Strange Science

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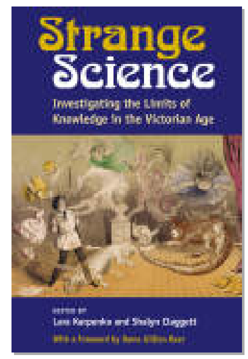

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CHAPTER 9

Chaotic Fictions

Nonlinear Effects in Victorian Science and Literature

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In his 1853 preface to *Bleak House*, Charles Dickens responds to two objections to the novel: the first objection comes from a Chancery judge who claims that the operations of Chancery (the central object of Dickens's sustained satire) are "immaculate," its progress impeded only by a "parsimonious public" unwilling to allow the appointment of more judges.[1] The second objection comes from more or less scientific authorities, who insist that spontaneous combustion, such as that which kills the novel's Mr. Krook (chap. 32), is simply impossible. Dickens's response to these objections constitutes the whole of his preface, in which he insists that everything set forth in the pages that follow regarding Chancery is "substantially true" (preface, 5). He insists, moreover, that his portrayal of spontaneous combustion rests on the testimony of numerous reliable authorities of his own. Only his final caveat suggests that he may have distorted reality for the sake of good fiction: "In *Bleak House* I have purposely dwelt upon the romantic side of familiar things" (preface, 7).

Dickens implies that "familiar things" actually have a "romantic side," that the portrayal of such a romantic side may be "substantially true," and, moreover, that this kind of truth inheres both in the physical world and in the social. What he means by "romantic," here, is not entirely clear. It seems rather unlikely that *Bleak House* is intended to portray anything along the lines of an idealized reality. It makes more sense to consider Dickens as alluding to Romantic emphases on emotion and intuition in the face of an Enlightenment rationalization, especially of nature. But Dickens quite clearly does not set the romantic in opposition to the realistic; the romantic, that which we feel or imagine but cannot confirm, far from being opposed to the empirical, even positivist, mandate we associate with realism, is part and parcel of the real.

Needless to say, the spontaneous combustion of Mr. Krook has been much discussed over the years. Contemporary scholars have interpreted the incident in numerous ways: as solely metaphorical, as testing our willingness to suspend disbelief, and as representing Dickens's resistance to scientific authority.[2] As one critic put it, "In the end, most of us agree that, for literary purposes, the scientific accuracy of Spontaneous Combustion doesn't matter."[3] And yet we can't leave it alone. In this we join a long and proud tradition: Krook's smoldering embers immediately sparked an extended conversation between Dickens and his friend George Henry Lewes, who bemoaned the inclusion of the scene because he thought it likely to set back public scientific knowledge considerably, "tend[ing] to perpetuate the error in spite of the labours of a thousand philosophers."[4] While Dickens fails to establish the truth of spontaneous combustion, his efforts to do so make visible the process by which fiction may participate in transforming statements into facts. The failure to thus factify spontaneous combustion, on the one hand, illustrates that such transformations cannot be effected by fiction or even language alone. On the other hand, this failure brings into focus the contributions *Bleak House* makes toward establishing entropy as a thing and the second law of thermodynamics as a fact. While discursive elements are essential to the transformation of statement into fact and to the shaping of the scientific object, the material world must cooperate. Thus, "the immense popularity of [our] dear Dickens" that so worries Lewes lest the ignorant be persuaded, can do much to promote the acceptance and further dissemination of the principles of entropy that *Bleak House* depicts so compellingly but, for reasons of chronology, cannot name.[5] In this case, discourse cooperates with the universe to establish entropy as a scientific object.[6]

Although spontaneous combustion often functions as an intellectual scapegoat that carries away the sins of scientific inaccuracy, Dickens may not be so far off in his thinking as he first appears, either from the science of his day or from that of our own.[7] His nonlinear reasoning is indicative of certain tendencies in Victorian scientific fictions more broadly: those flights of nonlinear fancy in both fictional and scientific writing that wrestle with the myriad natural systems whose apparent randomness, disproportionate effects, and unpredictability baffle traditional mathematics and science. In what follows, I gesture to a few of what I call *chaotic* fictions in Victorian literature and science. Such fictions (a word I construe quite broadly) may be found in the writings of authors as different as Alfred, Lord Tennyson, Norman Lockyer (astronomer and friend of Tennyson), Herbert Spencer, James Prescott Joule, William Thomson (later Lord Kelvin), and his less well-known colleagues Balfour Stewart and P. G. Tait. These fictions, I wish to argue, represent more than a mere mash-up of Victorian science and fancy. Instead, they are indicative of a Victorian attitude toward scientific speculation, especially within the science of energy and its "North British School," with which the above-named physicists were associated.[8] Here we find a peculiar mix of the romantic, the religious, and the scientific, the connections between which, Stewart and Tait insist, have foundation in the quintessentially scientific principle of continuity. Where continuity is assumed, principles flow across length and time, even across disciplinary boundaries, such that the novelist and the scientist converge in their social and moral, as well as scientific, speculations. And continuity assures us that even the most perplexing phenomena must have a familiar side—or, as George Levine observes of Dickens, "The ordinary . . . is latent with possibilities of the extraordinary."[9]

