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“Knotting into” *Gravity’s Rainbow*: Scientific Paradigms and Literature

No, this is not a disentanglement from, but a progressive *knotting into*—they go in under archways, secret entrances of rotten concrete that only looked like loops of an underpass . . . certain trestles of blackened wood have moved slowly by overhead, and the smells begun of coal from days far to the past, smells of naphtha winters, of Sundays when no traffic came through, of the coral-like and mysteriously vital growth, around the blind curves and out of the lonely spurs, a sour smell of rolling-stock absence, of maturing rust, developing through those emptying days brilliant and deep, especially at dawn, with blue shadows to seal its passage, to try to bring events to Absolute Zero. (*GR* 3)

Scientific inquiry is considered as the basic authority of knowledge in most of the civilized societies. Consequently, the idea of scientific objectivity frequently makes people believe that science is above the culture within which it arose. This privileging view has been debated upon and challenged (since the eighties) by various cultural currents, among them social constructivists (Latour 1987) and feminist critiques (Harding 1986), demonstrating that cultural background is as important and that scientific theories are socially constructed and thus can be employed as temporary expedients.

Addressing the long-standing primacy that the natural sciences enjoy in public life, acting as stimuli to analogous theories in other fields of study (Adam 48), this essay demonstrates that, although science is used as a “repository of tropes” which enlightens literary texts (Hayles, “Introduction” 20), literary expression goes hand in hand with science as a progressive force that frames cultural values and the way we experience reality. It traces the connections between literary discourse and scientific paradigms in Thomas Pynchon’s *Gravity’s Rainbow* (1973), which go beyond metaphor to assert deeper correspondence. Embraced by a larger revolution in contemporary thought, science and literature share common ground in coping with and giving meaning to our complex space-time, where contingency, randomness, irreversibility, and self-organization rule. The term ‘space-time’ is used in this essay to accommodate both physical reality and the realm of literature, denoting a relative, dynamic event-space that is process-dependent and treats space and time not as segregated, but as entwined entities.

The 1960s, when *Gravity’s Rainbow* was in gestation, were times of progressive transformations in science, technology, aesthetics, and socio-economic structures,

which links literary texts and their advanced narrative unfoldings (innovative in both form and content) to physical changes, generating a postmodern space-time that unravels as accelerated, nonlinear, fragmented, accidental, probabilistic, consumption-oriented, and disposable, delineating in McHale's words "the pluralistic and anarchistic ontological landscape of advanced industrial cultures" (38). The major scientific turnover took place during the first decades of the twentieth century, theorized by Einstein, Planck, Bohr, and Heisenberg, and it removed the limits imposed by Aristotle's philosophy of categorical thinking and Newton's physics of absolute space, time, and matter (the monoliths of traditional Western thinking). The premises of science continued to develop in accordance with the revelations of the external world (micro and macro), made possible by advancements in technology, where experts in mathematics, physics, and chemistry such as Mandelbrot, Lorenz, and Prigogine (in the sixties and seventies) disclosed and scrutinized a highly intricate, contingent, and nonlinear world of interconnected structures, teeming with unpredictable evolutions.

However, these changes encompass a broad spectrum of scientific fields, transcending beyond the natural sciences and contextualizing within a wider socio-cultural framework. Foucault and other philosophers altered absolutist views to relativistic notions, while in psychology, Lacan and others converted "the emphasis from material causes of disorder to energetic processes of relation in language" (Strehle 13-14), whereas in literary criticism, Kristeva and Derrida highlighted the undecidability of textual meanings, and in history, White and his contemporaries emphasized historiography's compositional strategies, grasping it as "a work of construction rather than of discovery" (White 487). The encounter with this complex, fluid, indeterminate, and process-dependent reality discloses our world as a realm of emergent potentialities, where apparently random systems uncover patterned motion, which is investigated by both sciences and arts. Moreover, these developments in science concur with the ideas explored and presented by many postmodern novelists, including Pynchon for revolutions in all aspects of life emerged almost contemporaneously, and literature both pursues its epistemological investigation of fundamental scientific arguments and creates these assumptions, denying any claim of absoluteness in critical discourse.

From the very beginning of *Gravity's Rainbow*, the author lures the reader to *disentangle* epistemological confusion, operative throughout Pynchon's opus, while granting it will only result in additional *knotting into*, offering "a maze of possible interpretative strategies that each leads to a dead end, where seemingly valid explanations herald new complexities and dilemmas" (Grgas, "Thomas" 215). So thick is this text with recursivity and self-reflexivity that scientific metaphors additionally energize the context, being involved in feedback loops with culture and literary discourse. These developments do not render the multiplicity of patterns into a coherent unity (in a classical sense), but rather display the text as a flow of circulating information, an intricate and infinite tangle of connective tissues that make *Gravity's Rainbow* the masterpiece it is.

However, like many Pynchonesque enthusiasts, I will try to detangle certain aspects of this fluid, vibrant, and pluralized world in process, taking the novel as a liv-

ing organism with transformative potentials that continues to produce new meanings upon each reading. Precisely because it deals with a continuous flow of events, characters, and images that ooze and surge into one another, revealing unpredictable evolutions, perplexing networks, and emergent potentialities, *Gravity's Rainbow* emanates complex dynamics that are analogous to the world of natural sciences. Following Pynchon's utilization of scientific paradigms that render more intelligible the fluidity and shapelessness of reality, this essay deals with modern physics and chaos theory, which are detected in this particular novel, demonstrating that "where the furthest-flung sciences are showing us the essential limitation on the sweet, complex, turbulent slip between mind and universe, literary discourses are well placed to serve as avatars for a new science, a new way of knowing" (Porush 80). Pynchon connoisseurs in particular stand witness to the ingenuity with which this author explains the web of life. Indeed, his 'errant labor' into encyclopedic knowledge masterfully engrained into both global and local tapestries gives birth to a new way of knowing, an embodiment of the complexity of "eigenorganizations," as Hanjo Berressem calls animated, autopoietic systems (356) "that locally contradict the second law of thermodynamics" (Porush 57).

