with it plays a major role in *Gravity's Rainbow* and *Mason & Dixon* and characterizes the concept of Science that he argues has wrought havoc in Western culture since the Enlightenment. This "clockwork" view of the universe provided a sense of certainty that future events could be accurately predicted given adequate information. According to Newton's laws, "[t]he future motions of any object can be predicted from knowledge of their initial positions and velocities, and knowledge of the laws of just the few universal forces" (Friedman, "Einstein" 28). In the paradigm of Newtonian mechanics, complete human knowledge of God's creation could be eventually attainable through science, as represented by Newton's simple and elegant series of laws. "The successes of Newton's theory in astronomy created a wide-spread belief that eventually all aspects of the universe, even social relations, would be explained by the analogous mechanical modes" (Friedman, *Einstein* 31).

The eighteenth century brought continued reliance on Newtonian mechanics, and if the writing of Locke, Swift, Pope and others discouraged the expectation of absolute knowledge, further advances in science encouraged the belief that humans had at least a firm hold on those aspects of the universe that were within the reach of the human mind (Abrams 1773). The eighteenth century brought both increased codification of general scientific principles and, as is evident in *Mason & Dixon*, a tendency to direct the mind away from those topics whose mysteries seemed beyond the reach of reason (Wolf 61).

Pynchon associates these beliefs with Science and the destructive military-industrial complex of *Gravity's Rainbow.* Newtonian mechanics set the scene for the cultural revolution that characterized the Enlightenment and, Pynchon would argue, set humanity on a course of arrogance and destruction.

Prior to the late sixteenth and seventeenth centuries, the classical Greek view of Aristotle had held sway for over a thousand years. Aristotle assumed that a state of rest is natural for all objects, including the Earth, which he believed to reside at rest in the center of the universe.

Newton, though, building on the work of Galileo, created a series of new laws that would dramatically alter our perception of the universe. Coming on the heels of the humbling Copernican revolution, Newton's laws of motion reasserted the ability of science to explain the workings of the universe. Contrary to Aristotle's belief in a default state of rest, Newton stated in his first law of motion that an object will continue either at rest *or* in uniform motion, unless it is acted on by a net force. Newton's second law provides a formula (Force = Mass x Acceleration) that allows us to calculate the acceleration that a given force will cause in an object given the object's mass and the magnitude and direction of the force. The third law states that for every action there is an equal and opposite reaction (Friedman, "Science" 75). Newton also stated a law of universal gravitation, which proclaims that "every body attracts every other body with a force that is proportional to the mass of each body." In Newtonian mechanics gravity, like all other forces, is determined by the interaction between bodies (Hawking 16).

Although future developments in physics have radically altered the accepted view of space and time, the rules of motion set forth in Newtonian physics are remarkably accurate for objects on earth traveling well below the speed of light, and Newtonian mechanics consequently provides the tools that are used to describe the path of the V-2 rocket in *Gravity's Rainbow*. The V-2 plays a major role in the novel, as interest in Slothrop is inspired by his apparent ability to predict the strike locations of the German's supersonic V-2 rockets. In order to scientifically predict the path of the V-2 rocket, we apply the equation A=F/M to the rocket at standard intervals throughout its flight; the shorter the interval, the more accurate the calculation. With the interval defined using the Greek Δ (delta) to represent change and *t* (time), the interval is represented as Δ *t* (*i.e.,* change in time). As Friedman explains, "Calculus permits us to do a calculation in which, in effect, Δ *t* approaches zero," (Friedman, "Science" 73). This calculus metaphor is used as a launching point in *Gravity's Rainbow* for Pynchon's exploration of the number zero, which I will discuss in section two.

Statistical mechanics is used in *Gravity's Rainbow* to frame Pynchon's development of the statistician Roger Mexico and the pitfalls of interpreting human experience in terms of probabilities. While Newton's laws of motion precisely describe the path of objects like the V2 rocket in theory, in practice it is difficult to predict the exact path or location of a strike due to the impossibility of accurately measuring all forces acting on the rocket (Friedman, "Science" 78). Thus, statistical mechanics gained precedence in the 19th century as a way in which to calculate probabilities of each in a range of possible outcomes. The Poisson Distribution, a mathematical formula devised in

1837, is used in *Gravity's Rainbow* to predict the overall pattern -- although not the individual location -- of rocket strikes.

The chaotic structure of *Gravity's Rainbow* and Pynchon's warnings regarding the destructive potential of Science take their form in part from the laws of thermodynamics and the concept of entropy. The first law of thermodynamics states generally that energy cannot be created or destroyed but only transformed, a concept that I will discuss later in relation to the opening epigraph of *Gravity's Rainbow*. The second law of thermodynamics states that "for the universe as a whole, or an isolated part of it, processes forward in time tend to increase disorder" (Friedman 84). This concept, often described as entropy, is absent from the formal dictates of Newtonian mechanics. The latter implies, incorrectly, that it is equally plausible for someone reading a newspaper to rip it into shreds as it is for the shreds to spontaneously regenerate into a complete sheet of paper. While the second law of thermodynamics alone does not state that this spontaneous regeneration is impossible, it indicates that processes forward in time tend toward disorder, thus making regeneration unlikely.

Pynchon's fascination with the concept of entropy is well documented. He describes his attraction to entropy as a young man in terms of an adolescent "somber glee at any idea of mass destruction or decline," suggesting that as he matured his interest tended more toward the connection between entropy and time, "that human one-way time we're all stuck with locally here, and which terminates, it is said, in death" (SL 14-15). These meditations on entropy and time are evident in *Gravity's Rainbow* -- along with a good dose of lingering "somber glee."

Pynchon also makes use of a well-known failed attempt to challenge the second law of thermodynamics in the sorting demon theorized by James Clerk Maxwell in 1871. In a thought experiment, Maxwell invented a hypothetical sorting demon that he argued would be capable of violating the principle in the second law of thermodynamics that states that any inequality of temperature or pressure cannot be created without the expenditure of work. Maxwell suggested a vessel divided into two sections, A and B, by a partition in which there is a small hole. A being then opens and closes the hole, sorting the faster molecules into section A and the slower molecules into section B. This would raise the temperature in Section A, supposedly without exerting energy. The sorting demon hypothesis was later refuted on the basis that the act of opening and closing "the door" requires the use of energy (Mangel 88). However, this image plays a large role in *The Crying of Lot 49* and Pynchon uses it in several instances in *Gravity's Rainbow*.

In *Gravity's Rainbow* Pynchon explores the tension between Newtonian mechanism and twentieth-century cosmology and quantum physics, making use of concepts drawn from the latter two to illustrate the failings of Science and to warn of potential consequences. Pynchon attacks Science through creation of a paranoia/antiparanoia dichotomy that mimics the relationship between Newtonian mechanics and Quantum physics, as well as the ongoing debate over the question of whether or not indetermism is an inherent characteristic of the universe. Although Pynchon's characters -- and his readers -- are caught in a web of indeterminacy, they continue to slalom through events as they transpire, ill-equipped because they use the teachings of Science as their guide. Pynchon incorporates the concept of a black hole,

which I will discuss below, as a framing device in *Gravity's Rainbow* to suggest that Science has led the Western world to a precipice and left it teetering between destruction and potential salvation. Many of these concepts and other more specific theories related to twentieth-century physics and cosmology contained in *Gravity's Rainbow* followed the changes in our understanding of space and time brought about by Albert Einstein's theories of relativity.

In Newtonian mechanics, "the physical world was considered to be composed of isolated objects separated from one another in an empty space that was rigid and unchanging, with a universal 'now' pervading all space at any given moment" (Hayles, "Cosmic" 42). In the late nineteenth century, Maxwell's theories of electricity and magnetism yielded a description of light as an electromagnetic wave that travels at a constant speed through a substance called the ether, which was supposed to be present everywhere, "even in 'empty' space". The hypothesis of the ether was necessitated because, if light was a wave, it needed a medium. Were the ether theory accurate, "[d]ifferent observers, moving relative to the ether, would see light coming toward them at different speeds, but light's speed relative to the ether would remain fixed" (Hawking 19).

However, this supposition was called into question when the Michelson-Morley experiment found the speed of light to remain constant under circumstances in which -- were the ether theory accurate -- it should have appeared to differ (Taylor 14). Newton's laws required "inertial" reference frames of measurement -- reference frames in which the velocity (speed and direction) remained constant during observation. Observers in two

different inertial reference frames, then, would be expected to measure different speeds of light. According to this long-held law of relativity, formulated by Galileo, "[M]easurements may be relative, but the laws of physics cannot be relative. They must be exactly the same for all inertial reference frames" (Friedman, "Einstein" 47).

Einstein dismissed the ether concept by disposing of the assumption of universal time in his 1905 paper presenting the Special Theory of Relativity. Einstein assumed, first, that the laws of physics should be the same for all inertial reference frames. Second, he asserted that the speed of light will be observed to be the same for any inertial reference frame (Hawking 20). The most startling implication of Einstein's equations is that if the speed of light is constant, both space and time must be relative to the reference frame.

Einstein altered our ideas of space and time as two distinct concepts by combining the two into a space-time continuum, a system of three coordinates of space and one of time by which physical objects can be located. Prior to Einstein's 1915 General Theory of Relativity, space and time were conceived as a "fixed arena in which events took place, but which was not affected by what happened in it." In the General Theory, space and time become dynamic quantities. "[W]hen a body moves, or a force acts, it affects the curvature of space and time -- and in turn the structure of space-time affects the way in which bodies move and forces act" (Hawking 33). Published ten years after the Special Theory, the General Theory states that the laws of physics must hold for both inertial reference frames and reference frames moving with a changing velocity.

While Einstein's theories of relativity are not specifically referenced in Pynchon's novels, the twentieth century cosmology that arose from it is. Through a combination of observation and the efforts of scientists revisiting Einstein's General Theory of Relativity, it was postulated in the 1920s that the universe, rather than being static, as had been assumed, is in fact expanding. "[W]hile Einstein and other physicists were looking for ways of avoiding general relativity's prediction of a nonstatic universe," Alexander Friedmann attempted to explain it and his hypotheses about the universe spawned the Big Bang theory (Hawking 40). Friedmann suggested that the distance between neighboring galaxies was, at one time, zero. According to Friedmann, prior to the Big Bang, the universe was infinitely dense and space-time infinitely curved, contained within a singularity, now called a Friedmann point, at which the known laws of physics cease to apply. According to the big bang theory, at the beginning of time, the universe began expanding from this hypothetical center (Hawking 46).