Hidden Order

Driven by a deeply held hope that order and purpose were at the base of even the most dismaying of natural phenomena, the Victorians sought for "the hidden order that exists within chaotic systems."[10] Such a hope suffuses Tennyson's *In Memoriam*; so popular was this elegy, so epigrammatic did its phrases become, that we may well take it as a litmus of Victorian concerns regarding the apparently chaotic, unpurposeful, and violent in nature. As I have argued elsewhere, such hopes—evident in Tennyson's "faintly trust[ing] the larger hope" that in spite of appearances, "God and Nature" might not be "at strife"—were indeed critical in shaping the Victorian science of energy.[11] The impulse to reason away destruction and waste similarly emerges in James Prescott Joule's earliest statements about the conservation of energy. Despite evidence to the contrary, Joule is firm in his belief that it would be "manifestly absurd to suppose that the powers with which God has endowed matter can be destroyed any more than they can be created by man's agency."[12]

Such a belief is also foundational in the counterentropic transformation Tennyson articulates in imagining the birth of a child at the end of *In Memoriam.* Moving from the language of waste that dominates the earlier parts of the poem to the etymologically linked concept of vastness, Tennyson imagines that "star and system rolling past, / A soul shall draw from out the vast /And strike his being into bounds" (CXXXI, 291). Such an image resonates with Dorian Gray's late-century fantasy of awakening to "a world that had been re-fashioned anew in the darkness for our pleasure."[13] And even Herbert Spencer, driven by his wish to establish the possibility of renewal in nature in spite of the drive to universal entropy, posits a mechanism for the restoration of order from a universe, or at least a solar system, that has gone to its final rest: "Certain of the great facts which science has established imply potential renewals of life, now in one region now in another, followed, possibly, at a period unimaginably remote by a more general renewal."[14] Chaos thus figures "as order's precursor and partner, rather than as its opposite,"[15] something understood (as Tom Stoppard observes regarding the second law of thermodynamics) "by poets and lunatics from time immemorial."[16] In such cases, it seems that only the science lags.

Tennyson's image of counterentropic transformation, moreover, soon gives way to a picture of human development that not only finds potential order in chaos, but also suggests the likeness of processes across vastly different scales. In Tennyson's account, the unborn child "move[s] through life of lower phase" before it can be born and think and result in man (CXXXI, 291). Tennyson, of course, anticipates what would be termed "recapitulation theory," popularly disseminated in the phrase (generally attributed to Ernst Haeckel) "Ontogeny recapitulates phylogeny." His suggestion that the life of his friend plays out in miniature the development of the species, that the movement of the species "from more to more" (prologue, 203) echoes the development of the earth, suggests the recursion of complex patterns at vastly different scales of time and size. Tennyson, of course, did not have access to the term "fractal" (coined by the mathematician Benoit Mandlebrot in 1975). He uses, however, the term "type," not only as a noun, but also as a verb. As a noun, "type" in its Victorian conception gestures backward to a notion of the archetype, grounded in a view of an essentially stable natural world. The verb form, however, implies at once that change inheres in the soon-to-be Darwinian concept of species. And for all that recapitulation theory has been disproved, the notion that each individual undergoes in miniature the whole of evolution, that the development of man, in Tennyson, "type[s] this work of time" (CXVIII, 281), suggests a larger Victorian fascination with similarities across scale.