Essays focusing on Pynchon and scientific paradigms, particularly relativity theory and quantum physics, are substantial in number (Berressem, Friedman, Hayles, Porush, Strehle, etc.) due to the author's elaborate use of the natural sciences in his fiction and his sound undergraduate education in physics. In his works, Pynchon undermines the traditional constructions of classical physics, challenging the causality principle, demonstrating indeterminacy in predicting the outcomes of possible measurements, subverting deterministic laws, and sustaining nonlinearity, discontinuity, and self-organization. His entire oeuvre can be understood as a representative diagram of scientific changes. *Gravity's Rainbow* is itself a miniature history of scientific paradigms, in which the author demonstrates (among other scientific touchstones) how relativity theory disqualified the Newtonian illusion of absolute time frame, how quantum mechanics eradicated infinite precision, invalidating determinism on the microscopic level, and how "chaos [theory] puts a definite stop to the idea that the course of the universe is both determined and predictable" (Morris 211).

As the narrative of *Gravity's Rainbow* speculates on modern scientific theories, it also exposes the nature of reality and phenomena that are not yet formally theorized, specifically when deliberating about the complexity of chaos theory and nonlinear dynamics, for "literature has a longer history of dealing with it and is more suited to describe its complexities than science" (Hayles, "Introduction" 21). In other words, the new paradigm (chaos theory) was not formalized until well into the second half of the twentieth century, and while the mathematicians Li and Yorke were the first to use the concept of 'chaos' in relation to nonlinear systems in 1975, *Gravity's Rainbow* was published in 1973. Gleick's bestseller *Chaos: Making a New Science* validates this dependence of any new theory on cultural contexts (enveloping transformations in both scientific and social domains of life), for it relates quotations of canonical literary authors (such as Herman Melville, Wallace Stevens, and Christopher Marlowe) to the scientific framework of the new paradigms. But it must also be noted that any

meaning-making method demonstrates certain limitations and therefore conceptual insufficiency of construed theories. Even natural sciences re-think and question established meanings and procedures, which turns out to be specifically challenging when dealing with subatomic phenomena because of “the absence of mathematical tools with which to analyze a vital realm that lies beyond experimental accessibility” (Greene 15), so that scientists occasionally have to rely on their imagination.

Displaying a world which is in constant flux, Pynchon’s narrative discloses a vibrant interplay of pluralized rhythms of both human cognition and information-intensive environments, moving unpredictably from subject to subject, teeming with (dis)connected events that uncover an array of dynamic and interwoven structures in an open exchange with their surroundings. The reader is challenged to piece together coincidental, digressive, and seemingly unimportant data and is left with missing segments not followed by the author’s retrospective reasoning. Characters, locations, and actions move in multiple and discontinuous directions. The narrative itself refuses to be captured into causal oneness, circling endlessly with information and/or “mysteriously vital growth” (*GR* 3), reflecting the subatomic ‘underworld’ that has become our own reality, substantiated by chaos theory, which brought unpredictability onto the macroscopic level.

The highly disconnected pattern is visible when following protagonists and their stories. The narrative first spotlights Pirate Prentice, his dreams and work; then it moves to lieutenant Tyrone Slothrop’s map, desk, genealogy, and erections, suddenly shifting to Roger Mexico and his views of scientific probability, yet repeatedly returning to Slothrop, the ‘main’ character around whom the reader is mocked to construct a meaningful storyline. The fundamental instability of his self-hood augments as the narrative proceeds for Slothrop transforms physically and psychologically, changing costumes, roles, and opinions, (finally disappearing from sight), reflecting the intrinsic fluctuations of life and postmodern textuality.

The readers also have a peek into the fragmentary stories about Enzian, Blicero, Katje, Gottfried, Jessica, and many other characters, revealing their own transgressions, the narrative jumping from one subject to another just like quanta do in a “discontinuous movement” (Pearce 226), refuting the ‘tyranny’ of sense-making, Enlightenment, and closure. At the same time, the locations are being erratically altered: from London to Holland and France, back to England, then to Switzerland, and to the German Zone and California. Among these sites, the author intertwines a few analeptic space-times: South-West Africa and Mauritius, introducing “supposedly preterite races and species by a self-appointed elect,” who are burdened with colonial genocide and extinction, storylines which additionally weigh down the understanding of the 1944-45 diegetic present of the novel (Saint-Amour 308). Analepsis and proleptic jumps follow the same nonlinear structure, unleashing deep intertexts that connect monopolies of violence, shaping a dazzling, yet recursive nature of reality in its refusal to privilege any one subject or plotline. The readers are decoyed to the fragmented pasts of hundreds of protagonists, switching frequently and presented with anachrony, lured into multiplying accounts and associations of various

historical and cultural references. The frequent alterations of tone, the plethora of styles and their shifts without apparent pattern or reason, from technical to slang, songs to historiography, realism to comedy and fantasy, substantiate nonlinearity and discontinuity. As Pearce notes, *Gravity's Rainbow* "is about speed and energy" and forces us "to discard those categories of thought which have mentally secured us, and accept a world where there are no links, no directions, but only continual transformation" (226).

In the opening pages, Pynchon introduces perhaps the most alarming discovery made during the first decades of the twentieth century. It concerns causality, for at that time, physicists began talking about nonlinearity and probability, the likelihood that one phenomenon would cause another, rather than insisting that one thing (the cause) would always give rise to another (the effect). Pynchon depicts an anomaly that challenges causality, revealing the curious reversal that Prentice anticipates while a missile is approaching: "He won't hear the thing come in. It travels faster than the speed of sound. The first news you get of it is the blast. Then, if you're still around, you hear the sound of it coming in" (*GR* 7). Since the V-2 travels faster than the speed of sound, the source is ahead of the sound waves that it produces so that the explosion is perceived first and then, after detonation, the survivors hear the noisy engine of the aircraft, denying logic and common sense.

Although nature itself seems to prefer causality, there are some physical theories that support backward causation, such as the mathematical possibility of the existence of "tachyons"—superluminal particles (Nicholls 70), Richard Feynman's theory of positrons, and quantum mechanical entanglement, keeping in mind that although individual particle processes can move forward or backward in time, "the universe as a whole is skewed in the forward direction" (Musser). Kurt Gödel whose "Theorem" of incompleteness is discussed in the novel through "inevitable repetitions" (*GR* 320) so that the system can never be theoretically complete, presented retrocausality in 1949 by using general relativity. Gödel clarifies that, in a curved global structure of space-time, a traveler oriented toward the future travels along a spiral path rather than in a straight line, and could arrive home to precede his departure, assimilating, but not involving, backward causation (qtd. in Davies, *About* 243).

