ThermoPoetics

Energy in Victorian Literature and Science

Barri J. Gold

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I am grateful to the Modern Language Association for permission to reprint my article, "The Consolation of Physics: Tennyson's Thermodynamic Solution" (*PMLA* 117, no. 3 [May 2002]:449–464), which is revised and included as chapter 1 of this book.

1 Tennyson's Thermodynamic Solution

HANNAH: Is there anything in it?

VALENTINE: In what? We are all doomed? (Casually.) Oh yes, sure—it's called the second law of thermodynamics.

HANNAH: Was it known about?

VALENTINE: By poets and lunatics from time immemorial.

—Tom Stoppard[1]

Could Thomasina Coverly, a thirteen-year-old girl living in a country house in Derbyshire, possibly have discovered the second law of thermodynamics in the spring of 1809, over four decades before the term *thermodynamics* was even coined? In fiction, where such things happen, she can and does. And though this rather remarkable teenager exists only as a character in Tom Stoppard's 1993 play *Arcadia*, her unlikely discoveries trigger the very real suggestion that in 1809 we knew. In some sense, we have always known. Byron knew in 1816, when he opened the poem "Darkness" with these lines:

I had a dream, which was not all a dream.
The bright sun was extinguished, and the stars
Did wander darkling in the eternal space,
Rayless, and pathless, and the icy earth
Swung blind and blackening in the moonless air.[2]

And in the same sense, Alfred, Lord Tennyson knew in 1851, when he finally published *In Memoriam*, a really long, important Victorian elegy that he had begun writing almost two decades earlier on the death of his friend Arthur Henry Hallam. By the time it was finished, *In Memoriam* had greatly extended its reach, not only commemorating a lost friend, but also addressing many of the concerns and anxieties, hopes and aspirations, characteristic of early Victorian England. Within its hundred-or-so pages, coping with the loss of a friend becomes thoroughly entangled with coping with other kinds of loss: a threat to faith; a sense of instability wrought by changes in the economy and social structure; anxieties associated with advances in technology and science, with landscape, foreign relations, the map of Europe, gender relations, conceptions of race, and education, and of course, with the loss of nature's usable energies soon to be associated with the second law. The poem spoke to many; the consolation it effected was widespread. Queen Victoria was said to have kept it at her bedside, and Tennyson was made poet laureate shortly after its publication. *In Memoriam* was undoubtedly what so many elegies are not; it was a crossover hit.

The poem's name alone suggests that it is engaged in remembering that which might otherwise be lost; as a memorial, its job is a kind of conservation of memory. Now savvy readers are already anticipating a parallel that this chapter pursues at length, as we extend *In Memoriam*'s reach just a bit further. For it speaks to us, too—enabling us to recover a moment prior to what one might call *thermodynamic memory*, when notions of conservation and dissipation are finally inscribed in and as the laws of thermodynamics. Tennyson thus seems to fulfill the promise of the poet and the lunatic—not to mention the genius. He seems to know things before the rest of us. Or perhaps more accurately, he seems to have said in words what we could not yet say in words. Some might even say that within his poem, we find ideas in circulation, before they are properly commodified.

In this chapter, I want to look at *In Memoriam* in a way that is both familiar and new. It is familiar, because we have spent a century and a half considering this poem as somehow representative of the spirit of the age, the zeitgeist, the cultural milieu or political unconscious. It is new because *In Memoriam* has not been properly appreciated as the brilliant work of thermodynamics that it almost certainly is. As such, it allows us to study the literary production of ideas we think of as scientific. *In Memoriam* suggests, if nothing so simple as the influence of poetry on science, at least something more conversational—something I have come to call *ThermoPoetics*, a term intended to suggest mutual influence, common concerns, and even simultaneous discovery. And it gives us a sense of how such a thermopoetic conversation might go, how poetry speaks to science, how it says in words what cannot yet be said in words, how tender, young, unformed scientific ideas reflect and inform the other concerns that pervade what we will loosely call a culture, and even how a culture prepares itself to embrace such ideas.