A particularly telling example occurs in a short story entitled "The Tree of Knowledge" published in 1853 in *Dublin University Magazine*. After noticing that the marks left by his electrical experiments bear "a strange and striking resemblance to the foliage of a tree, imitating with a marvelous mimicry" stems, branches, leaves, and sap down to the "most delicate extremities of the plant," the narrator proceeds to find the pattern everywhere.[17] Such repetition of patterns across systems and scales accounts for much that, according to contemporary standards, is "wrong" and a surprising amount that turns out to be "right" in Victorian science. Correct or incorrect, much of Victorian science could not have been carried on without the presumptions attached to the capacity of systems to type other systems. The geological principle of uniformitarianism that informs Tennyson's "type" was essential to Darwin's reasoning, as was the notion that what could be done on a small scale (artificial selection) was similar to what happened on the large (natural selection). On the other hand, William Thomson (later Lord Kelvin) famously calculated a far-too-short lifetime for the sun based on the presumption that it burned in the same way as "matter in our laboratory" only on a much larger scale—an assumption of similarity eventually undermined by the advent of nuclear physics.[18]

The physicist Balfour Stewart and the astronomer Norman Lockyer (also friends with Tennyson) take the notion of the type quite literally in their scientific speculations. Their two-part article "The Sun as a Type of the Material Universe" anticipates much of what is elaborated in Stewart's *The Conservation of Energy* as well as in *The Unseen Universe*.[19] The article begins with a discussion of solar physics, concluding that the molecular state of the sun must be one of "infinite delicacy" (327). They also observe that the "manifest relation" (327) between sunspots and the positions of both Venus and Jupiter suggests a relationship between the "different members of our system" and of the universe more broadly, far more intimate than even our mathematical calculations would suggest: "They feel, they throb together, they are pervaded by a principle of delicacy even as we are ourselves" (327). The article's title further underscores the authors' desire to find a likeness between systems of vastly different scale. For the sun to figure as a "type" of the material universe is a kind of physically manifested synecdoche; its operations enact in (relative) miniature those of the larger system of which it is part. At the other end of the scale, solar activity figures as a very large model of our own smaller systems, enacting macroscopically the submicroscopic principles at the roots of life itself, for it is among the goals of their essay to argue for "the place of life in a universe of energy" (319).

Stewart and Lockyer further identify this similarity across scales as necessarily connecting disciplines:

> There is often a striking likeness between principles which nevertheless belong to very different departments of knowledge. Each branch of the tree of knowledge bears its own precious fruit and there is a unity in this variety—a community of type throughout. Nor is this resemblance a merely fanciful one, or one which the mind conjures up for its own amusement. While it has produced a very plentiful crop of analogies, allegories, parables and proverbs, not always of the best kind, yet parables and proverbs are or ought to be not fictions but truths. (319)

They claim such "unity in variety" exists across such "different departments of knowledge" as biology, astronomy, energy physics, social relations, and imperial politics. Not mere analogy or even synecdoche, the part exhibits the properties of the whole in ways at least some Victorian scientists understood as "not fictions but truths."

Such "true" analogies shape Stewart and Lockyer's prose as they introduce their readers to energy both kinetic (the energy of motion) and potential (the energy of position) through an extended analogy to social energy. Like so many evocations of what's natural, their use of this trope reflects their political concerns. And like other applications of thermodynamic principles to social dynamics, theirs ring remarkably conservative, in a social as well as an energetic sense.[20] Nonetheless, the real analogies described by Stewart and Lockyer do not allow us to distinguish as clearly as we might like between literal and figurative likeness, because there is little distinction between likenesses of degree and likenesses of kind. When the authors suggest that "energy in the social world is well understood," or that breaking a chemical bond is like lifting a stone from the earth, or that "food is the fuel which we burn in our own bodies instead of on our hearths or in our engines," such real analogies suggest not a dichotomy, but rather a continuum between the literal and the figurative (321–23). Metaphorically related, these various processes are also different manifestations of the same scientific principles: the social, the gravitational, the chemical are all instances of the transformation of energy, governed by the laws of thermodynamics.

As they move from the social to the scientific, Stewart and Lockyer find likeness between physical systems at vastly different scales, between different departments of scientific knowledge, between chemistry and physics. It is thus no accident that in enumerating such histories of the "creation" of potential energy, they use the same language to discuss both gravitation and chemical bonding. They claim we obtain such usable energy "when we tear asunder a stone from the earth" or when we "tear asunder the component atoms of some chemical compound" (321). And while we might more exactly refer to the chemical potential or higher energy state that results from separating the atoms of carbonic acid, Stewart and Lockyer refer to this as "a very convenient form of energy of position," emphasizing the likeness between astronomic, atomic, and experiential-sized systems (321). They further emphasize that the effectiveness of such an energy-storing enterprise depends on "whether our scale of operations be sufficiently great" (321). Their "community of type" thus suggests a kind of self-similarity or scale invariance: physical systems repeat themselves, their shapes and processes, at very different scales, some as familiar as our day-to-day interactions, some as strange as the microscopic workings of the mind, the splitting of a molecule, or the production of sunspots.