Apart from Pirate's ominous presentiment and Pointman's and Spectro's imagery of "a missile one hears approaching only *after* it explodes. The reversal!," reversed temporal order can also be associated with Pavlov's stimulus substitution theory, which in Slothrop's case triggers "response before stimulus" (*GR* 48; 49). Slothrop was allegedly conditioned in childhood, but reaches "one of the transmarginal phases" (*GR* 48) "due to excessive behavioral training," which stimulates "him to respond like a machine to stimuli repeated until he begins to reverse the stimulus and response, and finally to blur the distinction completely. He has become a causation machine" (Brownlie 101). Since Tyrone's love affairs precede the bombings (sometimes in days) and his love-making hideouts geographically coincide with the rocket blasts, this mysterious reversal "subverts cause and effect" (Schaub 93). Slothrop's conditioning apparently operates in reverse.

Backward causation is also administered towards the end of the novel when von Göll runs his last movie in reverse, featuring: “guns which are like vacuum cleaners operating in the direction of life [. . .] and bullets are sucked back out of the recently dead into the barrel, and the Great Irreversible is actually reversed as the corpse comes to life to the accompaniment of a backwards gunshot” (*GR* 745). According to Katherine Hayles, von Göll’s act is in tune with a particularly bizarre singularity related to the black hole, whose conversion into a white hole would demand a similar scenario, for “if the substance of the cosmos is being sucked into black holes,” there is a possibility that “it is being spewed out again from white holes” into a circular motion (*Cosmic* 196). This view sustains the universal cycle of life and death, which is in agreement with the gravitational force’s double role: pulling the universe together and yet not allowing anything to come out of black holes.

Pynchon’s title—*Gravity’s Rainbow*—as well as Slothrop’s code name—Schwarzknabe” (*GR* 286) (Jamf allegedly named the infant Tyrone ‘Blackchild’)—are both in concord with these scientific (or pseudoscientific) ideas; for Slothrop can be revived only if he is annihilated completely, and the universe can be reborn only by going through absolute gravitational collapse. Neither of these two possibilities occur by the end of the novel. As Dewey notes, “The cataclysm is forever countered, because, in Gödel’s universe, ending implies completeness” (175). Although scattered and invisible (like a black hole), Tyrone still exists as a cognitive force, and the rocket is still there, haunting, just about to hit a movie theatre, and yet “[t]here is time” (*GR* 760). Pynchon “open[s] up the moment, that slice of time forever approaching but never reaching the zero” (Dewey 175), “because a gravitational field is associated with a warping of time” (Davies, *About* 107). A time warp is a hypothetical deformity occurring in the flow of time that would move events from one time period to another or suspend the passage of time. Even Pöckler experiences this suspension: “the time base has lengthened, and slowed: the Perfect Rocket is still up there, still descending” (*GR* 426). In Safer’s words: “As the rocket descends, there is a sense of anesthetized time, different by far from the eternal glory of God” (164).

The novel opens with the rocket approaching London and ends with a missile suspended above Los Angeles, maneuvering from the historical capital of imperialism to the present hallmark of consumerism, illustrating “ 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). The paradox of Δt , indicating the rate of random change is that it thwarts causal construction. Weisenburger compares Δt —“temporal bandwidth” (*GR* 509) with the novel, claiming that its open form never keeps “the different channels discrete, for all of them (literary, historical, scientific, pop-cultural) partake in a gargantuan whole that is fearfully inclusive” (149). Indeed, the novel assimilates a shuffled puzzle that the readers need to put together, and yet the pieces are either lost or seem to mismatch awkwardly with sudden shifts of scenes and four hundred plus characters.

In the analysis of Slothrop’s code name “Schwarzknabe,” Hayles notes that it could be linked with the “Schwarzchild radius named after Karl Schwarzchild, who

noticed, in 1917, anomalies in Einstein's gravitational equations that later were recognized to describe black holes" (*Cosmic* 194). A short digression to Schwarzschild radius will be made to explain how Pynchon mystified Slothrop's status, his apparent disappearance from the text or, rather, his evolution into pure empty cognizance. At the gravitational radius, time is infinitely dilated, which physicist Paul Davies explains through the "twin paradox," sending one of the imaginary twins—Betty—to the vicinity of the imploded star (human beings could not withstand the tremendous gravitational forces this would entail); while the other sister, Ann, stays on Earth (*About* 114-120). Betty does not notice that her time is warped until she compares her temporality with Ann's, realizing her sister's time runs with greater velocity, while her own processes are at half speed, including ageing, so that Betty stays much younger. Ann barely sees Betty as Betty approaches the radius "because of the spiraling red shift [. . .], [t]he intensity of the light correspondingly diminishes toward zero. Betty and her ship fade from sight completely" (Davies, *About* 116). All Ann can see is blackness, which is why the compression of the star is called a black hole.

In a similar manner, and just as "[e]ach alternative Zone speeds away from all the others, in fated acceleration," so is Slothrop "red-shifting, fleeing the Center," and his "mythical return [. . .] seems less possible" (*GR* 519). When he finally disappears from the novel, it closely assimilates a star implosion described by the twin paradox, for his space-time appears to be that of gravitational time dilation. An often cited passage from *Gravity's Rainbow* metaphorically assimilates this phenomenon: "he became a crossroad, after a heavy rain he doesn't recall, Slothrop sees a very thick rainbow here, a stout rainbow cock driven down out of public clouds into Earth, green wet valleyed Earth, and his chest fills and he stands crying, not a thing in his head, just feeling natural (*GR* 626). Likewise, a few pages before, the narrator is quoting Rilke's prophecy: "And though Earthliness forget you, / To the stilled Earth say: I flow. / To the rushing water speak: I am" (*GR* 622). Explicit in these and previous lines are Pynchon's genius and literature's ability to reveal complex dynamics of life that hard sciences have difficulty transferring. Unfolded in them are also traces of Buddhist philosophy, which inspires individuals to become aware of and embody pure empty cognizance, a formless presence, and timeless awareness through which life continues to unfold, grounded and yet stripped of anything solid, flowing freely through life, "just feeling natural" (*GR* 626).