Useful Anachronism

Alfred, Lord Tennyson's *In Memoriam* is a strange mix of past and future. On the one hand, Tennyson embraces certain distinctively Romantic beliefs, especially the notion that poetry is a way of knowing. At the same time, he embraces a characteristically Victorian investment in scientific modes of inquiry. Tennyson thus insists on the consonance of the "two cultures" of science and literature at a moment when they seem to be diverging. And *In Memoriam* not only evinces a deep concern with the science of the day, but also disrupts expected patterns of influence. Even where readers have sought to explore the interaction between science and literature, they tend to posit a unidirectional influence, considering almost exclusively the influence of science on literature. Why we do this relates to what Bruno Latour has called a "diffusion model" of how scientific facts move about. Studying science "in action," Latour does much to mess with our comfortable assumptions that these have a life of their own, that somehow they exist and circulate spontaneously, without any human help. This "diffusion model" tends to operate more as an unexamined assumption than as an articulated model and implies that scientific facts don't need any help from one distinctly human endeavor—poetry.[3]

In Memoriam suggests otherwise.[4] It not only circulates such facts, but arguably even helps them to exist. The first clue comes from Tennyson's apparent prescience in scientific matters—something readers have noted for over 150 years. We are by now thoroughly familiar with *In Memoriam*'s struggles with the anxieties wrought by evolutionary narrative. Published eight years prior to Darwin's *Origin of Species*, its phrase "Nature, red in tooth and claw" has been "vested by historians with the power to sum up nothing less than the impact of evolutionary thought on Christian humanism."[5] In fact, some of "the sections of 'In Memoriam' about Evolution had been read by his friends some years before the publication of the *Vestiges of Creation*,"[6] which Tennyson requested from his bookseller, after seeing an ad suggesting that the work "contain[ed] many speculations with which [he had] been familiar for years, and on which [he had] written more than one poem."[7] It seems that *In Memoriam* anticipates not only Darwinian evolution, but also one of its significant precursors in early nineteenth-century science.

But that's not all. The 1850s witness the consolidation of two sciences; both evolutionary biology and energy physics emerge in this moment as viable—indeed, as what one famous scholar calls "dominant paradigms."[8] But while Tennyson's engagement with biological and geological thought is well known, his conversation with the physical sciences has been largely overlooked.[9] Tennyson's own, oft-quoted to-do list—"Monday. History, German./Tuesday. Chemistry, German./Wednesday. Botany, German./Thursday. Electricity, German./Friday. Animal Physiology, German./Saturday. Mechanics./Sunday. Theology"[10] —coupled with the posthumous testimony of his friend, the astronomer Norman Lockyer, suggest an early and abiding interest in the physical sciences. Indeed, Thursday's regimen as well as Saturday's suggest that in spite of Romantic antipathy to certain Newtonian ways of knowing, there is a place for physics in poetry.

However, my concern here, as I have suggested, is less with what Tennyson knew than with what he could not possibly have known: the laws of thermodynamics. We are hard-pressed to pinpoint when these laws were first articulated. Indeed, for one historian, "the hypothesis of energy conservation . . . publicly announced by four widely scattered European scientists" between 1842 and 1847, is an exemplary case of simultaneous discovery.[11] Some locate the genesis of energy physics considerably earlier: Thomas Young's 1803 lecture "On Collision" seems to offer one of the earliest usages of the term *energy* in its modern physical sense.[12] But Young focuses on the motion of macroscopic objects. He identifies what will come to be called kinetic energy, which is only one subcategory of what energy will come to comprehend once the Victorians get their hands on it. A French engineer by the name of Sadi Carnot also gets a lot of credit for inventing thermodynamic theory. His 1824 paper "On the Motive Power of Fire" is often taken to be the earliest formulation of what I have been calling the "law of entropy" or the "second law"—the law that posits the inevitable loss of useful energy. William Thomson will later call this work "a perfectly clear and general statement of the 'Conservation of Energy'"—that is, of the first law of thermodynamics.[13] (Thomson, if you recall, has already shown up in this book as the one who coined the term *thermodynamics*. His work was so valued that he was eventually knighted, becoming Baron Kelvin, a name that will probably be more familiar to scientists and engineers, who undoubtedly recall the absolute temperature scale he developed, in which measurements are made in degrees Kelvin.) Anyway, Thomson was largely responsible for the circulation of Carnot's essay in English. And his attention suggested that Carnot's contribution was undoubtedly significant. Still, it isn't exactly clear what that contribution was. Was it about conservation or dissipation? How could it have been both? And even if we think we understand what Carnot's contribution was, even if we understand it largely as having to do with conservation, it seemed to be contradicted by the work of James Prescott Joule, the Manchester brewer whose experiments showed heat *loss* far more than he seemed to like. Thomson sought to reconcile this increasingly disturbing contradiction in his essay "On the Dynamical Theory of Heat" (1851) (see Thomson 1882). The considerable conceptual work this required suggests that the scattered pronouncements of a principle here, a definition there, did not suffice to establish thermodynamics as a science or, more precisely, a physical theory.[14] It was not until 1854 that Thomson identified this science as "thermodynamics"; not until 1865 that Clausius coined the key term *entropy*.[15] A very broad popularization of thermodynamic theory followed, marked not least by John Tyndall's *Heat: A Mode of Motion* (1863) and by Balfour Stewart's *The Conservation of Energy* (1873). Thus, much of the development of thermodynamic theory coincided with—and virtually all of its popularization followed—the writing and publication of *In Memoriam*.