Continuity

The notion that the familiar and the unfamiliar share such a "community of type" is consistent with the scientific principle of continuity. This principle—that what we learn or hypothesize about the natural world must be consistent with what we already know—constrains and shapes any paradigm shift within the sciences. For example, the quantum mechanical models of the early twentieth century, when taken to macroscopic limits, are constrained to agree with Newtonian predictions that are backed by over two centuries of observation and common sense. With this in mind, Joule's insistence that it would be absurd to suppose that man's agency could create or destroy what we come to call energy may be understood as his insistence that what he finds must be consistent with what he already knows. It then follows that when Joule and his contemporaries found so much evidence to the contrary (in the heat loss associated with all mechanical processes), they knew they hadn't yet got the whole picture; along with all that observable heat loss, there must be conservation as well.

In their book *The Unseen Universe*, Balfour Stewart and P. G. Tait put such commonsense reasoning to a rather different use. They wished to refute those who would find science opposed to religion, to "[strip] off the hideous mask with which materialism has covered the face of nature" (xv).[21] They tried to find the confidence that George Levine ascribes to Dickens in his portrayal of Krook's death, "the confidence of natural theology, in which material reality corresponds meaningfully to a moral reality."[22] Ultimately, they hoped to demonstrate that notions of an afterlife are consistent with the second law of thermodynamics. Tamara Ketabgian, whose chapter in this volume discusses this project far more fully, notes that in spite of the authors' insistence that their methods are "absolutely driven by scientific principles," *The Unseen Universe* provoked widespread scientific criticism and spiritualist emulation (see Ketabgian n. 7). What interests me here is a particular scientific principle by which they claim to be driven—the principle of continuity—and the various ways it enables their chaotic fictions.

The principle of continuity, generally attributed to Gottfried Leibniz (who, in addition to being a philosopher was also a mathematician best known for developing calculus independently of Newton), has been summed up as the notion that "nature never makes leaps."[23] Leibniz's own statement that "the rules of the finite are found to succeed in the infinite," reveals its close association with infinitesimal calculus, wherein we can add infinitesimally small pieces to determine the area delineated by complex curves.[24] In *The Unseen Universe*, Stewart and Tait, undoubtedly of a mind with Leibniz in his conviction that the principle should serve "not only as a test" of scientific theories (such as that applied to quantum mechanics, mentioned above), "but also as a very fruitful principle of discovery,"[25] complain that neither the "extreme scientific school," nor "the old theological school" have "loyally followed" this principle, which, they insist in words that echo Leibniz, "underlies not only all scientific inquiry, but all action of any kind in this world" (87, xx). They write:

> All this follows from the principle of Continuity, in virtue of which we make scientific progress in the knowledge of things, and which leads us, whatever state of things we contemplate, to look for its antecedent in some previous state of things also in the Universe. This principle

> represents the path from the known to the unknown, or to speak more precisely, our conviction that there is a path. (xv–xvi)

From this perspective, scientific progress is possible only when we can reconcile emerging scientific principles with knowledge of how the world is, or even our strongly held convictions of how it should be. The latter is tricky ground, of course, though it is key to Stewart and Tait's argument. In the state of our knowledge as well as in states of the physical world, before and after must connect in the present.

Victorians certainly were not proof against finding anticipations of their own science in the beliefs of the past. Stewart and Tait were quite explicit about the connections between ancient religion and contemporary science. They evoke the ancient Egyptians, whose records attest not only to belief in the immortality of the soul, but to the grounding of this belief in something very like the first law of thermodynamics—the law of conservation of energy: "Dissolution, according to them, is only the cause of reproduction—nothing perishes which has once existed, and things which appear to be destroyed only change their natures and pass into another form" (5). Such assertions are similarly prominent in the beliefs of Edward Bulwer-Lytton's fictional underground race, the Vril-ya, whose buildings evoke "the earliest form of Egyptian architecture . . . the Corinthian capital. . . . Etruscan vases [and] the walls of Eastern sepulchers" (24). These architectural impressions are reinforced by the figures, attire and demeanor—the Oriental quietude and sphinxlike faces—of the people, whose belief in an afterlife is grounded in a conviction not unlike Joule's: "They hold that wherever He has once given life, with the perceptions of that life, however faint it be, as in a plant, the life is never destroyed; it passes into new and improved forms, though not in this planet" (83).