Although the issue is still being debated, according to Friedmann, at some point in the future, the gravitational attraction between the bodies in the universe will eventually surpass the force of expansion, causing the universe to recollapse. "The rush inward toward the Center would then end in another incredibly dense mass, which would again explode, expelling matter outward. The universe would thus act like a rubber band being stretched and then released" (Hayles, *Cosmic* 193). A similar collapsing phenomenon is thought to occur on a smaller scale when a large star exhausts its fuel source: the star collapses in on itself, forming what is known as a black hole, a concept that plays a

structural and thematic role in *Gravity's Rainbow* and which I discuss in detail in chapter two.

Another revolution of modern physics is the uncertainty principle. Uncertainty in statistical mechanics results from a practical human inability to attain the necessary data, thereby creating the need to approximate. In contrast, developments in quantum physics in the twentieth century have led many to conclude that uncertainty is an inherent characteristic of the universe. It's not that we don't know -- it's that we can't know.

Quantum theory diverged even further from the Newtonian worldview, abandoning the idea that future events could -- given complete data -- be predicted and instead depicting a universe that could only be approximated with probabilities. Research into the properties of light began to generate conflicting results in the early twentieth century, with some results indicating that light is composed of particles, and others showing light as composed of waves. Einstein's explanation of the photo-electric

ffect in 1905 suggested that light is composed of particles; in his theories of relativity, though, light was assumed to be a wave (Friedman, *Einstein* 115). Several scientists determined independently that both theories appear to be correct. This concept is summarized in Niels Bohr's 1927 "Principle of Complementarity," which suggests that "[t]he wave-like and particle-like pictures of light should be seen as complements to each other, both required for achieving the full description of the entity called light" (118).

Werner Heisenberg's 1927 "Uncertainty Principle" further called into question our ability to pin down elements of the sub-atomic universe. Heisenberg set forth several sets of conjugate pairs of knowledge related to a given particle, including position and

momentum and energy and time, and stated that only one element of each pair can be determined at a time. In other words, if we are able to determine the exact position of a particle, the act of measuring the position automatically restricts our ability to measure its momentum. Thus, the observer becomes inextricably linked with that which is being observed. "The fuzziness in knowledge is unavoidable because it is a fuzziness inherent in the universe described by these new laws of physics" (Friedman, *Einstein* 119).

The implications of quantum physics have been debated since its inception, with some scientists coming out in favor of indeterminacy and others, including Einstein, arguing in favor of a unified -- but as of yet undefined -- theory that would explain the uncertainties and preserve the possibility of attaining complete knowledge (Friedman, *Einstein* 122). A similar dichotomy between paranoia and anti-paranoia is evident in Pynchon's novels.

While twentieth-century cosmology and quantum physics called into question assumptions about causality and the ability of science to attain complete knowledge, these challenges have not been incorporated into the worldview of Science as presented by Pynchon in *Gravity's Rainbow*, perhaps because they suggest that the scientific method may be incapable of leading us to complete knowledge. Thus, Pynchon's critique of the limitations of Science is primarily a critique of the Enlightenment worldview, within which he argues Western culture is still entrenched. Although Pynchon's symbolically proposed alternatives have some characteristics in common with twentieth-century cosmology and quantum physics, the primary similarity between Pynchon's alternatives and modern science lies in the failure of Science to explain either.

In describing and critiquing Science, Pynchon appropriates the concepts and speculates about the consequences of ideas from these four scientific paradigms in *Gravity's Rainbow* and *Mason & Dixon*, selecting theories with suspiciously-consistent characteristics -- and often prompting frustratingly conflicting conclusions. In sections three and four I examine how Pynchon incorporates these and other concepts from science and math in *Gravity's Rainbow* and *Mason & Dixon*, respectively, to explore the boundaries of scientific ways of knowing and a deep ambivalence about the scientific enterprise.

II. *Gravity's Rainbow*

In *Gravity's Rainbow*, Pynchon sets the stakes of Scientific revolution high, arguing that the Western world is at a crossroads that offers the prospect of either annhilation or redemption through the rejection of Science.

The central narrative in *Gravity's Rainbow* and that with which all other plots intersect, is the scientific interest surrounding U.S. Army Lieutenant Tyrone Slothrop, whose sexual conquests in London appear to correspond exactly to a map illustrating the impact sites of the German's V-2 rocket bombs in World War II. Suspecting that the correspondence is related to an alleged experiment in conditioning to which infant Slothrop was subjected by chemist Laszlo Jamf, a bizarre collection of scientists headed up by Dr. Edward Pointsman initially lead, then lose, Slothrop in a comical and paranoid quest for answers about his past and a search for the famed Rocket 00000 played out on the European continent. Intersecting plots follow the exploits of Pointsman and his competing team of scientists and mystics; German rocket engineer Franz Pokler and his wife Leni; the herero Enzian and his German half-brother Tchitcherine; and the trio of Dutch double agent Katje Borgesius, German soldier Gottfried, and Major Weissman (aka Blicero), whose sadomasochistic staging of Hansel and Gretel leads to the novel's surreal final launching of the elusive Rocket 00000.

Although *Gravity's Rainbow* touches on elements of all of the scientific paradigms outlined in the previous chapter, its narrative structure shares characteristics with other postmodern novels that suggest parallels between the changes in world view

associated with quantum physics and changes in narrative form. The narrative of *Gravity's Rainbow*, while generally linear, is packed with unannounced prolepses and analepses, which themselves often contain sudden jumps to a tenuously related time and place and a story that may or may not seem related to anything previously encountered in the novel. The characters are plagued by uncertainty, the explanations are fuzzy and many of the questions raised are left unresolved.

These distinctly postmodern characteristics of the narrative, while in accordance with the ideas of twentieth-century quantum physics, create a serious challenge for the cause-and-effect seeking characters depicted within the novel. In fact, the Science that Pynchon challenges in *Gravity's Rainbow* is so pervasive in Western culture that it reinforces expectations of causality in the very process of reading. Although the concept of causality, of course, predates the rise of Science, Pynchon makes use of expectations of causality in reading to challenge Science's own faith in strict causality. In the face of such narrative chaos, the reader seeks to create meaning by attempting to establish causal relations between the events ... only to be mocked by the narrator, who at one point acknowledges, begrudgingly, "You will want cause and effect. All right." (GR 663). The reader is forced into the same dilemma that torments Pynchon's characters, who, suspecting a master plot, but being unable to either confirm or deny the existence of one, are left to struggle with their own paranoia. Of course, they are only paranoid if there *is* no plot. Ultimately, Pynchon makes it impossible for the reader to achieve complete understanding of the novel through a reliance on expectations of causality, thereby highlighting the limitations of Science.

Pynchon's treatment of science and mathematics in *Gravity's Rainbow* is carefully designed to challenge Science by establishing realms of human experience to which it does not apply and by presenting alternatives to the symbolic order of the scientific method. In order to accomplish this, Pynchon identifies the scientific method with rigidity, causality and binary oppositions and then presents a symbolic alternative to it with scientific concepts that are concerned with the unification or elimination of binary oppositions and boundary crossing.

Pynchon links Science to the military-industrial complex that has created and profited from the horrors of World War II and depicts its adherents as naive followers who, believing the promises of the Enlightenment, blindly follow where Science leads them, without regard for the human and spiritual consequences of the technology it creates.

The narrative shape of *Gravity's Rainbow* is indicative of Pynchon's revolutionary intent. Although the narrative in *Gravity's Rainbow* seems initially chaotic, most critics are in agreement that it takes the form of a geometric shape. However, critics are in disagreement over whether the dominant image is a parabola or a circle. These two images are repeatedly juxtaposed and intermingled in both the novel's narrative form and throughout the text. The parabola, which matches the trajectory of the V-2 rocket, is most often associated in the novel with doom and destruction. "Katje has understood the great airless arc as a clear allusion to certain secret lusts that drive the planet and herself, and Those who use her--over its peak and down, plunging, burning, toward a terminal

orgasm" (GR 223). The entrance to the Mittlewerke is shaped like a parabola, and the actual path of the V-2 rocket is referred to several times as an ellipse of uncertainty.

"Its counterpart," argues Steven Weisenburger, "is the circular mandala, a symbol of opposites held in delicate equipoise" (10). Weisenburger argues that the chronology of the novel suggests a carefully devised circular design (9). The novel opens with a description of the V2 missile strike in September 1944 and ends -- barring the brief description of the Orpheus Theater in 1970 -- in September 1945 (Tololyan 32). But Molly Hite and others contend that the parabolic path of the rocket "controls and structures the novel" (98). The action of the novel begins with the sentence, “A screaming comes across the sky,” a flashback that recalls the first supersonic V2 missile launched on London in September of 1944. The novel ends with the final firing of Rocket 00000, which, once it begins to fall, “does not fall into the same world that fired it, and it is no longer a specific V-2 weapon with a young German soldier aboard; it is now the Rocket ...” (Fowler 89).

Thus, according to Weisenburger and others, the basic narrative structure adheres to the cyclical form of the calendar year -- suggesting a circular chronology; the opening and closing V2 images give the impression of a giant parabola arching over the text. Combined, these two images are suggestive of a conical shape. The circle and the parabola, known as conic curves in mathematics, are mathematical curves that are generated by the intersection of a plane with a cone. As illustrated in Figure 1, the base of the cone is a circle, also generated when a plane intersects parallel to the base. A plane intersecting parallel to the edge of the cone creates a parabola.