Stripped from "Earthliness," Slothrop assimilates a black hole, invisible to the narrator and the readers, but somehow still present. He could be compared to Christ and his sacrifice, more so because Jesus died as a man and was resurrected, and Slothrop "becomes a cross himself, a crossroads, a living intersection" (*GR* 625), 'felt,' although not seen or palpable. Some critics suggest that Slothrop achieved "Dionysian charisma" (Plater 214), or became a humbler form of life, which entailed the "dismantling of [his] ego" (Hume 215).

The time warp Slothrop is in appears natural to him, for, unlike Betty, he does not compare his time with the rest of the people; he is not interested any longer: "he was changing inside [. . .] what he might've been hearing in the water, flowing like himself

forever, in lost silence, behind him, already behind him" (*GR* 572). He succumbed to nature, and the "rainbow cock" passage confirms this because, for the first time, Slothrop's sexuality is not tied to machinery but to nature. Devoid of rationality, he forgot the times when "he could *make it all fit*, seeing clearly in each an entry in a record, a history: his own, his winter's, his country's" (*GR* 626); he does not even recall a recent "heavy rain." The discontinuity of his temporality is only natural to him; he does not notice it, while the readers and the characters experience it as a distortion, scattering, and possible suspension of time.

Slothrop's story is in a way presented as a chronology of changes in scientific paradigms (and our understanding of reality) from Newton's causality to insecure quantum leaps, black hole time dilation, nonlinearity, and 'strange attractors' of chaos theory (a regenerative possibility). As Friedman and Puetz put it, "Equations of calculus decorate the pages, and from the quantum mechanical behavior of elementary particles to the Friedmann geometry of the curved universe, we are teased with facts about chemistry, physics, mathematics, and cosmology" (69). Slothrop's expanding and contracting temporalities, his psycho-physical transformation can be associated with Friedmann's "infinitely dense point from which the present Universe expanded" (*GR* 396)—the Big Bang theory. For unlike "Einstein's static solution," Friedmann claimed there was a possibility of the universe "expanding and contracting" (Davies, *About* 138)—which might have happened to Slothrop.

But to start from the beginning in pursuit of Slothrop's transformations, his story commences with expectations of teleological continuity. Pynchon ironically introduces his main character through realistic narrative conventions where Slothrop's material goods appear before the character himself, implying in a realistic representation manner what he is like: "His map of London constitutes a realist's effort to fix, sort out, and memorize his experience; his desk, in contrast, displays a surrealist's capitulation to disorder, flux, and unconnectedness. On the map, Slothrop plots events; on the desk, he allows them to scatter and disperse" (Strehle 39). In part I of the novel, the reader observes his analytical side as he attaches paper stars labeled with the names of various women he has met or imagined encounters with onto a map of London. The mapping discloses his wish to "save a moment here or there" (*GR* 23), to keep track of his conquests and endow them with meaning. Slothrop nourishes a vision that all phenomena combine in a single unified pattern, encouraging "paranoia [. . .] that *everything is connected*" (*GR* 703), voicing his commitment to Newtonian causality.

Yet the initial desk scene gives hints that, underlying Slothrop's meticulous updates on the map, his striving for coherence is his life's utmost fragmentation. His desk is muddled with forgotten debris and "godawful mess," including layers of pencil shavings, unanswered letters, abandoned memoranda, a ukulele string, missing pieces of various jigsaw puzzles, etc. (*GR* 18). The messy desk setting is a perfect miniaturization of a larger reality, displaying the complexity of life and its indeterminacy that Slothrop becomes aware of later on and abandons Newtonian expectations. Still, his initial urge is to connect diverse, often contrasting phenomena into a whole, which

is also transparent through his passion for jigsaw puzzles. Yet the narrator makes sure to announce that Slothrop possesses "lost pieces to different jigsaw puzzles showing parts of the amber left eye of a Weimaraner, the green velvet folds of a gown, slate-blue veining in a distant cloud, the orange nimbus of an explosion" (ibid.), revealing discordant fragments and an inability to assemble a complete picture. The same metaphor runs throughout the novel, underlying the reader's inability to connect all the detailed, ambiguous, and disparate information (or randomness).

Most of the characters accept Newtonian heritage, assuming that, with enough information, any physical occurrence could be predicted. Thus, behaviorist philosophers and Pointsman are convinced that Slothrop attracts bombs falling on London. As already said, the map of his sexual innuendos coincides with the raids on London: rockets hit the spots Slothrop has marked on the map as his love-making terrain. Pointsman believes that these patterns are not random, but that something mechanical or biological within Tyrone makes him an attractor to the rockets (Slethaug 154), advocating "the most traditional view of causality: the reduction of all processes to the sequence of stimulus and response" (Heise 185).

Other interpretations of this phenomenon include Mexico's "statistical oddity" (GR 85), claiming that this has nothing to do with cause and effect. Some characters insist that this strange occurrence is "precognition," while others view it as "psycho-kinesis" (GR 85-87), or maybe Slothrop is "in love, in sexual love, with his, and his race's death" (GR 738). The creative assumptions that protagonists come up with and Pynchon's masterful allusions and subplots tied with their hypotheses, connecting apparently disconnected entries, corroborate the idea that in our complex space-time of unpredictable, nonlinear systems, "literary discourse must be understood as a superior form of describing" reality (Porush 77), keeping in mind that both literature and science illuminate our culture's underlying paradigm.

Although Pointsman tries to interpret Slothrop's erections in accordance with Pavlovian determinism—"No effect without cause, and a clear train of linkages" (GR 89)—the phenomenon introduces nonlinearity, chaos theory, and 'strange attractors.' An attractor is "any point in an orbit that seems to pull the system toward it"—which could be a fixed-point or a limit-cycle, such as a motor-driven pendulum and heart rhythm, or an unusual combination of "orderly disorder" called a "strange attractor" (Morris 213). Slothrop's love-making topography that corresponds with V-2 detonations, together with the dates of his engagements that precede the strikes, form a strange synergy which cannot be explained. Repeating the pattern strangely—for each of Slothrop's stars soon has its 'twin' on Mexico's map of rocket strikes though never exactly repeating the same orbits of motion—introduces another scientific category: Lorenz's attractor model (Hayles, *Chaos Bund* 149).