Nonetheless, *In Memoriam* is saturated with the language of energy physics. Though "energies" itself appears only twice,[16] the concepts that *energy* eventually comprehends—heat, light, power, force—surface again and again, as do images that suggest the concerns of thermodynamics more broadly: loss and gain, waste, systems, the behavior of gases, order and disorder, and changes of state or form. In Tennyson, as in the emergent science of energy physics, these terms evince considerable overlap and—like the things they represent—they tend to transform into one another. As James Prescott Joule will observe in 1847, "All three, therefore—namely, heat, living force, and attraction through space (to which I might also add *light* . . .)—are mutually convertible into one another. In these conversions, nothing is ever lost."[17] Similarly, in Tennyson, light and heat, life and attraction, will prove interconvertible and will be governed by the same principles. And when read through the lens of constructive anachronism—the same kind of vision that enables us to identify retroactively the significance of contributions such as Young's and Carnot's—the poem's repeated, apparently disconnected returns to these concerns emerge as a coherent thermodynamic narrative.

Drawing on the same culture of science in and through which the physicists developed their ideas, reading Laplace and Kant, among others,[18] Tennyson can be said to have discovered—poetically—not only the terms, but also the principles and processes of the nascent science of energy physics, especially the poetic evocation of the tension between conservation and dissipation that haunts the first and second laws of thermodynamics. Of course, saying such a thing requires us to stop and rethink what we mean by *discovery*. Usually, when we think of discovery, we imagine that one of us found (uncovered, recognized, introduced) something that was already out there, in something we call nature. Then, all we have to do is give it a little push and it diffuses—so to speak—on its own; it's so compelling, so true, so simply factual that except for a stubborn few, people just accept it.[19] I'd like to use the term *discovery* somewhat differently to include not only the circulation, but also the shaping of what we come to know as scientific fact. In this kind of discovery, physicists as well as poets participate in a process by which facts are made—not out of nothing, but made nonetheless. Poetry, I would suggest, offers one of many "strategies that give the object the contours that will provide assent,"[20] making something (a fact, an idea, a physical theory, a scientific object) we can actually work with, think about, build on, accept or resist.

In this expanded sense, then, *In Memoriam* exemplifies poetic discovery simultaneous with—even prior to—scientific discovery. As such, the poem requires us to reexamine our expectations of the relation between Victorian poetry (or religion for that matter) and science, especially physics. Far from being antagonistic or mutually exclusive endeavors, poetry and science draw on the same language and in many ways wrestle with the same contradictions as each develops the principles physics will call the laws of thermodynamics. Working out how Tennyson anticipates these laws, we also elicit the ways he reshapes what seem like familiar tropes of Romantic elegy. As he deploys these tropes in the context of his own scientific concerns, they resonate in important physical, as well as spiritual, ways. At the same time, *In Memoriam*'s conversation with energy physics leads us to revisit our ideas about relations in and among Victorian science: we find elegiac echoes within the discourse of energy physics itself. And we discover that Victorian physics and biology may have enjoyed an affective relation quite counter to what we have come to expect.