This conical shape to the novel, which to my knowledge has not been suggested previously, corresponds roughly to the projected shape of a black hole, as illustrated in Figure 2. A few critics have noted the presence of potential references to black holes within the text. Lawrence Kappel's 1980 essay suggested black holes as a trope within the novel, stating "The Zone is inside a black hole in historical and political space, a Bermuda triangle, through an exit door from 'reality'" (234). The same year, T.S. Tillotson published an enthusiastic one and a half page article in "Pynchon Notes" suggesting a relation of gravitational entropy and black holes to *Gravity's Rainbow* but provided few specifics and did not publish, as intended, a more substantial follow-up article.

The most revealing treatment of the subject to date comes from N. Katherine Hayles, who, in the context of a discussion about Pynchon's treatment of singularities -- "points in mathematical functions where the derivative, or rate of change, of the function becomes discontinuous" -- notes the presence of several possible references to black holes in *Gravity's Rainbow* (*Cosmic* 190).

One particularly interesting type of singularity, akin to the one from which the universe is postulated to have exploded, black holes are believed to be created when stars run out of the nuclear fuels that enable them to avoid collapsing in on themselves by balancing their gravitational attraction against the heat from nuclear reactions. When stars of a sufficient mass begin to collapse they form black holes. When one of these collapsing stars has "shrunk to a certain critical radius, the gravitational field at the surface becomes so strong that ... light can no longer escape" (Hawking 87). The

boundary at which the gravitational field makes it impossible for anything to escape is called the event horizon, the magnitude of which is calculated by the Schwartzchild radius, named after German physicist Karl Schwartzchild, who postulated black holes based on one solution of a set of equations created by Einstein shortly after his General Theory of Relativity[3].

"In Pynchon's text, 'Schwartzchild' is the Jamf code name for infant Slothrop," notes Hayles (194). Weisenburger points out that in fact Slothrop's code name is *Schwartzknabe* and calls the connection "tenuous: wholly reliant upon the reader's (not Pynchon's) translation" (193). While I concur that the Schwartzchild translation is not the only possibility, placing the responsibility for translation with the reader, and giving just enough information to suggest -- but never verify -- the black hole theory, it seems in keeping with Pynchon's paranoia-creating narrative style.

The black hole is one of a number of scientific concepts in *Gravity's Rainbow* concerned with boundaries. The image fits perfectly with Pynchon's symbolic system, as the difference between annihilation and survival depends upon a given threshold. The presence of the image of the V2 rocket arching over the text suggests that the technology that man has created with Science is leading humankind dangerously close to its own destruction.

A much quoted passage from the beginning of the novel describing the evacuation of London contains language that has been taken as descriptive of the whole and that is similarly descriptive of the formation of a black hole: "No, this is not a disentanglement from, but a progressive knotting into." The narrator describes the scene: "There are no

[3] The term "black hole," however, was not coined until 1968.

lights inside the cars. No light anywhere." And again: they "try to bring events to Absolute zero ... and it is poorer the deeper they go ... ruinous secret cities of poor, places whose *names he has never heard* ... the walls break down, the roofs get fewer and so do the chances for light" (GR 3). Within a black hole, all matter collapses to zero volume and infinite density and light is unable to escape.

If Pynchon is incorporating black hole imagery here, he is clearly doing so with a great deal of creative license, but that, again, is characteristic of his incorporation of scientific concepts. Further evidence of the black hole concept comes near the beginning of Part 4: The Counterforce. It is generally agreed upon that there is a final scene with Slothrop, and then he begins to scatter, to fragment and become invisible. Black hole imagery is incorporated here as well, as Pynchon hones in on symbolic singularities: "The sand-colored churchtops rear up on Slothrop's horizons, apses out to four sides like rocket fins guiding the streamlined spires ... at last, lying one afternoon spread-eagled at his ease in the sun ... he becomes a cross himself, a living intersection" (GR 625).

Here, the churchtops, which "rear up" on Slothrop's (plural) horizon**s** are reminiscent of both the V2 rocket and the black hole singularity, as mimicked by the "streamlined spires." Later, Slothrop sees a rainbow, "a stout rainbow cock driven down out of the pubic clouds in to Earth, green wet valleyed Earth, and his chest fills and he stands crying, not a thing in his head, just feeling natural" (GR 626).

Tillotson notes "Every black hole is surrounded by a literally invisible rainbow shell at the Schwartzchild radius (where r = 2M). It must be more than mere coincidence (heh, heh) that the title of *Gravity's Rainbow* reads as a symbol for this light-shrouded

null horizon of our universal destiny, and holds the promise of illumination to be gained through some steps taken (perhaps even unknowingly) across unseen thresholds of no return" (24).

Schwartzchild's theory -- and others corresponding to the years just prior to the publication of *Gravity's Rainbow* -- contained a second solution to Einstein's equations and suggests the existence of white holes, the properties of which are opposite to those of black holes: they radiate matter and energy outward (see Figure 3). Schwartzchild's geometry consists of a black hole, a white hole and "two universes connected at their horizons by a wormhole" (Hamilton). Thus, "whereas the black hole is a powerful metaphor for the absolute annihilation of no Return, the white hole promises rebirth" (Hayles 195).

Slothrop's disintegration and disappearance from the novel can be read as both cautionary tale and redemption. As Hawking explains, an observer present on the surface of a star or other object as it is collapsing to form a black hole would fragment either before or after formation of the event horizon. Gravitational forces "would stretch [an observer] out like spaghetti or tear him apart" (88). Slothrop begins to fragment just after the dropping of the atomic bomb on Hiroshima, suggesting obliteration as a possible fate for humanity following along in the path set out for it by Science and the transnational powers, who are able to use technology to advance Their agenda. At the same time, though, Slothrop's own experience of scattering paradoxically seems like a welcome release, as evidenced by his feeling of naturalness and by the church and mandala

imagery. Slothrop alone is able to transcend the scientific-military-industrial complex that is the basis of the novel's They-system.

Pynchon's primary attack on Science, though, is carried out in a much more straightforward fashion as Pynchon tests the boundaries and limitations of several of the scientific paradigms outlined in chapter two. He does so through a variety of non-scientist and scientist characters who all labor under oppressive forces of Science.

The most unlikable among them, Edward W. A. Pointsman, is the mastermind behind the schemes to uncover the mechanism that allegedly enables Slothrop to predict the locations of the V-2 strikes. Pointsman, a dedicated Pavlovian, runs the show at PISCES -- Psychological Intelligence Schemes for Expediting Surrender -- constantly strategizing ways to distract Brigadier Pudding from affairs at The White Visitation in order to maintain control of operations there.

Pointsman is dedicated to and obsessed with cause and effect, a belief system that corresponds to Newtonian mechanics as outlined in the previous chapter and which is one of the central tenets of Science. Pointsman "is one of seven owners of The Book, and if you ask Mr. Pointsman what Book, you'll only get smirked at" (GR 47). These seven rotate the Book, which goes unnamed, on a weekly basis. The mysterious Book, which functions as their bible, is an Ivan Petrovich Pavlov text on conditioned reflexes, a practice that Pavlov illustrated using dogs ... and which Pointsman, following in the footsteps of Laszlo Jamf, wishes to test on humans (Fowler 102, Weisenburger 37).

Pointsman is entirely unwilling to traverse any ideological boundaries, being completely devoted to cause and effect, and confident in man's ability to uncover the

secrets of the clockwork universe. And while, one by one, the other co-owners of the Book are killed in the war and pass over the boundary between the living and the dead, Pointsman remains, stubborn and determined, with his career in ruins as the result of the accidental castration of Major Marvy.

Franz Pokler, like Pointsman, is a "cause-and-effect" man (GR 159). Perhaps the most clueless of Pynchon's scientist pawns of various shadowy They-systems, Pokler is incapable of understanding Leni's metaphorical language, her reliance on astrology, or her politics. After Leni leaves him, Pokler remains a dutiful, though increasingly disgruntled, rocket engineer due to the annual visits with "Ilse" that Weissman arranges. When Pokler is transferred to the Mittelwerke in Nordhausen, he realizes that the Dora camp is just on the other side of the wall, and yet he continues his labors, despite the suspicion that Ilse could be enduring torture so nearby. After getting confirmation from her "[h]e tried, and kept trying, to get into the Dora camp and find Ilse ... [T]he SS guards each time were courteous, understanding, impossible to get past" (GR 430).

As the camp was on the eve of liberation, Pokler was finally able to cross through the gates, to find a scene of horror. "All his vacuums, his labyrinths, had been on the other side of this. While he lived, and drew marks on paper, this invisible kingdom had kept on, in the darkness outside ... all this time ... Pokler vomited" (GR 433). Pokler's mechanical practice of his science, his complacency and his reliance on the established laws of Science prevented him from really acknowledging what was on the other side of the walls he worked within -- until it was too late.

Pynchon's depiction of the holocaust in these terms suggests the evils of relying on cold and abstract belief systems regarding race to justify human slavery, oppression and genocide. Pynchon associates the machinistic nature of the holocaust with Science and is unforgiving of scientist characters like Pokler who fail to acknowledge the realities of the enterprise they are participating in.

Roger Mexico, PISCES statistician, serves as a likeable foil to Pointsman and Pokler. "[I]n the domain of zero to one, not-something to something, Pointsman can only possess the zero and the one. He cannot, like Mexico, survive anyplace in between" (*Gravity's* 55). Mexico exists in the space between -- in statistics and probabilities. Although he works among psychics, telekinetics and others with mysterious powers, he relies on only the tools of statistics in acquiring knowledge and views the methods of his mystic peers as suspect. "Never had a prophetic dream, never sent or got a telepathic message, never touched the Other World directly. If anything's there, it will show in the experimental data, won't it, in the numbers" (GR 40).

Mexico, though as trapped in his scientific paradigm as Pointsman is in his, seems sometimes to throw a glance towards the boundaries. "It's not my forte, of course," Mexico tells Pointsman, "but there's a feeling about that cause-and-effect may have been taken as far as it will go. That for science to carry on at all, it must look for a less narrow, a less ... sterile set of assumptions. The next great breakthrough may come when we have the courage to junk cause-and-effect entirely, and strike off at some other angle" (GR 89).