However fanciful such connections may seem, we still find such intuition incredibly useful to scientific hypothesizing. This process resonates strongly with what Charles Sanders Peirce calls "abductive reasoning." Peirce's abduction is the step between perception and reasoning, a logical process that precedes deduction and induction. Far more recently, Wendy Wheeler has used Peircean semiotics as a model for the synthesis of science and the humanities that drives contemporary ecocriticism, with its willingness to embrace the poetic, the numinous, as well as scientific accounts of how the world works. Peircean semiotics sidesteps the proliferation of arbitrariness in meaning evolved from the Saussurean model, by rooting signs in the material world—signs we read long before our personal or phylological development of language. In this way, "New theories and models are [indeed, must be] forged from creative re-readings of the past."[26] Peirce, in other words, puts forth a model for what Stewart and Tait assure us there must be: a "path from the known to the unknown" (xv–xvi).

Delicate Constructions and Explosive Effects

The path from the known to the unknown articulated by the law of continuity and enabled by abductive reasoning is highly suggestive regarding the connections between the literal and figurative found above in the connections Stewart and Lockyer make among the actions of gravitation, of chemical attraction, and of "the force which keeps a man down in the world."[27] The principle of continuity suggests how these metaphorical connections might be part and parcel of the connectedness of the world. If Stewart and Lockyer oversimplify (and politicize) by ascribing one man's high position to the personal energy expended by the founder of the family, they are nevertheless more sensitive to the difficulties of tracing such causes in material phenomena. For this, they evoke Leibniz's continuity principle. Within their "principle of delicacy," however, they move not only from the known to the unknown, but from the finite to the infinite, as they identify systems of "great delicacy" and hypothesize systems of "infinite delicacy." Going a step further than their "community of type," their principle of delicacy implies that the typologically similar systems in question are similarly complex at every scale.

Great delicacy, for Stewart and Lockyer, accounts also for a common feature of such systems—that within them, small or even imperceptible causes may produce disproportionately large effects. They conclude that the sun is such a system, a star "of great delicacy, so that in our luminary a very small cause might be the parent of enormous effects, of a visible and mechanical nature" (327). Contemporary science would say that such a system exhibits sensitive dependence on initial conditions. We find it not only in astronomical phenomena, but also in the apparent unpredictability of global markets, as well as in daily disappointments with our local weatherman. Stewart and Lockyer, too, posit that systems of great delicacy exhibiting such sensitive dependence may be found, or at any rate imagined, at more familiar length-scales: "By an amount of directive energy less than any assignable quantity a current may be made to start suddenly, cross the Atlantic, and . . . explode a magazine on the other side" (325). A tiny spark in a gun with a hair trigger, poised just so, may win an empire.[28] A small change in the initial conditions—a shift in the position of the gun, an eddy in the winds of change—and perhaps nothing of note will occur. But poised just so, and the effects may well be, literally and figuratively, explosive.

As Stewart and Lockyer move from this relatively familiar machine of great delicacy to the less familiar workings of the mind, life, and even a Supreme Being, they posit machines of "infinite delicacy" whose unpredictability is nonetheless fully consistent with a physical universe governed by the principles of energy. Denying the possibility of a living being whose actions are fully calculable, they locate "the very perfection of . . . animated beings . . . in the fact that their motions cannot possibly be made the subject of calculation."[29] Such freedom, through which living beings not only produce motion but produce it discontinuously, must nonetheless conform to the laws that govern the physical universe. For this reason they propose that the delicacy of living beings enables them to supply an infinitely small amount of "directive energy" that nonetheless brings about perceptible results (326). Thus, even without the nonlinear mathematics that explains such disproportionate effects, they provide a model of how something may be rooted in physical causes but defy prediction by articulating a principle of sensitive dependence on initial conditions.

Stewart and Lockyer thus beat back the materialist monster, both "the man who could predict his own motion" and, presumably, the godless scientist who could conceive of such a horror (324). Their delicacy-of-construction model allows for the presence of an engaged and potentially omnipotent God, incalculable but still causally connected to the material universe, "a Supreme Intelligence [that] without interfering with the ordinary laws of matter, pervades the universe, exercising a directive energy," not unlike that which enables living beings to make choices (327). Neither religion nor morality is ever far from their thoughts, "and as in the social world a man may degrade his energy, so also in the physical world may energy be degraded" (322). Such dissipation is at once physical and moral, literal and figurative. Indeed, it is almost Dickensian.