A Brief Scientific Interlude: The Laws of Thermodynamics and the Paradox of *Heat*

The *affective relation* between physics and biology refers to the emotional weight attached to each as they come to permeate popular conversation. By the second half of the nineteenth century—significantly, in the wake of the publication of *In Memoriam*—evolutionary theory seemed relatively optimistic. Victorians invested the term *evolution* with the promise of progress (a promise, biologists insist, by no means inherent in the theory); it was taken to imply an onward and upward development—of individual, species, race, and nation—into increasingly perfect forms. So much so, in fact, that when evolution worked in what was considered a downward or regressive direction, the process was often given a different name: *devolution*. Thermodynamics, on the other hand, was widely experienced as the scientific basis for universal pessimism; it seemed to promise only decay, dissipation, degradation, and death. The second law in particular "seemed from the start to run counter to the optimistic 'progressivist' directions of most contemporary science, particularly evolution."[21] This affective opposition, moreover, found reinforcement in a professional one: William

Thomson and his followers were the most vocal scientific opponents of Darwinism. Indeed, Thomson himself remarked on the impossibility of Darwinian evolution within the universal time scales allowed by thermodynamic theory.[22]

In Memoriam, however, is not constrained by late-century expectations of thermodynamic pessimism. So I would suggest we try to revisit, as best we can, both the poem and the laws of thermodynamics without the pressure of late Victorian affect. The simple statement of these laws originally articulated by Rudolph Clausius in 1865 is one that we still use (the annotations, in italics, are mine):

1. The energy of the universe is constant. *The first law implies that energy can be neither created nor destroyed. In a closed system, though energy may change forms, the total energy is always conserved.*

2. The entropy of the universe tends towards a maximum. *"Entropy" is the term given to the measure of disorder in a system. The second law thus implies that in a closed system, energy always changes to increasingly less orderly, less usable forms.*[23]

The first law, the "conservation of energy," seems to promise that nothing can be lost. It operates in affective opposition to the second law, which in threatening the perpetual and irreversible increase of entropy, suggests that everything must be lost. Nonetheless, the combination suggests not only a tension, but also a careful balance, an elegant parallelism. Indeed, Clausius "intentionally formed the word *entropy* so as to be as similar as possible to the word *energy*."[24] Both laws, moreover, imply the necessity of closure; failing other modes of closure, the universe itself acts as the ultimate closed system. And both are implicitly, though centrally, concerned with change—the *dynamics* in *thermodynamics*. Indeed, identifying, articulating, and resolving the apparent contradiction between loss and conservation was nothing short of the work of integrating important but loosely connected observations into the science of energy physics (more on this later), but we may understand the physical resolution in simple terms as follows: Yes, energy is conserved. It can take many forms, including heat and mechanical work. But once it has been transformed into heat (more precisely, into heat at a uniform temperature), no work can be done with it. Thus energy is conserved, but it becomes unavailable for use.

Heat itself is a tricky term, which carries some of the tension we see between the two laws. In physics at least, this term generally represents energy in its least useful, most entropic or diffuse state. *Heat death* then refers to a state of things in which all energy has been, not lost, but transformed, albeit irrecoverably and uniformly, into heat. Of course, in popular parlance, heat death tends to be associated not with the excess, but with the loss of heat. Heat is its own opposite; its popular usage suggests usable energy, what scientists and engineers call *heat sources*, bodies at higher temperatures from which we can derive warmth or run steam engines. However, as we have seen, *heat* in technical parlance just as often signals energy in its least usable form; here the word evokes the heat sink, those "waste places" that form the repositories of energy past its usefulness.[25] Thus *heat* itself proves a "contradiction on the tongue"[26] that reproduces linguistically the tension between the first and second laws.

In short, while there is no fundamental physical contradiction (a resolution that required a good deal of negotiation) between the first and second laws, thermodynamics is laden with tension. And the interplay between conservation and dissipation structures a central tension within Tennyson's poem, as within Victorian thought more broadly. But where (except for certain diehard optimists) the second law came to dominate a Victorian mindset increasingly concerned with dissipation and degradation outside of, as in conversation with, popularizations of thermodynamics, Tennyson's willed optimism shaped itself according to a first-law sensibility that rendered the second law not merely palatable, but hopeful. *In Memoriam*, as I will argue, though driven by loss, is finally able to find consolation by subordinating loss to the larger concept of change, to hold loss and conservation in tension, to effect a careful balance between the two. In this way, the intellectual work done by *In Memoriam* parallels that done by the founders of thermodynamics. Both are the work of negotiating contradiction, of holding apparent oppositions in well-balanced tension, of shaping the whole in a way that people would not only accept, but even find consolingly consistent with certain widely held and cherished beliefs about how the world works. Section 1 (completed about 1834) lays out this consolatory program, suggesting—in terms that look uncannily thermodynamic—that the poem's work will be "to find in loss a gain to match," to soothe second-law anxieties through the promise of first-law compensation.