Mexico might have been redeemed by his love for Jessica, which enables him to cross over into the unknown realm of human emotions, in which mathematics is no guide. In the midst of a long passage about Mexico's intense love for Jessica, the narrator notes, "The time Roger and Jessica have spent together, totaled up, still only comes to hours. And all their spoken words to less than one average SHAEF memorandum. And there is no way, first time in his career, that the statistician can make these figures mean anything" (GR 121). Still, from early in the novel, Mexico is predicting the end of the relationship, attempting to calculate the probabilities of her leaving him for the more predictable Beaver. Such are the pitfalls of applying the tenets of statistical mechanics to the social realm. Although Mexico succeeds in crossing the Force-Counterforce boundary and joining the resistance, that effort is ultimately ineffective and Mexico's character is left as a foil to binarism and a symbolic representation of the perils of existing in the space between the zero and the one ... he is unable to escape nor fully to commit; he is able to move partway to redemption and then no further.

In this novel in which technology -- the product of faith in Science -- serves as the mechanism that ushers the war's victims through death to a shadowy afterlife, Pynchon's mediums channel spirits of the dead that seem keen, in their moments of connection with the world of the living, to characterize the rationality and causal beliefs of Science as a destructive construct that serves Their purposes.

Walter Rathenau, assassinated German foreign minister and himself a likely candidate for membership in Their ranks, is channeled by Leni Pokler's lover Peter Sachsa (who, in turn, serves as the control in Caroll Eventyr's channeling of Roland

Feldspath). "Rathenau was prophet and architect of the cartelized state" (GR 164). Rathenau's connections to IG Farben have inspired the prewar Nazi elect to attempt a séance through which to question him and prior to which "[a] gentle sorting out process is under way. Reasons of security. Only certain guests are allowed to go on into Peter's sitting room. The preterite stay outside, gossiping, showing their gums out of tension, moving their hands..." (GR 163).

Rathenau's vision for Germany after World War I was for "a rational structure in which business would be the true, the rightful authority" (GR 165). As Rathenau is channeled through Sachsa, he hints at alternate ways of knowing that, he suspects, will be difficult for the living to comprehend: "All talk of cause and effect is secular history, and secular history is a diversionary tactic. Useful to you, gentlemen, but no longer to us here. If you want the truth -- I know I presume -- you must look into the technology of these matters. Even into the hearts of certain molecules ... " (GR 167).

Rathenau instructs his listeners to consider, what is the nature of synthesis? And what is the nature of control" "You think you know, you cling to your beliefs. But sooner or later you will have to let them go ..." (GR 167).

Earlier, Rathenau attempts to direct his listeners where to look for answers through a discussion of organic chemistry -- and particularly the inception of the dye and pharmaceutical industries, including the production of Oneirine (Weisenburger 95). "Tyrian purple, alizarin and indigo, other coal-tar dyes are here, but the important one is mauve." Rathenau continues to explain how the creation of mauve, the first synthetic dye, came about through the synthesis of coal tar ... previously thought to be a useless

waste material. The significant aspect of the explanation is that coal-tar exists at the boundary between two other materials. "Consider coal and steel. There is a place where they meet. The interface between coal and steel is coal-tar ... We passed over the coal-tars. A thousand different molecules waited in the preterite dung. This is the sign of revealing. Of unfolding" (GR 166).

The séance attended by Roger Mexico and Jessica, at which Caroll Eventyr, via Sachsa, channels Roland Feldspath, carries a similar message. Feldspath speaks of a mystical wind that brings unity ... and states that, while living, he was unable to feel it but felt only secular wind. Speaking of alterations in market forces, he states: "It's control. All these things arise from one difficulty: control ... [T]he illusion of control. That A could do B. But that was false. Completely. No one can do. Things only happen, A and B are unreal, are names for parts that ought to be inseparable" (GR 30).

Pynchon uses these contacts with the afterlife to challenge the authority of Science and to juxtapose it with an alternative that he associates with a mystical wind, unity and the interface between opposites. In using the concepts from science and math I discuss below, Pynchon creates a symbolic system that illustrates the weakness or destructive nature of science and then seeks to replace it with a suggested, though abstract, alternative.

Pynchon identifies binarism and the concept of opposites with Science and makes these ideas negative within the symbolism of the text. During the séance that Jessica and Mexico attend, Jessica inquires about Milton Gloaming's language investigations. Gloaming, relying on George Kingsley Zipf's Principle of Least Effort, as described in

his 1935 book *The Psycho-Biology of Language*, makes notes of the words spoken during séances and other instances of automatic texts, records their frequency, and then graphs them to determine if there is any variation from "normal" speech. As Gloaming attempts to explain to Jessica, he graphs the information, "plotting the frequency of word P sub N against its rank-order *n* on logarithmic axes" (GR 32). Or, as Zipf describes it, Gloaming indicates "on the abscissa of a double logarithmic chart the number of the word in the series and on the ordinate its frequency" (Zipf 44). Zipf argues that in normal speech the result will be a straight line.

"[H]owever, we've data that suggests the curves for certain -- conditions, well, they're actually quite different -- schizophrenics for example tend to run a bit flatter in the upper part then progressively steeper -- a sort of bow shape," Gloaming tells Jessica (GR 32).

The bow-shape suggested by the abnormal speech patterns of the schizophrenic, of course, mimics the flight path of the V-2 rocket. Pynchon, though, pushes further. Gloaming, suggests that the medium they've been observing is a "classical paranoiac," noting, upon Jessica's inquiry, that he relies heavily on words that mean "against" and "opposite." The most frequent word, reports Gloaming, is "death" (GR 32).

The meaning of words is not taken into account in Jamf's Principle -- only their frequency and use. Yet Pynchon associates ideas of opposition with the diseased state of the paranoiac.

Mexico uses the Poisson distribution mentioned in section one to predict the pattern of the V2 rocket strikes in London. The distribution allows him to determine "for

a number of total hits arbitrarily chosen, how many squares will get none, how many one, two, three, and so on" (GR 55). While Mexico's predictions are accurate -- the bombs do fall into a perfect Poisson distribution, the frustrating limitation of the method is that, while the distribution can determine how many squares will get at least one bomb, it provides no way to predict which ones, and no way to predict when the bombs will fall.

As Jessica laments, "Why is your equation only for angels, Roger? Why can't *we* do something, down here? Couldn't there be an equation for us too, something to help us find a safer place?" (GR 54).

Pynchon incorporates the world of Pavlov into the text via Pointsman. Pavlov's work was particularly concerned with ideas of opposition: pleasure and pain, light and dark, dominance and submission (all topics that hold a fascination for Pynchon as well). Pavlov -- and Pointsman after him -- not only explored the brain functions associated with these opposites, but was particularly interested in subverting them. "[W]hen, somehow -- starve them, traumatize, shock, castrate them, send them over into one of the transmarginal phases, past borders of their waking selves, past "equivalent" and "paradoxical phases" ... you weaken this idea of the opposite, and here all at once is the paranoid patient who would be master, yet now feels himself a slave" (GR 48).

Pointsman proposes a correlation between this mechanism and Slothrop's ability to anticipate the V-2 rockets ... as if the boundary that separates cause and effect has been broken down, become passable. Pointsman, in a conversation with Kevin Spectro, suggests that some element of the war environment automatically sends Slothrop "transmarginal," triggering a reflex that allows him to feel the V-2 bombs coming days in

advance (GR 49). Although this is never proven to be the case, it is of interest that the phenomenon that gives Slothrop an ability akin to magic is hypothesized to be associated with boundary crossing. To Pointsman, the possibility is a frightening sign of disease; but within the symbolic system of the novel, going transmarginal is one method of combatting Science.

Pynchon incorporates entropy into the novel, as in his short story "Entropy," in the obvious increase in disorder as the novel progresses and in individual references to the process. But he also makes reference to challenges to the Second Law of Thermodynamics, suggesting that the German chemist Justus Freiherr von Liebig was acting as a sorting demon similar to that hypothesized by Maxwell when he encouraged Kekulé, who created the plastics that the military-industrial complex hold so dear, to switch his major to chemistry. In doing so, the narrator proposes, Liebeg was "helping to concentrate energy into one favored room of the creation at the expense of everything else" (GR 411). Within the symbolic order of the text, this act of sorting is negative because it contributes to the success of the military-industrial complex.

The number zero serves as a lightning rod in *Gravity's Rainbow* for discussion of Science and its alternatives and the prospects for annhilation or salvation, as Pynchon makes repeated reference to the number zero and the idea of moving beyond the zero. There are a plethora of ideas linked to the number, among them negative associations with Science and positive associations with alternatives to it. It is linked with a possible explanation for Slothrop's ability to predict rocket strikes, which is suspected to be associated with the response conditioned in him as an infant by Laszlo Jamf. Jamf,

presumably, followed tradition and deconditioned him as well. But, as the narrator states, quoting Pavlov, "Not only must we speak of partial or of complete extinction of a conditioned reflex, but we must also realize that extinction can proceed *beyond* the point of reducing a reflex to zero. We cannot therefore judge the degree of extinction *only* by the magnitude of the reflex or its absence, since there can still be *a silent extinction beyond the zero*" (GR 85).

Zero is also associated with the rocket, in calculating both its projected path and the point of its projected landing: "Ascending, programmed in a ritual of love ... at Brennschluss it is done -- the Rocket's purely feminine counter part, the zero point at the center of its target, has submitted." Further, the rocket and similar destructive technology, is associated with the threshold at which man's love affair with science will become destructive (GR 223).

Leni attempts to appropriate the number zero to explain to Pokler one of her non-scientific ways of knowing, making use of calculus as a metaphor for the excitement and sense of possibility she feels at street demonstrations: "She even tried, from what little calculus she'd picked up, to explain it to Franz as Δt approaching zero, eternally approaching, the slices of time growing thinner and thinner, a succession of rooms each with walls more silver, transparent, as the pure light of the zero comes nearer ..." (GR 159). Leni tries, and fails, to explain to Pokler in his own terms the infinite possibilities of the world beyond Science.