And so we come full circle—to that sensational scene in *Bleak House* wherein Mr. Guppy and his friend Mr. Jobling come upon the charred remains of the recently exploded Mr. Krook. He has (the narrative insists, against the protestations of authorities both real and fictional) died of "Spontaneous Combustion, and none other of all the deaths that can be died" (chap. 32, 519). Suddenly, men of science and philosophy and medicine, capable of "learned talk about inflammable gases and phosphuretted hydrogen," find themselves the target of Dickens's irrepressible wit, as the wisest among them are depicted as alive with "indignation that the deceased had no business to die in the alleged manner" (chap. 33, 532). In spite of all the authorities and case studies attesting to the possibility of spontaneous combustion, to which Dickens now alludes in his novel, his fictional observers "still . . . regard the late Mr. Krook's obstinacy in going out of the world by any such by-way as wholly unjustifiable and personally offensive" (33, 532).

But for all that he dubs the combustion in question "spontaneous," Dickens suggests that while Krook's death may be incalculable, it does not follow that it is without cause. Indeed, even the offended authorities who ascribe Krook's death to obstinacy thereby posit a cause. But Dickens is more transparent about it: "The death of all lord chancellors in all courts and of all authorities in all places under all names soever, where false pretences are made, and where injustice is done . . . the same death eternally—inborn, inbred, engendered in the corrupted humours of the vicious body itself" (chap. 32, 519). His allusion to the body's "humours" suggest that Dickens is fully aware of his stubborn persistence in what will most certainly be taken as archaic science. At the same time, and true to the spirit of continuity, this gesture backward is also a gesture forward. Dickens's "humours" operate very much like Stewart and Lockyer's "directive energy": ubiquitous and speculative, they nonetheless link nonlinear effects to imperceptible causes, bringing to the fore what we might term the "romantic side" of such science writers as Stewart and Lockyer. This is both comforting and unnerving. Certainly, there is reassurance in the moral predictability inherent in Dickens's model—the certainty that the same fate will overtake all such corrupt chancellors—especially where we can see no readily discernible physical cause. There is a comforting continuity in Dickens's portrayal of this particular sensitivity to initial conditions, not unlike that ascribed to the conservation of energy. Indeed, the first-law closure that permeates the very structure of novelistic form suggests similarly that everything comes from within. And yet Dickens goes beyond the comforting assurances of Stewart and Lockyer's model. Where their model of nonlinear effects reassures us of our own free will and of the possibility of a superior intelligence, Dickens's explosive morality disturbs us in unanticipated ways. Where theirs spins a social model that remains relatively simple, predictable, and (politically as well as energetically) conservative, Dickens entangles us in a matrix of complex and nearly untraceable, networked relations.

For Stewart and Lockyer, the macroscopic history of energy accounts for the high social position and the low. In a universe neither unpredictable nor unfair, they posit that the high position of one family has been earned through the expenditure of great personal energy on the part of its founder. And even where nonlinear effects come into play, they still shore up the rightness of British expansion. The very delicacy of life itself, they claim, accounts for the marvelous advance of civilization, technology, empire, as "from an exceedingly small primordial impulse great and visible results are produced":

> In the mysterious brain chamber of the solitary student we conceive some obscure transmutation of energy. Light is, however, thrown upon one of the laws of nature; the transcendent power of steam as a motive agent has, let us imagine, been grasped by the human mind. Presently the scene widens, and as we proceed, a solitary engine is seen to be performing, and in a laborious way converting heat into work; we proceed further and further until the prospect expands into a scene of glorious triumph, and the imperceptible streamlet of thought that rose so obscurely has swelled into a mighty river, on which all the projects of humanity are embarked. (326)

Stewart and Lockyer seem as blithely unperturbed by this imperialist progression as they are by the promiscuous slippage between literal and figurative. The spark of implicitly British genius works through the progress of decidedly British technology to bring light into the heart of darkness, all fully consistent with (and seemingly predestined by) the laws of thermodynamics.