"Spring No More": Waste, Death, and the Second Law

William Thomson's 1862 announcement in *Macmillan's Magazine* of "the age of the sun's heat" triggered a widespread cultural anxiety that encompassed no less than the cooling of the world and the death of all things as the sun burned itself out. And while such an event may have been predicted "by poets and lunatics from time immemorial," the second law of thermodynamics brought new urgency and new form to this ancient fear. To a public just recovering from the fossil-induced anxiety of extinction that Tennyson articulates so nicely—"From scarpéd cliff and quarried stone/She [Nature] cries, 'A thousand types are gone' "[27]—the death of the sun seemed not just inevitable, but frightfully imminent. Depictions of the sun's death, newly energized by scientific authority, "pass[ed] rapidly into uncontrolled and mythologized form."[28] By way of illustration, we can look to a fiction that was particularly troubled by the sun's imminent demise. In H. G. Wells's *The Time Machine* (1894), the unnamed time traveler "watch[es] with a strange fascination the sun grow larger and duller in the westward sky, and the life of the old earth ebb away."[29] Wells captures the fear that William Thomson famously expresses, "that inhabitants of the earth cannot continue to enjoy the light and heat essential to their life, for many million years longer."[30]

Some time earlier, Tennyson also depicts a dying sun. "The stars," he writes, "blindly run;/A web is woven across the sky,/From out waste places comes a cry,/And murmurs from the dying sun."[31] Tennyson is evoking Laplace's Nebular Hypothesis, but his lines also strongly suggest the second law. Though Laplace's theory postulates a mechanism for solar origins (through the cooling and contraction of a cloud of gas or nebula that formed the sun and planets), Tennyson here focuses on its implications for endings. The death of the sun is linked to an anxiety about the blindness and cruelty of nature evident in the poem's evolutionary narrative, even as it evokes a broader cosmological concern through the image of waste space. The term *waste*, which has not yet given way, in physical theory, to *dissipation*, *disorder*, or especially *entropy*, also suggests a further Victorian anxiety that would attach to the second law. For added to the increasing conviction that the sun was limited as a power supply was the realization that most of the sun's energy would be wasted: how little of the sun's heat and light (late

Victorians calculated anxiously) would be intercepted for use on earth; how much would dissipate uselessly into space! One more thing: this moment is also an interesting (and traceable) example of this poem's contribution to scientific thought. In writing to Faraday about whether he can transfer his methods for modeling the behavior of electrical interactions to a model of gravitation, Maxwell formulates this possibility in words that are self-consciously evocative of Tennyson: "then your lines of force can 'weave a web across the sky.'"[32]

The general waning of power, moreover—suggested above by the transformation of a "cry" into mere "murmurs"—returns emphatically in a later image of heat death: "I dream'd there would be Spring no more./That Nature's ancient power was lost;/The streets were black with smoke and frost."[33] This moment exemplifies how Tennyson operates at the intersection of Romantic poetry and Victorian physical theory. The end of the universe as that which occurs in dreams echoes those lines from Byron's "Darkness" quoted earlier: "I had a dream. . . ." But in Tennyson, the ultimate loss of power, the end of heat and light, is that which occurs in nature, as well as in dreams. In this way, it is more like the scientifically driven fictions of H. G. Wells or of Camille Flammarion, author of the 1894 novel *Omega: The Last Days of the World*. The poem's concern with nature failing, at least implicitly scientific by this time, confirms the anxieties *In Memoriam* repeatedly expresses: Tennyson's "Nature" almost always evokes the anxieties wrought by science, most especially the threat of science to faith (as in "Are God and Nature then at strife?"[34]). And when *She* does finally give out (yes, Tennyson's "Nature" is quite explicitly female), it is specifically her "power" that is lost. This word choice is significant in contemporary as in Victorian physical theory; alongside *force*, *work*, and *energy*, *power* has a thermodynamic ring. Indeed, at this moment, *energy* has yet to take its central place in thermodynamic language. "Motive power" (*puissance motrice*), on the other hand, is the term Carnot, for one, uses in the 1824 essay that is so evocative for those who build on his work.