In a discussion between Ombindi, the lead proponent of tribal suicide for the Hereros, and Enzian, the narrator draws parallels between Enzian's strategy and that of

The Empty Ones. Enzian seeks to bring his people to a state of mystical union: "The people will find the Center again, the Center without time, the journey without hysteresis, where every departure is a return to the same place, the only place" (GR 319). The strategy of The Empty Ones is to commit tribal suicide simply through failing to reproduce, thereby determining the fate of the Zone-Hereros in bed, in a sexualized sort of suicide that the pair discuss in detail. The zero here is linked to the mystical unity of the Center: "The Eternal Center can easily be seen as The Final Zero. Names and methods vary, but the movement toward stillness is the same" (GR 319).

Finally, as I illustrated above, zero is also associated with black holes in terms of their volume and in the imagery of the opening scene, which describes the evacuation of London in imagery that is suspiciously descriptive of the black hole phenomenon. This provides a unifying image for the other destructive and redemptive associations with the number.

Perhaps the most iconic mathematical concept within the text is the singularity. Pynchon uses singularities as a symbol of both the limitations of Science and of the exhilarating, formally undefinable, possibilites that exist outside of it. Pynchon makes references to the Friedmann point, "the hypothetical center from which the universe exploded" (Hayles, *Cosmic* 190), which, like the singularity at the center of a black hole, has zero volume and infinite density. The narrator drools over the "singular point at the top of a lady's stocking," suggesting at this point, "there is a cosmology: of nodes and cusps and points of oscillation, mathematical kisses ... *singularities!* Consider cathedral spires, holy minarets ... mountain peaks rising sharply to heaven ... even, according to the

Russian mathematician Friedmann, the infinitely dense point from which the present Universe expanded." The narrator points out, too, that the point at the very top of the rocket, "where the fuse is," is a singularity as well, suggesting that "the change from point to no-point" in each of these cases inspires wonder -- or perhaps fear. "Do all these points imply, like the Rocket's an annihilation?" (GR 396).

The narrator suggests that the Polish undertaker who rescues Thanatz in his boat would gain an understanding of cataclysm if he were to succeed in getting struck by lightning. "[T]he ones who do get hit [by lightning] experience a singular point, a discontinuity in the curve of life -- do you know what the time rate of change *is* at a cusp? *Infinity*, that's what! A-and right across the point, it's *minus* infinity! How's *that* for sudden change, eh?" (GR 664).

At a singularity, as Δx moves to zero, Δy goes to infinity. Thus, the rate of change at a singularity that differential calculus attempts to express goes to infinity. As Hayles explains, "The differential dy/dx, is defined as the limit, as Δx approaches zero, of $\Delta y/\Delta x$. At the singularity, this limit must be formally expressed as infinity because it fails to converge, becoming larger and larger as the cusp is approached." Pynchon latches on to this concept because it serves both as symbolic boundary and because "the singularity ... represents a point where the behavior of the function ceases to be mathematically expressible, except in a purely formal way" (Hayles 191).

Pynchon sneaks the singularity concept into his description of Oneirine as well. "There is in Laszlo Jamf's celebrated molecule a particular twist, the so-called "Pokler singularity," occurring in a certain crippled indole ring, which later Oneirists,

academician and working professional alike, are generally agreed is responsible for the hallucinations which are unique to this drug" (GR 703). The descriptions of the effects of the drug Oneirine sound similar to some of the concepts, made strange by conventional conceptions of time and space, of twentieth-century cosmology, as if the drug enables the user to cross some threshold.

Describing the paranoia that is experienced under the drug, the narrator notes, "Like other sorts of paranoia, it is nothing less than the onset, the leading edge, of the discovery that *everything is connected*, everything in the Creation, a secondary illumination -- not yet blindingly One, but at least connected, and perhaps a route In for those like Tchitcherine who are held at the edge ..." (GR 703). Recall that Oneirine is linked to the color mauve and coal-tar -- formed at the interface between two opposites -- discussed by Walter Rathenau during the séance. Thus, Pynchon posits a connectedness in the symbolic alternatives to the scientific method that he presents; a connectedness that does not require causality.

Another area of particular interest to Pynchon, which appears in both *Gravity's Rainbow* and *Mason & Dixon*, is the union of humans/animals and technology. Pynchon uses this device to comically illustrate the Western world's love affair with Science. During Slothrop's excursion into the labyrinths of the Mittelwerke, the soldiers he encounters happily sexualize the rocket. "Each young American in turn getting to his feet (optional), raising his tankard, and singing about different ways of Doing It with the A4 or its related hardware" (GR 306). Thus the production of a series of Rocket Limericks: "There once was a young fellow named Crockett,/ Who had an affair with a rocket./ If

you saw them out there/ You'd be tempted to stare,/ But if you ain't tried it, don't knock it! (GR 305).

The Hansel and Gretel-based love triangle between Blicero, Gottfried and Katje ends in Hansel/Gottfried, rather than the witch/Blicero being consumed in flames, and Gottfried's final union with Rocket 00000 serves as the climactic moment of the novel, unifying man and machine, along with many of the novel's plotlines. This scene suggests not only that Science is leading man on a path to destruction, but that the release of obliteration may be the only salve for the wounds it has created.

In addition to creating characters that seek physical union with the technological products of science, Pynchon often lends human characteristics to products of technology. In *Gravity's Rainbow*, Byron the Bulb takes on human traits, along with one distinctly nonhuman one -- immortality. "This bulb is *immortal!* It's been around, in fact, since the twenties, has that old-timery point at the tip and is less pear-shaped than the more contemporary bulbs. Wotta history, this bulb, if only it could speak -- well, as a matter of fact, it *can* speak" (GR 647).

The old-timery point on Byron represents another singularity, which in the context of the Byron narrative suggests possible alternatives to Science and the military-industrial complex to which it is tied. Byron starts out his life in Bulb Baby Heaven, where he begins plotting to organize all the Bulbs in several ambitious plots against the humans. After drawing the attention of the cartel and escaping several attempts on his life, he tries to explain to other bulbs that Bulb should move beyond the role assigned it by the cartel, that of a conveyor of light-energy. "'But there are other frequencies, above

and below the visible band. Bulb can give heat. Bulb can provide energy for plants to grow, illegal plants, inside closets, for example. Bulb can penetrate the sleeping eye, and operate among the dreams of men" (GR 653). But although his knowledge increases and "someday he will know everything" he is powerless to act because the dictates of the scientific-military-industrial complex prescribe his function (GR 655).

As described above, Pynchon sexualizes technology and blurs the boundaries between humans/animals and machines, animate and inanimate. His frequent references to the unconventional sexual escapades of Slothrop and others often draw attention to the boundary-crossing that is inherent in the various sex acts he describes. The orgy scene aboard the Anubis is particularly notable for its detailed and indulgent description of the many instances of sexual boundary crossing.

Pynchon's revolutionary undertaking in *Gravity's Rainbow* is highlighted by the fact that each of the novel's four sections represents a different boundary crossing. In section one, Beyond the Zero, the crossing is clear in the title. Section two, *Un Perm' au Casino Hermann Goering*, begins after Slothrop crosses the English Channel. His ability to predict the locations of V2 rocket strikes is linked to his physical presence in London; when he crosses the Channel his ability is no longer traceable. Section three represents Slothrop's passage into the Zone, with internal passages from one section of the Zone to the other stressed throughout. Finally, Section four, The Counterforce, is linked to the passage of several of the characters out of the grip of the They-system and into the resistance and the attempted creation of a We-system.

Pynchon uses images from science in *Gravity's Rainbow* to challenge Science through the identification of anomalies and the deconstruction of its symbolic order. In *Mason & Dixon*, Pynchon examines Science writ large as Mason and Dixon split the New World down the middle, creating a giant binary opposition, the boundary of which is the scene of the majority of the novel's spirited shenanigans and the development of the title characters' memorable friendship.

III. *Mason & Dixon*

Mason & Dixon, in many ways, seems like the inevitable masterpiece to follow *Gravity's Rainbow*, at once a crystallization of Pynchon's ideas about the limitations of Science and a return to perhaps the most archetypal American scientific endeavor -- albeit one that had previously been largely overlooked.

The narrative inspiration for *Mason & Dixon*, as in the case of *Gravity's Rainbow*, is found in a scientific endeavor. Charles Mason and Jeremiah Dixon are brought together, first, to observe the 1761 Transit of Venus and later to draw the American boundary that made its way into the popular imagination as the Mason-Dixon line.

The narrative structure is much more straightforward than that in *Gravity's Rainbow*, with the story of Mason and Dixon taking the form of an imbedded narrative. The presumed narrator, Reverend Wicks Cherrycoke, has been living at the home of his sister and her family for several months, having journeyed to Philadelphia for Mason's funeral. There is also a third, outer, layer of narrative, the narrator of which, for instance, describes the scene at the LeSpark home and informs us that Cherrycoke "arriv'd here back in October for the funeral of a Friend of years ago, -- too late for the Burial, as it prov'd" (M&D 6). And Cherrycoke seems to have no desire to bury Mason, Dixon or his memories of them, but instead spins their tale for his nieces and nephews, referring occasionally to his daybook for details.

As with *Gravity's Rainbow*, superimposed upon *Mason & Dixon* is the image of a geometric shape. The narrative is more linear than that in *Gravity's Rainbow*, and the majority of the narrative is concerned with laying down the line ... using the stars to impose a straight mark upon the surface of the earth. The line serves as a giant symbol of the division and subdivision that is characteristic of Science. And yet, although the negative associations with Science that are established in *Gravity's Rainbow* are also present in *Mason & Dixon*, Pynchon's depiction of the title characters sympathetically justifies the rise of scientific culture. The boundary endeavor becomes more than merely an assignment, with first one, then the other of the pair being overtaken with lust for westward movement beyond the agreed-upon stopping point. It is in this desire that the physical line and all of the symbolism that the modern reader associates with it is juxtaposed with and measured against the ideal and infinite line dreamt up by its creators.

The two major endeavors that Mason and Dixon undertake, observing the Transit of Venus and running the Mason-Dixon line, both symbolic crossings, push the world further into modernity and advance the Enlightenment agenda.