Edward Lorenz, a researcher associated with chaos theory, first published his paper "Deterministic Nonperiodic Flow" in 1963, but it was not noticed for at least a decade. Lorenz studied weather formations through nonlinear differential equations, and his observation turned out to be revolutionary for it demonstrated that "[the attractor's] loops and spirals were infinitely deep, never quite joining, never intersecting.

Yet they stayed in a finite space” (Gleick 140), exposing a groundbreaking discovery that the system never reproduced the same movement, although it repeated cyclic motion recurrently (Lorenz 137). Recursion and iteration are thus integrally related to attractors. Analogous patterns can be found in literature and art, whose acts are almost by definition recursive and iterative, for they self-consciously evoke and explore the patterns of their precursors, mirroring traditional forms, and yet they are never identical to their antecedents (Slethaug 124).

Another feature that chaotic systems share is nonlinearity, where a small initial discrepancy, a microscopic random fluctuation results in patterns quite different from the original, bringing about macroscopic transformation, which means that causality is challenged for there is no predictability. Within linear systems, minor causes produce minor effects, but when nonlinear systems are in question, minor stimuli can cause major consequences. In this particular aspect, quantum mechanics is in accord with chaos theory because it recognizes the existence of at least “some minimal level of fluctuation,” and even a slight “fluctuation can send a system off in a new direction” (Hayles, *Chaos Bound* 14). In this respect, chaos theory renders quantum fluctuations relevant to global experience. If we consider truthful the possibility that Jamf conditioned Slothrop, then he was de-conditioned, and with the appearance of the V2, by which his conditioning was hypothetically activated again (only in reverse), there is an obvious link with nonlinearity. The ‘suddenly’ failed de-conditioning insinuates that a discrepancy occurred, a fluctuation was amplified, making all the difference in Slothrop’s system and sending him into a new direction from this bifurcation point.

Unfortunately for the Pavlovians, who are desperately seeking causal clarifications, there is no “true mechanical explanation” (*GR* 89), although Ivan Petrovich wonders if “a conditioned reflex [could] survive in a man, dormant, over 20 or 30 years” (*GR* 85). But, as Kathryn Hume points out, conditioning is only a speculation, since Imipolex G was developed in 1939, and Tyrone was supposedly conditioned with the same substance around 1920, leading to a causal loop (7). Also, Imipolex was just part of the rocket that Gottfried was in; the narrative does not specify that the substance was used in other V2s, and “[i]f there is a causal link between phallic character and phallic rocket, the rocket should be responding to Slothrop, rather than vice versa” (Hite 116). Even if we suppose that Jamf conditioned Slothrop and then later on revoked the procedure, this does not allow for the causality principle inherent in Pavlovian philosophy to break its laws and grant Imipolex to cause an erection in Tyrone; what is more, “there is no way of aligning the temporality of *Gravity’s Rainbow* with Pointsman’s model of causality” (Heise 193).

The recursion of Slothrop’s erections before the rocket strikes suggests tinges of dynamic activity that can only be traced within nonlinear systems, emerging from relatively independent cells that appear disordered and closely related to fractals. Benoit Mandelbrot, the inventor of fractal geometry, who worked on highly irregular forms in the sixties and seventies, published *The Fractal Geometry of Nature* in 1982. Contemporary literature and art assimilate the basic concepts of Mandelbrot’s study, breaking with the Euclidean heritage of ideal forms, demonstrating complexity and

turbulent flow, and mirroring the images of fractals and their dynamic nonlinear structure, as is the case with Slothrop's erectile tissue. Each fractal pattern reiterates the others, building elaborate pattern within pattern, repetition across scales (from larger to smaller structures), involving unpredictability, irregularity, and fragmentation (Mandelbrot 2). The entire postmodern narrative encompasses some form of fracture, discontinuity, self-similarity, and fragmentation, assimilating chaotic patterns, as is the case with Pynchon's *Gravity's Rainbow* and *The Crying of Lot 49*. They incorporate repetition across scales and infinite nesting of pattern within pattern, mocking the idea of completeness and yet paradoxically revealing a whole, dismissing the causality principle as it was grounded in classical physics (although there is causality intermixed with unpredictability and randomness), and pointing to the complexities and juxtapositions the system acquires with time.

Contradicting mechanistic causal links, characters such as Leni, Bodine, Geli, Tchitcherine, Enzian, Mexico, and Bianca see reality "as a freak deviation from the probable, representing the truly random state of nature" (Friedman 74). They despise the Western world's "illusion of control. That A could do B. [...] Things only happen, A and B are unreal, are names for parts that ought to be inseparable" (GR 30). However, the Newtonian logic and determinism rule the military, so that the "PISCES" (GR 34) people and engineers employed at the rocket building engage in linear, positivistic doctrine. Pökler is identified as "the cause-and-effect man," and Leni tries to teach him: "Not produce [...] not cause. It all goes along together. Parallel, not series." (GR 159). Likewise, the Pavlovian assumption that a mechanical explanation must be underneath Slothrop's love affairs and bombings implies "the stone determinacy of everything" (GR 86). That is why Pointsman pursues Tyrone—to be the first to understand the functioning of the mechanism that causes the occurrence, so that he can utilize it as an operational tool. But Slothrop is also being chased by American, English, and Russian intelligence, and by other individuals and groups interested in the 'conditioning apparatus.' In his life, Slothrop has been exploited in various ways, from the alleged conditioning in his infancy, to the Berlin underground, to the Argentine anarchists, and finally, to Dr. Rózsavölgyi, who claims, "We, are in control. He, cannot *help*, himself" (GR 81-82). Even Katje uses him, initiating an affair only for the purposes of observation.