But as you've heard before, that's not all! It is not only Tennyson's use of language that places him squarely in conversation with emerging physical theory. His impulse to locate analogous phenomena at vastly different scales suggests how his poetic methods dovetail with those of his contemporaries in physics. The same concern with the loss of heat that here colors Tennyson's cosmos applies to the death of the individual and to the metaphorical death of day with nightfall. This mode of analogy is characteristic of thermodynamic discourse; physiologists were among the earliest advocates of energy theory, and by century's end, the depiction of the body as a thermodynamic system or of nightfall or an eclipse as a mini heat death will become familiar, if not commonplace.[35] Indeed, this mode of thinking is what—for one prominent Victorian physicist—distinguishes a physical theory, such as energetics, from an abstract science, such as Newtonian mechanics. Grounded in the observation of a wide range of phenomena, its principles must be "reduced to the form of a science"; in turn, this reduction is "the better the more extensive the range of phenomena whose laws it serves to deduce."[36] Eventually, Tennyson's friend, the physicist John Tyndall, will claim for thermodynamics a "wider grasp and more radical significance" than Darwinian evolution, which becomes merely one manifestation of the concept of energy.[37]

Tennyson too applies his principles to a wide range of systems. Personal death echoes cosmological death. Loss is tied to waste on the personal scale, for where space itself is figured as entropic—a "waste place"—so is the end that the poet anticipates for himself: "Somewhere in the waste," he says, "the shadow sits and waits for me." In the absence of faith in an afterlife, it would seem that "earth is darkness at the core/And dust and ashes all that is."[38] Waste and entropy seem fundamental and final. Or as two popularizers of the new science will soon put it: "The principle of degradation is at work throughout the universe. . . . As far as we are able to judge, the life of the universe will come to an end not less certainly, but only more slowly, than the life of him who pens these lines or of those who read them."[39] And repeatedly throughout *In Memoriam*, the speaker's own death is figured as the loss of heat, light, and even electricity. Thus he worries, "How dwarf'd a growth of cold and night,/How blanch'd with darkness must I grow!" and begs the spirit of his friend to "be near me when my light is low." And like so many things in thermodynamics, death itself transforms, manifesting itself even as the loss of electricity, a time when "this electric force, that keeps/A thousand pulses dancing, fail[s]."[40] Thus, Tennyson not only evokes the physiological imagination that animates Frankenstein's monster, but also links *electric* to *force*—a term relatively well defined under Newton, but very much in flux at this moment. Though a principle that finally cannot hold in the face of emerging physical evidence, the conservation of force (something Newton does not promise) is a key precursor to the first law; such uses of *force* illustrate how it functions as an early synonym of *energy*—though not the final word. Nor is *waste* the last word in Tennyson; "dust and ashes" are not "all that is." As I will argue, it is Tennyson's cognizance of what will become the first law of thermodynamics, in many ways rooted in Romanticism, that enables his famous consoling gesture on both the personal and the popular scales—for the loss of his friend as for the rift between God and Nature, science and faith, produced by evolutionary and geological concerns.

Meaningful Metaphor: The Progress of *Energy*

If it weren't for the particular transformations they undergo, light, heat, electricity, and certainly death, might leave us comfortably enough in the realm of poetic tradition. After all, even *energy*, the keystone term of thermodynamic language, carried metaphorical and social weight before the physicists took it up. Let's briefly track these sources—so to speak—of *energy*: "Physicists had already borrowed the language and authority of social prophets," and indeed had borrowed the idea that the concept of entropy built itself on the foundation of an ancient commonplace of decline, irreversibility, and disorder.[41] Energy concepts, moreover, suggest a connection between Romantic philosophy and Victorian natural science. Nineteenth-century positivism has been called the "true nineteenth-century successor to the romantics' efforts at totalization."[42] One historian traces in considerable detail the link between the "central tenet of Romantic philosophy that nature should be apprehended as a coherent and meaningful whole" and early nineteenth-century work to demonstrate the underlying unity of physical forces.[43] And another holds that the Romantic "doctrine of the essential unity of all forces in nature leads directly to the law of conservation of energy," further identifying the shift in thermodynamic affect from mid to late century: "The first law of thermodynamics (conservation of energy), inspired in part by the philosophy of romanticism, provided an organizing principle for the science of the realist period. Likewise the second law of thermodynamics (dissipation of energy), which arose from the technical analysis of steam engines, provided a *dis*organizing principle which turned out to be highly appropriate for the neoromantic period."[44] This important distinction is generally glossed over in literary treatments of thermodynamics—a shift from first- to second-law dominance, which correlates with the difference between early- and late-century depictions of cosmological burnout and the consolatory potential that, as I will argue, Tennyson is able to find in thermodynamic principles at mid century. And of course, Tennyson brings poetry into the fold.