After the failed attempt to sail to Bencoolen, Mason and Dixon observe the Transit of Venus in Cape Town, South Africa, where, surrounded by the lascivious Vroom girls, the astronomers' excitement about the Transit spills over into the town. And as the narrator observes, imagining a hypothetical frolicsome exchange among laypeople observing the Transit, somewhere in the world, "This, or odd behavior like it, is going on all over the World all day long that fifth and sixth of June, in Latin, in Chinese, in Polish,

in Silence ... Observers lie, they sit, they kneel, -- and witness something in the Sky" (M&D 95).

Astronomers spread out at points throughout the world observed the Transit and recorded "four Instants of perfect Tangency between Venus's Disk, and the Sun's" (M&D 97). That is, external and internal contact at ingress and internal and external contact at egress. As Mason explains, "One day, someone sitting in a room will succeed in reducing all the Observations, from all 'round the World, to a simple number of Seconds, and tenths of a Second, of Arc, -- and that will be the Parallax" (M&D 93).

And while Mason, ever the melancholy one of the two, records his observations with solemnity, Dixon exclaims at first sight "Eeh! God in his Glory!" reporting later that watching the Transit was "seeing not only our Creator about his Work ... but Newton and Kepler, too, confirm'd in theirs. The Arrival, perfectly as calculated, the three bodies sliding into a single Line ... Eeh, it put me in a Daze for fair" (M&D 98).

In America, Mason and Dixon bravely traverse the countryside, surrounded by country dwellers more and less enthusiastic about the boundary line, with some previously oblivious to it and others scheming up land plots that will benefit from establishment of firm state boundary lines. Add to this often hostile Native Americans, blood-hungry pioneers, revolutionaries and otherworldly creatures, and a general idea is acquired of the pre-union chaos through which the line is drawn.

Pynchon's selection of surveying as a topic is no surprise, as the act itself is a physical parallel to the mental dividing and categorizing that reason and scientific thought valorize. Here, Mason and Dixon arrive in a hitherto undivided land, and make

official the boundary that divides North from South and defines the shape -- and later, is symbolic of the values -- of those spaces with arbitrary names like Maryland and Pennsylvania. As with the holocaust in *Gravity's Rainbow*, the horrors of the American institution of slavery, which culturally is strongly associated with the Mason-Dixon line, stands as a largely unspoken warning of the evils of the actual and symbolic dividing line.

The sentiment that Pynchon is attempting to capture -- and then, of course, quietly obliterate -- is similar to that captured in this 1931 reflection on the science of measurement: "The measuring stick is the scepter in the hand of science; a tool of discovery, a means of record and an example of the exact use of knowledge. The gradual rise in the art of measurement gave no sign that in this century it would reach a commanding place in human affairs" (Hubbard qtd. in Kiely 356).

Whereas the scientists in *Gravity's Rainbow* are largely undeveloped and their science-inspired Achilles heels clearly demarcated, the title characters of this novel are depicted with both compassion and affection. The seeds of their love for science, as well as their aspirations, are depicted without condescension. Dixon, who hails from Durham county, is primarily a surveyor, but assures Mason, Assistant to the Astronomer Royal, "I've been *taught* the lot, Celestial Mechanics, all the weighty lads, Laplace and Kepler, Aristarchus, the other fellow, what's his name, -- but that's all Trigonometry, isn't it ... ?" (M&D 17).

Mason, who heads up the expeditions, with Dixon formally assisting, though they carry on as equals, has himself served as assistant to the Astronomer Royal, where he assisted in making and recording observations. As a child, Mason's interest in studying

the stars was met with staunch disapproval. Young Mason's father tries to make him into a breadmaker like himself. "[H]e would speak of duties to Charlie, who'd go along with it, tho' pulled at, the miller could tell, by something else, pull'd away from the silent loaves and the rumbling stones, out to London, the stars, the sea, India" (M&D 205). Mason's father refers to him, scornfully mocking, as "the little Starrrgazer." Young Mason, in turn, is terrified of the baker's trade and its sacramental associations, and wonders, "[is] he fleeing to the repetitions of the Sky, believing them safer, not as saturated in life and death?" (M&D 205). Perhaps Mason, in studying the sky, seeks to comfort himself with belief in an afterlife. As Rebekah's ghost reminds him, "You believ'd, when you were a boy, that the Stars were Souls departed" (M&D 172).

Dixon spent his young adulthood enjoying the "merry Life of a Journeyman Surveyor, errant all through the North country, one Great Land-Holding to another ... tho' spaces *not yet enclos'd* would ever make him uneasy" (M&D 241). Following his father's death when he was 22, Dixon's grief made him reckless: "He was turning into a Country Lout, soon to be beyond reclamation" (M&D 241). His craft was his salvation: "Jeremiah found himself indoors, perfecting his Draftsmanship, bending all day over the work table ... preparation he would once rashly have hurried 'round or in great part omitted, was now necessary, absolutely necessary, to do right." He spent his time painstakingly creating a map of an imaginary world, "a Map entirely within his mind, of a World he could escape to, if he had to." His map would allow him to travel this world and never get lost, through "Mountain of Glass, Sea of Sand, miraculous Springs, Volcanoes, Sacred Cities,

mile-deep Chasm, Serpent's Cave, endless Prairie ... another Chapbook-Fancy with each Deviation and Dip of the Needle" (M&D 242).

Despite the pure intentions of Mason and Dixon, there remain the occasional suspicions, much less pervasive than in *Gravity's Rainbow*, of an unknown They-system, often associated with Science, either masterminding their actions or plotting against them. Following the attack of the *Seahorse* by French, Dixon remarks, suspiciously, "Happen ... we were never meant at all to go to Bencoolen, -- someone needed a couple of Martyrs, and we inconveniently survived .. ?" (41). Mason suggests their talents are being used as part of a Jesuit plot ... and Dixon questions how a baker's son became Assistant to the Astronomer Royal and himself, a "Georgie Land-Surveyor get to be his Second on the most coveted Star-gazing Assignment of the Century? Happen 'twas my looks? ... they charm ... ? Or are we being us'd, by Forces invisible even to thy Invisible College?" (M&D 73).

When Mason fails to receive the Astronomer Royal position, Dixon feels obliged to set him straight, thinking, "[e]ither Mason here cannot admit there's a Class problem here, or, even this deeply compromised, he may yet somehow keep Faith that in the service of the Heavens, dramatic elevations of Earthly Position are to be expected of these Times, this Reign of Reason, by any reasonable man. Very well, 'Mason, you are a Miller's Son. That can never satisfy them'" (M&D). Here again, although the oppressive force is made clear, Dixon's statement that it can never satisfy *them* leaves cloudy its ultimate source, suggesting, as in *Gravity's Rainbow* that even the purest scientific

endeavors are co-opted and controlled by an overarching and only partially definable They-system.

Other scientists are presented with less than pure aspirations, with the half-crazed Maskelyne, brother of the famed Clive of India, seeking -- and gaining -- the undeserved role of Astronomer Royal, a perceived coup that Mason fancies part of a plot: "Is that what this fucking exile in America's about then, Morton and his fucking Royal Society, -- to get me out of the way so that Maskelyne can go prancing up to Greenwich freed of opposition, --" (M&D 438).

Just as in *Gravity's Rainbow*, the line between the living and dead is sometimes permeable in *Mason & Dixon*, with Mason's late wife Rebekah making periodic appearances from the other side. Although Mason seems to be trying to get some information about her fate from the Learned English Dog, he gets no information about her until she appears to him in ghostly form in St. Helena, upon the Windward Side, surrounded by the same sort of magical wind that is referred to in *Gravity's Rainbow*. When he first begins hearing her voice, "[h]e tries to joke with himself. Isn't this suppos'd to be the Age of Reason?" He suggests that " to believe in the cold light of this all-business world that Rebekah haunts him" is akin to blasphemy. "But if Reason be also Permission at last to believe in the evidence of our Earthly Senses, then how can he not concede to her some Resurrection?" (M&D 164).

During her first visit she inquires about what he is doing and he gives an explanation of the observations he is collecting, explaining that two people are required for the task " -- and I must do as others direct." To which she replies, enigmatically, "But

wait till you're over here, Mopery" (M&D 165). This response is arguably similar to the sentiments of the dead channeled in *Gravity's Rainbow*, indicating that the obsession with cause and effect, the dividing and categorizing that consume the living are irrelevant after death.

Mason and Dixon are portrayed as men of reason who are subject to frequent lapses of calculated judgment -- and a return to belief in fantasy and magic, to which, try as they will to fight it, they maintain equal allegiance. Pychon's portrayal of this struggle serves as a gentler attack on Science in that it suggests even Enlightenment scientists struggled to make it fit.

Dixon shames Mason against his reluctance to set sail in the *Seahorse* on Friday, the day of Christ's execution, saying, "Mason, pray You, -- 'tis the Age of Reason .. we're Men of Science. To huz must all days run alike, the same number of identical Seconds, each proceeding in but one Direction, irreclaimable ... ? If we would have Omens, why, let us recall that the Astronomer's Symbol for Friday is also that of the planet Venus herself, -- a good enough Omen, surely ...?" (M&D 27). The *Seahorse*, of course, is attacked by the French, splashing doubt on the reliability of reason -- or at the very least, highlighting its inability to prevent attacks at sea and the other unpredictable events of life from taking place. Notably, Dixon points out the linear nature of time as it is understood in the Age of Reason ... it runs in but one direction, in this case, just as does the Seahorse. Yet knowledge of this does nothing to predict or prevent those things that, moving forward, one might find blocking the way.

Again and again, "'Tis the Age of Reason!" each reminds the other, always in the face of some thing or circumstance entirely unreasonable, though, often, to all senses true. Such persistent lack of fit between Mason and Dixon's default systems of belief and the title that allegedly crowns the age they live in suggests that the "Age of Reason" is, at least for this pair, prescriptive rather than descriptive. Thus, reason becomes a dictate, imposed upon the unwary from on high, with the eighteenth century serving as a training period, and *Mason and Dixon* fashioned as an anticipatory Petri dish for cultivation of the disease of Science that wreaks havoc in *Gravity's Rainbow*.