But *Bleak House* is decidedly less reassuring. After thirty-one chapters of narration, driven back and forth like the pistons of a pumping engine by the systematic alternation between the third-person omniscience of an unknown narrator and the first-person account of Esther Summerson, the whole thing explodes into an undifferentiated "we." Though we are told of Guppy and Jobling that "*they* advance slowly" toward the scene of Krook's demise (italics mine), the "they" vanishes in the ensuing confusion:

> Here is a small burnt patch of flooring; here is the tinder from a little bundle of burnt paper, but not so light as usual, seeming to be steeped in something; and here is—is it the cinder of a small charred and broken log of wood sprinkled with white ashes, or is it coal? Oh,

> horror, he IS here! And this from which we run away, striking out the light and overturning one another into the street, is all that represents him. Help, help, help! Come into this house for heaven's sake! Plenty will come in, but none can help. . . . Call the death by any name Your Highness will, attribute it to whom you will, or say it might have been prevented how you will, it is the same death eternally—inborn, inbred, engendered in the corrupted humours of the vicious body itself, and that only—Spontaneous Combustion, and none other of all the deaths that can be died. (Chap. 32, 519)

Observations, which may or may not be theirs ("here is a small burnt patch . . . here is the tinder"), rapidly give way to unknowns (is it cinder? coal?). A horror centered in being ("he IS here") panics not them, but us. And a series of insights increasingly less likely to come from anyone on the scene culminates with a consolation as universal as it gets, addressed to a mysterious "Your Highness." Even representation seems to come from nowhere and everywhere, as "We run away . . . from all that represents him." Without semblance of narrative objectivity or expectation of readerly detachment, without even a clear perspective or identifiable voice, distinctions between characters, readers, speakers, writers, and texts collapse in an unascribed "Help! Help! Help!" in response to which no help can be forthcoming. Krook's ashy remains, hardly distinguishable from a smoldering piece of wood or coal, rocket us into the street, panic-stricken and stumbling over one another as we run from a scientific anomaly that can—apparently without cause—reduce us to cinders.

This sudden and disconcerting involvement of the reader draws us into an immediate experience of chaos. It is, however, the immediacy of the experience, rather than its nonlinearity, that distinguishes it from the broader chaotic universe of *Bleak House*. Disproportionate effects abound. For example, the establishment of coffee plantations on the shores of the Niger in Borrioboola-Gha leave little Peepy with his head caught in the area railings, while a bit of distinctive handwriting amid a pile of legal papers brings down the great house of Sir Leicester Dedlock. And even the constable might think twice about his habitual refrain of "Move on," if he knew that it would eventually carry smallpox right into the heart of the story. Thus, for all that he is a proponent of proportion, Dickens brings into sharp relief how the small and the large, the near and the far, are tightly bound—how things can get very bad very quickly and in wholly unanticipated ways. And though thermodynamics undoubtedly allows Dickens, among others, "to contain the world's seeming disorder, its disjunctive elements . . . within a single system," such disjunctive elements are no less a part of the "sustained continuities linking past and present."[30] Small and large, finite and infinite, known and unknown, the familiar and the romantic, the ordinary and extraordinary are inexorably and scientifically, if incalculably, linked. Explosive effects abound in a chaos that, however unnerving, is still only natural.

Notes

1. Charles Dickens, preface to *Bleak House*, ed. Nicola Bradbury (New York: Penguin, 1996), 5. Page and chapter numbers for subsequent citations will be given parenthetically in the text.

2. For an account of this critical discussion, see Brooke Taylor, "Spontaneous Combustion: When 'Fact' Confirms Feeling in 'Bleak House,'" *Dickens Quarterly* 27, no. 3 (2010): 171–84.

3. Ibid., 172.

4. G. H. Lewes, *Leader* 4 (January 15, 1853): 64, quoted in Gordon S. Haight, "Dickens and Lewis on Spontaneous Combustion," *Nineteenth Century Fiction* 10, no. 1 (1955): 53–63.

5. Ibid., 55.

6. Barri J. Gold, *ThermoPoetics: Energy in Victorian Literature and Science* (Cambridge: MIT Press, 2010), 189–92.

7. Ann Wilkinson, "From Faraday to Judgment Day," *ELH* 34, no. 2 (1967): 225–47. Ann Y. Wilkinson argues throughout her essay to establish the validity of reading Dickens in the context of physical science, identifying the scientific underpinnings of Krook's combustion in Dickens's connection to the highly esteemed chemist and physicist Michael Faraday.

8. Crosbie Smith, *The Science of Energy: A Cultural History of Energy Physics in Victorian Britain* (Chicago: University of Chicago Press, 1998). In the chapter "North Britain *versus* Metropolis" in *The Science of Energy*, Crosbie Smith describes these competing schools of the developing science of energy, especially as regards their relations to religion and scientific naturalism, as well as contention over scientific authority.

9. George Levine, *Darwin and the Novelists: Patterns of Science in Victorian Fiction* (Cambridge: Harvard University Press, 1988), 135.

10. This phrase is taken from a description of strange-attractor chaos theory, in N. Katherine Hayles, *Chaos Bound: Orderly Disorder in Contemporary Literature and Science* (Ithaca, NY: Cornell University Press, 1990), 9–10.