It is, perhaps, not surprising that the desire for Romantic wholeness should run strong in a poet like Tennyson, seeking consolation for the loss of a friend and restoration of a shaken faith, or that he should resurrect Romantic uses of *energy* to achieve these ends. The concept of energy would have had particular appeal for Tennyson, because "the classical or pre-scientific energy concept . . . operated ambivalently between physical and spiritual registers."[45] And energy's specific potential for elegiac consolation can be traced to Romantic poetry. *In Memoriam* in many ways echoes Shelley's "Adonais"—a poem Tennyson particularly admires, though he later declares that "Shelley had no common sense."[46] Even more striking is the way Tennyson's closing "one God, one law, one element" evokes Coleridge's "Religious Musings": "one Mind, one omnipresent Mind,/Omnific."[47] As energy, after a long period of disrepute in science dating from Newton's *Principia*, "re-emerged . . . for reasons primarily metaphysical, and especially religious, rather than physical," Coleridge draws a connection between this one Mind and energy, "declar[ing] it to be 'Nature's essence, mind and energy!' subsequently confiding that 'tis God/Diffused through all, that doth make one whole."[48]

It is this religious character, resonant in Tennyson's "full-grown energies of heaven,"[49] that makes the Romantic use of energy attractive to Tennyson and that, at the same time, begins to mark the divergence between his deployment of energy and theirs. What distinguishes Tennyson's energy-in-elegy, placing him squarely in conversation with the emerging science of energy physics, are the place of faith and the place of figurative language in his poem as well as in the new science—especially in relation to knowledge of the physical world. Although Coleridge, "a Victorian doubter before his time," may well have appealed to Tennyson precisely because he too wrestled with the increasingly visible gap between the truths of science and those of religion,[50] "Coleridge realizes that to proclaim is not to prove, and that the *sine qua non* for a faith such as the one he wishes to articulate is an unquestioning belief in God strong enough to lay aside any nagging questions."[51] Tennyson, by contrast, begins with huge, nagging questions. And far from reacting against the certainty of science (as the Romantics were inclined to do), he will draw on science as he formulates a response to his explicit questioning of faith. Moreover, where Romantic energy is decidedly extraphysical (what would a physicist make of Blake's "Energy is Eternal Delight"?), *In Memoriam*'s energetics attempt to marry the physical to the spiritual, to imagine the "soul,/In all her motion one with law."[52] Similarly, where the Romantics make claims for separate, poetic knowledge—what one scholar calls "romanticism's . . . supreme privileging of the artist as prophet-deliverer of a moribund social order"[53]—Tennyson does not strive to dissociate his from other, especially scientific, ways of knowing. Though Tennyson resists any simple materialism, the knowledge he seeks is not knowledge of the extraphysical, but of the physical and extraphysical as ultimately inseparable.

This meeting of physical and spiritual correlates with the changing uses of figurative language in poetic as well as in scientific inquiry. Romantic uses of energy are subject to what the Victorian critic John Ruskin will later call the "pathetic fallacy"; indeed the term *energy* seemed to many "a covert attempt to humanize the object-world through a species of anthropomorphic projection."[54] Tennyson, on the other hand, while rejecting the poetic as a uniquely privileged means of knowing, nonetheless retains metaphorical, or analogical, thinking as a powerful tool for knowing the natural world. Similarly, though opponents of the new physics would continue to raise such objections to *energy*—opting, by the 1870s, for the term *force* to signal their belief that however useful, the concept is still merely a "logical fiction"[55]—analogy and metaphor were increasingly acceptable tools for thinking within science.[56] And even Joule, as early as 1847, was hardly troubled by the figurative baggage attached to the term "*vis viva*, or *living force*." That expression, he notes, "may be deemed by some inappropriate, inasmuch as there is no life, properly speaking, in question; but it is *useful*."[57]

The usefulness of energetic metaphor extends beyond what Joule suggests here, and several scholars have noted the connection between the structures of energetics and those of metaphor. The concept of entropy becomes a deeply embedded and widely used cultural metaphor.[58] It seems ready-made to do so because of the structure of energy transformation itself. After all, Rudolph Clausius—in coining the term *entropy* "after the Greek word 'transformation' . . . borrowing the root of the term 'trope'—the linguistic torsion that produces nonliteral uses"—suggests a continuity between the metamorphic capacity of language and that of matter itself. "In the name of [entropy,] energic and linguistic transformation became metaphors for each other."[59] Transformation—refiguration—characterizes both poetic and scientific ways of knowing, because its structures inhere in the natural world that both seek to know. Tennyson's use of language thus proves not merely (as "pathetic fallacy") or exclusively (as "supreme privileging"), but meaningfully metaphorical, as a real way of coming to know the physical world, and indeed, as deeply apropos, in mirroring the physical world he at once describes and investigates.