Mason and Dixon seek evidence of magic, despite reminding themselves repeatedly that, as men of science, that ought not to believe in it. Mason, while in Cape Town, experiences repeated dreams of "some presence with a *Krees* or Malay Dagger, of indistinct speech, yet clear intention to Dowse for the Well-Spring of Mason's Blood" (M&D 70). Austra sends him to talk to an Asian Pygmy of a Malay tribe to learn how to protect himself. "It is at some point that night, after securing the second Altitude of Shaula, that the Astronomers agree to share the *Data* of their Dreams whenever possible" (M&D 71).

The next time Mason has the dream, he confronts his assailant, and following the instructions of the Pygmy sage, demands the *Krees.* Mason awakes to find the dagger laying beside him in bed. Though Dixon suggests it may be a prank played by the Vroom girls, the mystery is left unsolved and Mason and Dixon are again left tottering between their desire for magic and their allegiance to reason.

Pynchon fills the narrative with references to the minutiae of eighteenth-century science and culture, several of which provide challenges to or alternative versions of lines and thus suggest alternatives to Science.

Captain Zhang, himself reliant upon the tenets of Chinese geomancy, suggests drawing a dividing line among the people one desires to rule will ensure their indefinite domination, Bad History being the only requirement for an indefinite reign. "Nothing will produce Bad History more directly nor brutally, than drawing a Line, in particular a Right Line, the very Shape of Contempt, through the midst of a People," warns Zhang (M&D 615).

Ancient Chinese wisdom holds that "neither Heaven nor Earth is complete in itself, and it is left to Man, the mediator between the two, to complete things and bring them to perfection," the idea being that man will "correct the natural outlines of the earth's surface to a more perfect configuration" (Skinner 36). As Zhang argues, this involves paying close attention to the original form of the natural landscape: "Ev'rywhere else on earth, Boundaries follow Nature, -- coast-lines, ridge-tops, river-banks, -- so honoring the Dragon or *Shan* within, from which Land-Scape ever takes its form. To mark a right Line upon the Earth is to inflict upon the Dragon's very Flesh, a sword-slash" (M&D 542). The line that Mason and Dixon are running is the projection of a geometrical concept upon the surface of the earth, without regard for the existing geography.

Pynchon's inclusion of Dixon's adventures flying along ley-lines, the term itself an anachronism, provides an interesting foil to the carefully drawn Mason-Dixon line.

Led by William Emerson, who the narrator observes, is easily imagined as a wizard, students are taught how to sense, the line. "The Ley seems to generate, along its length, an Influence, -- palpable as that of Earth's Magnetism upon a Needle" (M&D 218).

The term ley lines -- descriptive of alignments of prehistoric sites and natural landmarks across Britain -- was actually not coined until 1921. At this time, Alfred Watkins noted the alignment of these ancient monuments and began studying them. Although the phenomenon is often relegated today to discussions of mysticism, which in the West is increasingly marginalized, researchers in the 1920s argued that the ley system was connected with "a former code of mystical science which acknowledged the existence of energy streams across the earth and the part they play in the renewal of life on this planet" (Michell 8).

Dixon later makes use of another of Emerson's teachings to balance the tub they are preparing to steal from the Lepton estate upon a mysterious axis. Dixon explains: "Laws of Leverage ... Secret techniques of mechanickal Art, rescued from the Library at Alexandria, circa 390 A.D., before rampaging Christians could quite destroy it all, jealously guarded thereafter, solemnly handed down the Centuries from Master to Pupil" (M&D 423). In this reference to a classical text, perhaps some fictional text of Archimedes, being secretly rescued and passed down to land in the Age of Reason, Pynchon takes a jab at the intellectual presumptiveness of the age via his own Tale of a Tub, an absurd blend of science and fantasy that vaguely recalls Jonathan Swift's satirical essay of the same name. In Pynchon's version, the tub is a bath tub, the whale a torpedo ... and the scene ridiculous.

Talk of Emerson's exploits draws comparison to the exploits of the German doctor Franz Anton Mesmer, whose sham electromagnetic treatments and apparent ability to hypnotize brought him fame on both sides of the Atlantic (Wolf 494). Pynchon highlights this apparent eighteenth century reluctance to let go of magic. Instead the order of the day is to preserve it -- but dress it up in the trappings of science, thereby cementing faith in reason, which, at least temporarily, can be believed to produce wonders equal to those it forbids.

Pynchon includes several machines and animals that take on human characteristics, first among them the Learnèd English dog, with whom both men seem eager to converse. For Mason, the dog seems his most promising chance to learn about Rebekah's possible fate, and he inquires as to whether the dog is in fact a human soul reincarnated. To which the dog replies: "'Tis the Age of Reason, rrrf? There is ever an Explanation at hand, and no such thing as a Talking Dog, -- Talking Dogs belong with Dragons and Unicorns. What there are, however, are Provisions for Survival in a World less fantastick'" (M&D 22). And so, a reasonable explanation is forthcoming: Learnèd is merely an extreme expression of the canine strategy of acting as human as possible in order to prevent humans from eating them. A statistical improbability, but an explanation nonetheless, and one that seems to satisfy.

Jacques de Vaucanson's mechanical duck -- who humorously torments French chef Armand Allègre -- has characteristics of both a living duck and a human. Based on an actual mechanical duck created by the 18th century inventor, complete with digestive system and demonstrable excretory functions, the duck in *Mason & Dixon* presumably

comes to life as Vaucanson adds an additional function. "Vaucanson's vainglorious Intent had been to repeat for Sex and Reproduction, the Miracles he'd already achiev'd for Digestion and Excretion," the narrator fills in. As Armand conjectures: "'Who knows? that final superaddition of erotick Machinery may have somehow nudg'd the Duck across some Threshold of self-Intricacy, setting off this Explosion of Change, from Inertia toward *Independence, and Power.* Isn't it like an old Tale? Has an Automatick Duck, like the Sleeping Beauty, been brought to life by the kiss of ... *l'Amour?"* (M&D 373).

The duck, having learned that it can become invisible by flying at sufficiently high speeds, follows Vaucanson to America and then West along the line, variously seeking love and revenge.

Vaucanson's contributions to the machine are plentiful; Pynchon, predictably, chose to recreate a defecating duck (Wolf 41). Vaucanson's actual mechanical duck "drank, ate, digested, cackled, and swam -- the whole interior apparatus of digestion exposed, so that it could be viewed" (Florescu 233). Vaucanson was in the processes of creating a similarly complex human automaton when he died.

The clocks scattered throughout *Mason & Dixon* are akin to the light bulbs that appear in *Gravity's Rainbow*. In both cases symbolic of the technology of their day, the clocks are able to communicate with one another, which seems fitting giving the uniqueness attributed to them by British scientific tradition. As Dixon explains, the French never rotate their instruments, but the British, in order to account for any unique characteristics specific to each clock, exchange the clock's positions so as to perhaps increase the accuracy of their observations.

Thus the two clocks Mason, Dixon and Maskelyne are using for observations, designated the Shelton Clock and the Ellicott Clock, have a few minutes to chat before one is switched out for the other in preparations for Dixon's return to Cape Town. Though they spend those moments trading information about what to expect in their respective new homes, "what they wanted to talk about all along, was the Ocean ... Its Wave-beats have ever been with them, yet can neither quite say, where up it they may lie. What they feel is an Attraction, more and less resistible, to beat in Synchrony with it, regardless of their Pendulum-lengths, or even the divisions of the Day" (M&D 123).

Pynchon uses these products of technology to poignantly suggest the redundancy of many of man's creations. Technology allows us to create a mechanical duck with excretory functions just like a real duck .. and clocks that mimic the ocean in creating the rhythms by which humans structure their lives. Further, both the duck and the clocks harbor desires more elegant than those evidenced by the fact of their creation. The duck is obsessed by love, while her inventor is smitten with the idea of replicating duck excrement. The duck's desire, as the clock's Attraction to the ocean, trumps the intentions of the humans that create and use them. Science, Pynchon argues, has led Western man away from the essential beauty of being alive.

As in *Gravity's Rainbow*, the sections in *Mason & Dixon* each correspond to one or more boundary crossing of some sort. The main action and impetus of Section One: Latitudes and Departures is the Transit of Venus. Section Two: America opens just as Mason and Dixon, having crossed the Atlantic, arrive in the New World. This section is concerned with drawing the Mason-Dixon line. Section Three: Last Transit begins as the

two arrive back in England, having reversed their Westward passage and again crossed the Atlantic. This section contains the second Transit of Venus, along with the final transit for both Mason and Dixon, into death.

In *Mason & Dixon*, Pynchon depicts the Western world as it crosses into the realm of Science, discarding questions and beliefs that are not easily contained within or easily explained by it. As I have illustrated above, the sympathetic treatment of Mason and Dixon contrasts dramatically with the aggressive attack on Science in *Gravity's Rainbow*. Whereas the characters in *Gravity's Rainbow* -- even those who are struggling against the sterile assumptions of Science -- and their relationships are largely hollow, Pynchon creates in *Mason & Dixon* a sympathetic story of human aspiration, of faith, and above all, of friendship. Far more than any of Pynchon's other alternatives to Science, the friendship of Mason and Dixon holds the most substantial value of anything in the either *Gravity's Rainbow* or *Mason & Dixon*. In section four, I discuss how this fits into the revolutionary intentions I have claimed for Pynchon above.

IV. Conclusion

Upon the publication of *Mason & Dixon* in 1997, a review published in the Raleigh *News and Observer* made mention of rumors, years before Pynchon published the novel, "that the reclusive genius was walking the Mason-Dixon line" (Duyfhuizen 1). I imagine some aged version of the young bucktoothed Pynchon who appears, peering out of those high school photos to which Pynchon aficionados cling for verification that his stories are the novelistic product of a living being, rather than some spontaneous hallucination, walking along, knapsack on his back, some modern version of the daybook, perhaps, in hand. This image has stayed with me and it is, I feel, useful in understanding what *Mason & Dixon,* coming as it did years after *Gravity's Rainbow*, can teach us about Pynchon's philosophy of science.

What, then, can we find along this line that gives some instruction? Surely as he walked Pynchon considered the science that went into laying the Mason-Dixon line ... and possibly, given the plethora of negative associations with which he loads Science in *Gravity's Rainbow*, he linked the very act of dividing with slavery, war, destruction. Or maybe, walking the latitude alone, Pynchon reflected on how very easy it must have been to decide which way to go when faced only with a choice of forwards or back.