11. Barri J. Gold, "The Consolation of Physics: Tennyson's Thermodynamic Solution," *PMLA* 117, no. 3 (2002): 449–64; Alfred, Lord Tennyson, *In Memoriam*, in *Alfred Tennyson: The Major Works including "The Princess", "In Memoriam", and "Maude"*, ed. Adam Roberts (Oxford: Oxford University Press, 2009), LV, 235. Stanza and page numbers for subsequent citations will be given parenthetically in the text.

12. James Prescott Joule, *The Scientific Papers* (London: Taylor and Francis, 1884), 266–67.

13. Oscar Wilde, *The Picture of Dorian Gray*, ed. Joseph Bristow (Oxford: Oxford University Press, 2008), 112.

14. Herbert Spencer, *First Principles* (Honolulu: University Press of the Pacific, 2002), 474.

15. Hayles, *Chaos Bound*, 25.

16. Tom Stoppard, *Arcadia* (Boston: Faber and Faber, 1993), 65.

17. "The Tree of Knowledge," *Dublin University Magazine* 256, no. 51 (1853): 663–75. My thanks to Stella Pratt-Smith for bringing this story to my attention.

18. William Thomson, "On the Age of the Sun's Heat," *MacMillan's Magazine* 5 (March 5, 1862): 391–92.

19. Balfour Stewart and Norman Lockyer, "The Sun as a Type of the Material Universe," part 2, *Macmillan's Magazine* 18 (1868): 319–27. Subsequent references to this article will appear parenthetically in the text.

20. Allen MacDuffie, "Joseph Conrad's Geographies of Energy," *ELH* 76, no. 1 (2009): 75–98. MacDuffie has discussed how thermodynamic principles have been misapplied in the rhetoric of European energy and efficiency—a rhetoric undermined by the actual physical pressures of work and waste (95). I have explored the social and political implications of Stewart and Lockyer's analogy in *ThermoPoetics*.

21. Balfour Stewart and P. G. Tait, *The Unseen Universe or Physical Speculations on a Future State*, 9th ed. (London: Macmillan, 1890; repr.,Whitefish, MT: Kessinger Publishing, 2003), xv. Roman numerals identify pages in the Kessinger reprint; I use these when referring to preliminary materials, such as the prefaces to the various editions. Where I use Arabic numerals, these refer to the "Article" numbers in Stewart and Tait's original text.

22. Levine, *Darwin and the Novelists*, 134.

23. Gottfried Wilhelm Leibniz, *Sämtliche Schriften und Briefe*, ed. Deutsche Akademie der Wissenschaften (Berlin: Akademie Verlag, 1923–), VI.vi.56, quoted in Larry M. Jorgenson, "The Principle of Continuity and Leibniz's Theory of Consciousness," *Journal of the History of Philosophy* 47, no. 2 (2009): 223–48.

24. Gottfried Wilhelm Leibniz, "Letter to Varignon, with a Note on the 'Justification of the Infinitesimal Calculus by That of Ordinary Algebra," in *Philosophical Papers and Letters*, 2nd ed., trans. and ed. Leroy E. Loemker (Norwell: Kluwer Academic Press, 1989), 544.

25. Gottfried Wilhelm Leibniz, "The Principle of Least Action," in *Philosophy of Science: A Historical Anthology*, ed. Timothy McGrew, Marc Alsprector-Kelly, and Fritz Allhoff (Chichester: Wiley-Blackwell, 2009), 214.

26. Wendy Wheeler, "Postscript on Biosemiotics: Reading beyond Words—And Ecocriticism," *New Formations* 64 (Spring 2008): 138.

27. Stewart and Lockyer, *Macmillan's Magazine*, 319–27.

28. This image of a gun with a delicate trigger, and much of the subsequent reasoning regarding "delicacy of construction," is reiterated in Balfour Stewart's *The Conservation of Energy* and quoted at length in *The Unseen Universe*, where the authors emphasize the "incalculability" of such systems. Tina Young Choi reads in novelistic form itself, a "Thermodynamic sensibility" that suggests a reassuring systemic self-sufficiency attached to narrative closure, which itself resists the ever-present threat of entropy. Tina Yong Choi, "Forms of Closure: The First Law of Thermodynamics and Victorian Narrative," *ELH* 74, no. 2 (2007): 301–22.

29. Stewart and Lockyer, "Sun as a Type," 324.

30. Choi, "Forms of Closure," 308–17.