It is not surprising that, after being an object of manipulation throughout his life, Slothrop strives to get some control, clinging to causality. In part II of the novel he exaggerates even more, interpreting every minute detail that he comes across, where even "raindrops" can be read as "footnotes" (GR 204), connecting all the data into one continuous whole: "all in his life of what has looked free or random, is discovered to've been under some Control, all the time, the same as a fixed roulette wheel" (GR 209). Although these disparate phenomena that in Slothrop's view cohere can be understood as Newton's linear continuities, the last quotation can also be observed from the chaos theory perspective because even chaotic systems share certain universal characteristics, exposing a hidden order in which both symmetry and asymmetry appear. That is why we can connect Slothrop's view of 'controlled randomness' to a roulette

wheel, which mathematicians claim has an “expected return of at least 18%” (Small and Tse 1), and this randomness could also be linked to Prigogine’s “nonequilibrium dissipative structures,” where “new bifurcations typical of chaotic behavior may arise” (Prigogine 73; 68).

Although Tyrone tries to organize his life, connecting events and tracing them as linear and causal, reality strikes him with its unpredictable and random nature. After Tantivy’s disappearance and some other mishaps, Slothrop leaves Newtonian heritage. In part III we can see how he abandons the quest for coherence:

If there is something comforting—religious, if you want—about paranoia, there is still also anti-paranoia, where nothing is connected to anything, a condition not many of us can bear for long. Well right now Slothrop feels himself sliding onto the anti-paranoid part of his cycle, feels the whole city around him going back roofless, vulnerable, uncentered as he is. [...] Either They have put him here for a reason, or he’s just here. (*GR* 434)

Even characters that he meets behave in a random manner, nurturing mindless pleasures and hastening his oblivion. Geli Tripping, the ‘witch,’ provides the perspective of a less rational, more intuitive existence: “Forget frontiers now. Forget subdivisions. There aren’t any” (*GR* 294). Maureen Quilligan describes their adventures as “the gaiety of her tripping with Slothrop,” alluding to her name and behavior, as if there was no tomorrow (194). Bummer and his world of drugs and idealism detach Slothrop even more from reality for he strips Slothrop of his own identity by projecting superhuman powers onto him.

Throughout the novel, Slothrop adopts a whole series of disguises and fraudulent identities that do nothing to balance his fluctuating self. He becomes: British journalist Ian Scufflig, German actor Max Schlepzig, a Russian secret agent, Rocketman, and Pig-Hero Plechazunga. Slothrop is as unstable as quanta. If “quantum physics is a mirror-image of schizoid postmodern consciousness” (Kroker 159), Tyrone is a perfect specimen. Quanta oscillate in space-time, alternating between waves and particles, generating indeterminacy in nature, where randomness is the prevalent ontology, and order and disorder emerge spontaneously. Quantum indeterminism indicates that for “a particular quantum state there are many (possibly infinite) alternative futures or potential realities” (Davies, “That Mysterious” 47). This subatomic world reflects Slothrop’s personality. He promptly acquires the lifestyle of the people he meets but soon abandons them, which proves his instability.

As the novel proceeds, he shrinks from contact and isolates himself, even physically he “has begun to thin, to scatter” (*GR* 509). Pynchon associates Slothrop’s life with larger movements of time:

‘Temporal bandwidth’ is the width of your present, your *now*. It is the familiar ‘ Δt ’ considered as a dependent variable. The more you dwell in the past and in the future, the thicker your bandwidth, the more solid your persona.

But the narrower your sense of Now, the more tenuous you are. It may get to where you're having trouble remembering what you were doing five minutes ago, or even—as Slothrop now—what you're doing *here*, at the base of this colossal curved embankment. (GR 509)

Like quanta, he keeps moving and changing; thus, he is hard to detect. Depriving himself of human attire, even symbolically while wearing the Pig-Hero costume, others fail to recognize him, even the narrator. By the end of part III, he has lost any recognizable identity and memory, deprived of the will to connect, he “won't interpret, not any more” (GR 567).

In part IV, Slothrop appears as a “plucked albatross [. . .] *stripped*. Scattered all over the Zone. It's doubtful if he can ever be 'found' again, in the conventional sense of 'positively identified and detained.' Only feathers [. . .] redundant or regenerable organs [. . .] Hydra-Phänomen. [. . .] 'Regions of Indeterminacy in Albatross Anatomy.’” (GR 712) This quote corroborates Pynchon's brilliance, his ability to transfer his knowledge of natural sciences and the way he perceives reality, masterfully packaged with ambiguity in a poetic stance, so that Slothrop's identity radiates fluidity, displacement, scattering (which also means: diffusing or deflecting of wave phenomena), and yet it projects the universe in ecstatic motion, organogenesis, and evolution of life forms, unfolding its/his own myth (as the Hydra grew two heads for each head that was cut off). Pynchon first envisions Slothrop as a stripped albatross who “likes to spend whole days naked” and who kept “plucking the albatross of self,” getting rid of “ghost-feather[s]” (past, ideology, America, etc.) (GR 623), which is why they manifest as redundant. Then, his unstable core became more like feathers: light and fluttering, assimilating subatomic particles in their fluctuation, and demonstrating regenerative abilities, which agrees with the regenerative cycle of the black-and-white hole idea discussed previously.

The author's final hint at “indeterminacy,” or Heisenberg's uncertainty principle, crowns the whole story of Slothrop's scattering through the Zone. The uncertainty principle (1927) proves that to measure simultaneously and exactly two complementary variables is impossible, because “a particle physicist” cannot “specify position without suffering an uncertainty as to the particle's velocity” (GR 348), for when determining one s/he alters the other. This fundamental uncertainty undermines the notion of an objective observer and brings the whole notion of existence into question. As Heisenberg states, “What we observe is not nature itself, but nature exposed to our method of questioning” (58). The fact that every elementary particle exhibits wave-particle duality, behaving “as a particle or as a wave according to the manner in which we measure it,” raises questions if “the object we are measuring is in fact there: that is, if it is an object at all” and whether the observer “perhaps even created the 'objects' under consideration” (Brownlie 136-37).

Slothrop has disintegrated, (de)evolved into another, simpler or more complex form of life, depending on how we understand the micro world or worlds that exist

beyond our reach (black hole analogy). Since he now vibrates at a particularly low frequency, his persona is undetectable by most of the characters. Only Bodine can still point at him and say 'that:' "He's looking straight at Slothrop (being one of the few who can still see Slothrop as any sort of integral creature any more [...])" (*GR* 740). Just like an imploded star, where the intensity of the circumference within the gravitational field is so strong that not even light can escape to convey information about it, so is Slothrop's existence unknown hereafter to the characters and the readers. He dwells in his own dilated time, unrecognizable by those that have earthly perspective.