Mason & Dixon stands in contrast to *Gravity's Rainbow* in that, even as it chastises Science for excluding entire realms of human experience, it uses human nature and longing to justify its rise. It depicts the constraining process of the rise of Science, of weeding out the experience of magic, of spirituality and of faith, in exchange for the

promise of the power of knowledge and the comfort of control. In *Mason & Dixon*, the sterility of Science has not yet set in because in many ways, Science assumes the role of magic and all of its wonders. But by the time of the twentieth century, as depicted in *Gravity's Rainbow*, Science has leeched the magic out. The intense friendship depicted in *Mason & Dixon* is replicated nowhere in *Gravity's Rainbow*. Thus, *Mason & Dixon* serves as apologia for the rise of Science, but despite the sympathetic treatment, the critique of Science stands.

As Kuhn explains, scientific revolutions occur only after the dominant scientific paradigm is effectively replaced by an alternate paradigm (144). While Pynchon is fairly clear in his assertions of the limitations of Science, his proposals for a replacement are highly abstract, tending to suggest, when they are expressible at all, the ability to achieve some sort of release or spiritual oneness through chaos, anarchy and obliteration. Pynchon's efforts to subvert Science, though symbolically persuasive, are reminiscent of early attempts by feminist writers to envision an alternate ending for their female characters: wanting to resist marrying their heroine off, but, being but unable to imagine an alternate future, they decided most often just to kill her.

This dead end, as it were, is suggestive of arguments that postmodernism has, in practice, limited utility in that it provides no viable alternatives. And yet, as Pynchon so disturbingly argues, Science and the continued adherence to it has dramatic consequences. Pynchon is quite keenly aware of the dilemma we find ourselves in, and his use of overlapping and alternating symbols of destruction and redemption in *Gravity's*

Rainbow darkly suggest the possibility that the only way out of the increasingly global paradigm of Science is by following it through to a conclusion of absolute obliteration.

Despite Pynchon's attacks on Science, his repeated reliance on scientific thought within his novels reveals a deep ambivalence. It is ironic and unfortunate that Pynchon's inclusion of scientific material within his novels causes many literary types to shy away. Those readers who might feel most strongly Pynchon's pleas for alternative ways of knowing along with our universe of scientific thought, the ones who harbor this impulse as if in their blood, are too often made hemophiliacs at the site of the first equation in *Gravity's Rainbow*. Which raises the question of why Pynchon includes such material in his novels in the first place.

Gravity's Rainbow begins with the following quote from German rocket engineer Wernher von Braun: "Nature does not know extinction; all it knows is transformation. Everything science has taught me, and continues to teach me, strengthens my belief in the continuity of our spiritual existence after death" (GR 2). Pynchon's critique in *Gravity's Rainbow* and *Mason & Dixon* suggests that Science, in ignoring those realms of experience that it is powerless to describe, forbids belief in spiritual existence altogether. And yet, Pynchon's incorporation of theories of the oscillating universe, his insistence on rebirth through annihilation, his repeated inclusion of ghosts, séances and otherworldly visitors suggest otherwise.

And even as Pynchon denounces Science as the end of all unmediated human experience, the sterilizer of human emotions and a path of certain doom, his obsession reveals him. Maybe it is some version of his old glee in entropy, a dark joy in

destruction. Certainly, Pynchon's dabblings in science bring him at least the joy in creation that Dixon finds in his maps of indigo and verdigris, with their mountains of glass and seas of sand. Whatever inspires his twisted allegiance, I can only hope that whichever direction science next takes, Pynchon will be there to narrate it, strapped to its nose, whooping and hollering all the way.

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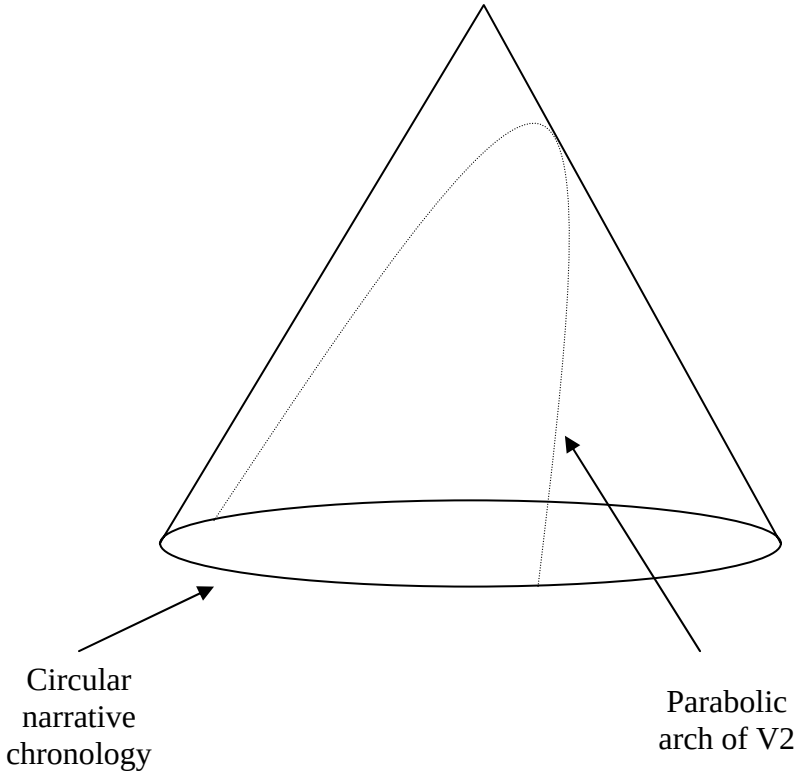

Figure 1
Conical Shape of Narrative in *Gravity's Rainbow*

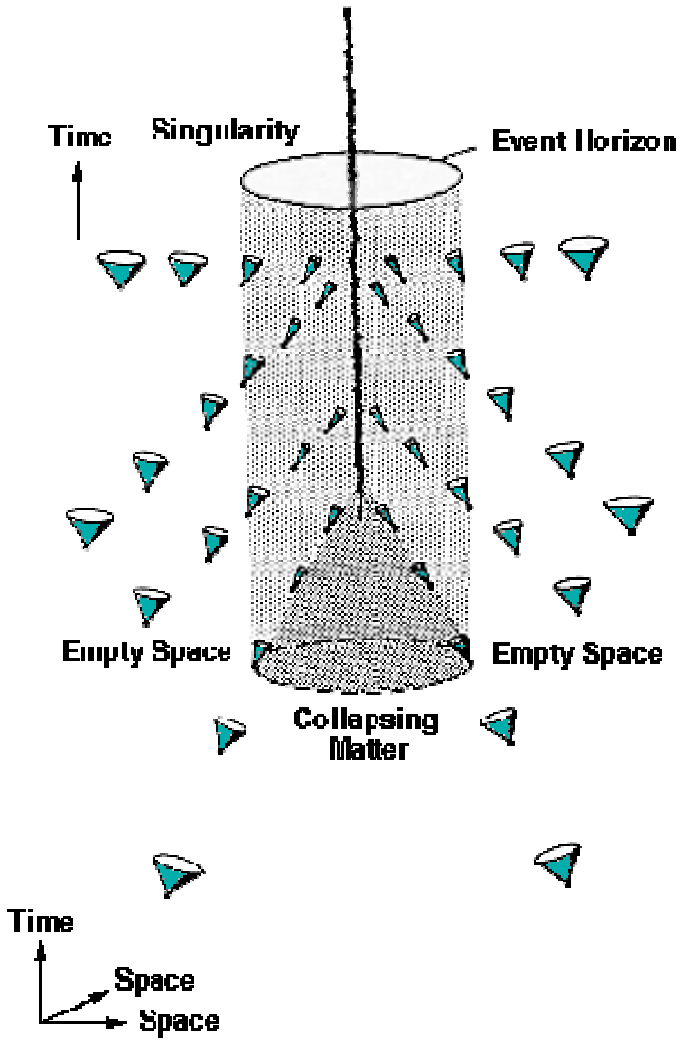

Figure 2
Diagram of Black Hole

Source: Penrose

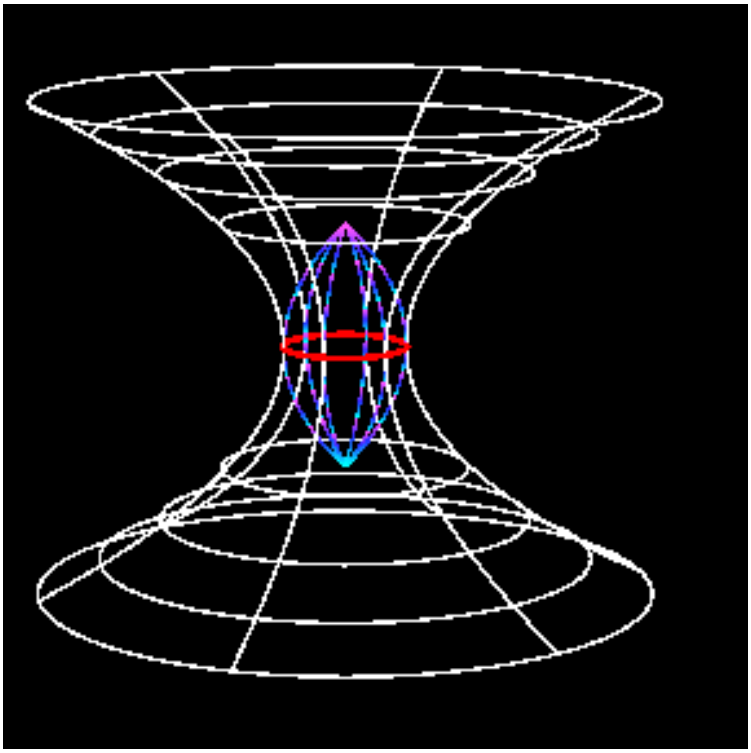

Figure 3
Diagram of Schwartzchild Black Hole

Source: Hamilton