Employing Prigogine's bifurcation point, where the dissipative structure originates, Porush gives an instrumental explanation of what can happen within nonlinear systems of any kind, and which can be used to describe Slothrop's status: "a system-shattering moment [occurs] when the previous, simpler organization can no longer support the intensity or frequency of its own fluctuations, and either disintegrates or jumps to a new level of order and integration" (68). Slothrop's frequency has reduced or redshifted (increased in wavelength) and now approaches 'signal zero.' As Mondaugen's (one of the characters) electro-mysticism teaches: "Only at moments of great serenity is it possible to find the pure, the informationless state of signal zero" (*GR* 404), and indeed, with "not a thing in his head," Slothrop is "just feeling natural" (*GR* 626), manifesting "a desire to become pure process," as Berressem views the German Zone (356).

One of the last scenes where Slothrop is detectable but already a 'stranger' that "is hearing, for the first time, the mighty river of his blood, the Titan's drum of his heart" suggests, together with Pynchon's vocabulary from the same page associated with "incredible electronic waveforms" (*GR* 697) that Slothrop is pumping, oscillating, and fluctuating; he is a life form, but as dispersed as quanta. Only gravity can keep this rainbow of particles earthbound, only gravity prevents his complete disappearance from the novel (although he strives to fly like feathers). He seems to be everywhere and nowhere, sabotaging deterministic laws, challenging causality, as "waveforms constantly changing with time, now positive, now negative" (*GR* 404), and finally turning into the singularity of a black hole, as it appears to be time for that part of the cycle to prevail in order to become a 'child'—reborn again. Hugo Caviola notices "the allegorical alignment of Tyrone and Byron the Bulb," which suggests Slothrop's re-emergence in a new subliminal incarnation, and might mean that our hero is still "here" (121) and 'shining.' Since a bulb connotes light, it might be that, after the darkness of a black hole, he is becoming a child again, reborn in a white hole.

Although so much more could be said about scientific paradigms and *Gravity's Rainbow*—and this essay is just an introduction, for each idea and question opens up layers of highly intricate and interconnected hypotheses (which trigger the need for further argumentation)—I would like to finish on a positive note with Slothrop, imagining his transformation as favorable: a rebirth, assuming that "[t]here is time" (*GR* 760). It should also be emphasized that Slothrop progressed in agreement with scientific advancements, changing according to human understanding of natural processes, which paradoxically makes his transformation natural and legitimate. But, as

Moly Hite observes, "all such attempts to enclose Slothrop in an explanatory structure (which tacitly affirm Pointsman's working premises by making Slothrop an object of study) fail to comprehend him, 'even as a concept.' Slothrop's conceptual fragmentation becomes an emblem for the impossibility of explaining him" (119-20). In the same manner, this essay, although engaged with analytical tools and explanatory techniques, reflects on *Gravity's Rainbow* and Slothrop as open, unpredictable, and nonlinear systems of emergent potentialities that no textual commentary can grasp in their entirety, mirroring our reality as contingent, discontinuous, and irreversible, yet recursive and iterative; random, yet with potentials of self-organization. In Derrida's words, while "trying to reinvent invention [...] through the economy of the same, indeed, while miming or repeating it [...] the initiative or deconstructive inventiveness can consist only in opening, in uncloseting, destabilizing foreclosure structures so as to allow for the passage toward the other" (45). While "[d]econstruction dreams of the 'absolute surprise'" (Caputo 76), *Gravity's Rainbow* arrives to presence as an absolute surprise.

Just as Pynchon's characters in the quotation at the beginning of this essay move through man-made constructions, "*knotting into*" the archways and underpasses that at the same time project as extensions of their and the author's minds (Nadeau 138), so the readers of *Gravity's Rainbow* try to disentangle it, and yet are only "*knotting into*," deeper and deeper. Stipe Grgas points out that this novel "jealously continues to be retentively silent, engaging the reader's curiosity and need for significance, submitting to foreplay yet evading consummation" ("Gravity's" 302). As readers happen upon "secret entrances" that could help out with the analysis, "the blind curves" crop up, looping and drawing attention to the "absence" of anything concrete, except for the "shadows" of meaning as "brilliant and deep" as only a literary pen can bestow. As we—characters, readers, humans—move through the intricate network of winding passages (labyrinths), texts, and life, trying to cope with or understand our present, past, or at least affect our future, the only past we can deliver is either re-produced or hidden under the layers of "maturing rust" which is discontinuously releasing itself through the smells of 'present absence' (as smells are "haunting" Slothrop [GR 286]). The past feeds our present with "a poisoning, an uneasiness" (GR 3)—the everlasting suspension—a time-warp that approaches but never reaches "Absolute Zero." The future brings nothing even close to what we have hoped to harvest, shuffling the seeds of time and revealing "mysteriously vital growth." Whether this growth be positive or negative, it is "vital," for it sustains life, disclosing the unknown and irreversible in natural processes and testifying to the unpredictable and discontinuous force of temporality—the eternal becoming of the universe that does not allow time to "seal its passage."

Works Cited

- Adam, Barbara. *Time and Social Theory*. Polity Press, 1994.
- Berressem, Hanjo. "‘Vectors and Eigen Values’: The Mathematics of Movement in *Against the Day*." *Against the Grain: Reading Pynchon’s Counternarratives*, edited by Sascha Pöhlmann, Rodopi, 2010, pp. 349-68.
- Brownlie, Alan. *Thomas Pynchon’s Narratives: Subjectivity and Problems of Knowing*. Peter Lang, 2000.
- Caputo, John. *The Prayers and Tears of Jacques Derrida: Religion without Religion*. Indiana UP, 1997.
- Caviola, Hugo. *In the Zone: Perception and Presentation of Space in German and American Postmodernism*. Birkhäuser Verlag, 1991.
- Davies, Paul. *About Time: Einstein’s Unfinished Revolution*. Simon & Schuster, 1995.
- . "That Mysterious Flow." *Scientific American*, vol. 287, no. 3, 2002, pp. 40-47, www.nikhef.nl/pub/services/biblio/bib_KR/sciam14327034.pdf. Accessed 12 May 2015.
- Derrida, Jacques. *Psyche: Inventions of the Other*, Volume I, edited by Peggy Kamuf and Elizabeth G. Rottenberg, Stanford UP, 2007.
- Dewey, Joseph. *In a Dark Time: The Apocalyptic Temper in the American Novel of the Nuclear Age*. Purdue UP, 1990.
- Friedman, Alan, and Manfred Puetz. "Science as Metaphor: Thomas Pynchon and *Gravity’s Rainbow*." Pearce, pp. 69-81.
- Gleick, James. *Chaos: Making a New Science*. Viking, 1987.
- Greene, Brian. *The Fabric of Cosmos: Space, Time and the Texture of Reality*. Penguin Books, 2004.
- Grgas, Stipe. "Gravity’s Rainbow and Ihab Hassan’s ‘Catena’ of Postmodernism." *Razdio Filoloških Znanosti*, vol. 18, 1988-1989. Filozofski Fakultet Zadar, 1989, pp. 283-305.
- . "Thomas Pynchon in the Maze." *Cross Cultural Studies: American, Canadian and European Literatures 1945-1985*, edited by Mirko Jurak, Filozofska Fakulteta Ljubljana, 1988, pp. 215-21.
- Harding, Sandra. *The Science Question in Feminism*. Cornell UP, 1986.
- Hayles, N. Katherine, editor. *Chaos and Order: Complex Dynamics in Literature and Science*, U of Chicago P, 1991.
- . *Chaos Bound: Orderly Disorder in Contemporary Literature and Science*. Cornell UP, 1990.
- . *The Cosmic Web: Scientific Field Models and Literary Strategies in the Twentieth Century*. Cornell UP, 1984.
- . "Introduction: Complex Dynamics in Literature and Science." Hayles 1991, pp. 1-33.
- Heise, Ursula K. *Chronoschisms: Time, Narrative, and Postmodernism*. Cambridge UP, 1997.

- Heisenberg, Werner. *Physics and Philosophy*. Harper, 1958.
- Hite, Molly. *Ideas of Order in the Novels of Thomas Pynchon*. Ohio State UP, 1983.
- Hume, Kathryn. *Pynchon's Mythography: An Approach to Gravity's Rainbow*. Southern Illinois UP, 1987.
- Kroker, Arthur, Marilouise Kroker, and David Cook. *Panic Encyclopedia: The Definitive Guide to the Postmodern Scene*. St. Martin's Press, 1989.
- Latour, Bruno. *Science in Action*. Open UP, 1987.
- Li, Tien-Yien, and James A. Yorke. "Period Three Implies Chaos." *American Mathematical Monthly*, vol. 82, no. 10, 1975, pp. 985-92.
- Lorenz, Edward. "Deterministic Nonperiodic Flow." *Journal of the Atmospheric Sciences* vol. 20, 1963, pp. 130-41, eaps4.mit.edu/research/Lorenz/Deterministic_63.pdf. Accessed 14 Jun. 2015.
- Mandelbrot, Benoît. *The Fractal Geometry of Nature*. W. H. Freeman, 1982.
- McHale, Brian. *Postmodernist Fiction*. Methuen, 1987.
- Morris, Adalaide. "Science and the Mythopoeic Mind: The Case of H. D." Hayles 1991, pp. 195-220.
- Musser, George. "The Quantum Mechanics of Fate: How time travel might explain some of science's biggest puzzles." *Nautilus*, no. 21, 19 Feb. 2015, nautil.us/issue/21/information/the-quantum-mechanics-of-fate-rp. Accessed 4 May 2015.
- Nadeau, Robert. *Readings from the New Book on Nature: Physics and Metaphysics in the Modern Novel*. The U of Massachusetts P, 1981.
- Nicholls, Peter, editor. David Langford and Brian Stableford, contributors. *The Science in Science Fiction*. Alfred A. Knopf, 1983.
- Pearce, Richard, editor. *Critical Essays on Thomas Pynchon*. G.K. Hall, 1981.
- . "Where're They At, Where're They Going? Thomas Pynchon and the American Novel in Motion." Pearce, pp. 213-29.
- Plater, William. *The Grim Phoenix: Reconstructing Thomas Pynchon*. Indiana UP, 1978.
- Porush, David. "Fictions as Dissipative Structures: Prigogine's Theory and Postmodernism's Roadshow." Hayles, pp. 54-84.
- Prigogine, Ilya (in collaboration with Isabelle Stengers). *The End of Certainty: Time, Chaos, and the New Laws of Nature*. The Free Press, 1997.
- Pynchon, Thomas. *Gravity's Rainbow*. Vintage, 2000.
- . *The Crying of Lot 49*. J.B. Lippincott, 1966.
- Quilligan, Maureen. "Thomas Pynchon and the Language of Allegory." Pearce, pp. 187-212.
- Safer, Elaine. "The Allusive Mode and Black Humor in Pynchon's *Gravity's Rainbow*." Pearce, pp. 157-68.
- Saint-Amour, Paul. *Tense Future: Modernism, Total War, Encyclopedic Form*. Oxford UP, 2015.

- Schaub, Thomas. *Pynchon: The Voice of Ambiguity*. U of Illinois P, 1981.
- Slethaug, Gordon. *Beautiful Chaos: Chaos Theory and Metachaos in Recent American Fiction*. State U of New York P, 2000.
- Small, Michael, and Chi Kong Tse. "Predicting the outcome of roulette." *Chaos: An Interdisciplinary Journal of Nonlinear Science*, no. 22, 033150, 2012, arxiv.org/pdf/1204.6412.pdf. Accessed 14 May 2015.
- Strehle, Susan. *Fiction in the Quantum Universe*. The U of North Carolina P, 1992.
- Weisenburger, Steven. "The End of History? Thomas Pynchon and the Uses of the Past." Pearce, pp. 140-56.
- White, Hayden. "Historical Pluralism." *Critical Inquiry*, no. 12, 1986, pp. 480-93.