"Power in Darkness": The Consolation of the First Law

The phenomenon-qua-metaphor that grounds Tennyson's investigation is heat. While images of heat loss dominate the early sections of the poem, Tennyson turns increasingly to the question of whether heat can also generate and be generated. As the poem progresses, heat figures increasingly as source, as that which can provide light or even life, that which generates and warms: "life is not as idle ore,/But iron dug from central gloom,/And heated hot with burning fears." Even in absence, heat figures as usable energy. The poem imagines the absent Hallam, for instance, sitting among his family "a central warmth diffusing bliss." Indeed, even allusions to light, life, and heat that are not realized figure rather strangely as something akin to what physicists will call potential energy: The "unborn faces [of Hallam's children] shine/Beside the never-lighted fire."[60] Thus Tennyson develops contrasting notions of heat sources and heat sinks (what Carnot calls "the source and . . . the refrigerator"[61]), notions that Tennyson, like a good physical theorist, can then apply to a broad range of phenomena. As he returns to Laplace's Nebular Hypothesis, he shifts his attention to its implications for beginnings. Replacing “I dreamed there would be spring no more” with “They say,/The solid earth whereon we tread/In tracts of fluent heat began,”[62] the poem now suggests the process through which (Laplace theorized) our sun and planets were formed. Looking at heat from both sides, Tennyson illustrates a central dilemma in the resolution of thermodynamic principles, even as he moves toward an increasingly optimistic vision of what those principles imply.

Similarly, much of Tennyson’s energetic language—especially the developing theme of light, which was previously marked by loss—attaches increasingly to the capacity to generate or change. For a time, darkness signals predominantly loss and lack as Tennyson worries about a time “when my light is low” and imagines himself “on the low dark verge of life.” The poem, however, becomes increasingly sure that the loss of light or electricity need not imply the loss of power. Darkness now evinces a power of its own: “And Power was with him in the night/Which makes the darkness and the light,/And dwells not in the light alone.” This development of faith out of doubt, a conventional feature of elegy, is described in distinctly thermodynamic terms. Clearly steeped in the spiritual concerns of Romantic energetics, this passage also suggests a physical revelation—that dark and light are both power, differently manifested. Conversely, where darkness may figure as source, light itself may figure as sink. Thus “‘Farewell! We *lose* ourselves in light.’”[63] Tennyson’s most complex thinking on light in its various manifestations, however, occurs in his 1849 Prologue: “Our little systems have their day;/They have their day and cease to be:/They are but broken lights of thee.” Resonating with the poem’s physical concerns (as in “star and system rolling past”[64]), “our little systems” suggests not only our belief systems,[65] but also our physical systems, our all-too-temporary bodies. In a move worthy of Einstein, these prove material manifestations of light itself. "Broken lights," moreover, implies at once disorder and transformation; in life or in death, our existence proves an entropic manifestation of divine light.

In terms increasingly distinct from Romantic elegy, death too figures as change—physical change—rather than loss: "I wage not any feud with Death/For changes wrought on form and face." Tennyson thus shifts from second-law anxiety to first-law hope, even as his thermodynamic language proliferates: *form*, *state*, *process*, *power*, and even *diffusion*. One of the many ways change is wrought, death is merely one part of an "eternal process moving on,/From state to state the spirit walks."[66] But change is not a sufficient—though it is a necessary—condition of conservation:

But thou art turn'd to something strange
    And I have lost the links that bound
    Thy changes; here upon the ground,
No more partaker of thy change.[67]

Change here clearly still implies loss. What, then, enables the shift from "I have lost the links" to the principle of conservation that eventually governs even the mechanics of friendship, such that "the all-assuming [all-destroying] months and years/Can take no part away from this"?[68] How is the second-law threat of an all-assuming entropic decay subordinated to the first-law promise that no part can be taken away?

As the poem reimagines death-as-change in a manner more consoling, it reconciles the problems wrought by this dissipative model by reconceiving these changes as "bound" within a larger system:

What are thou then? I cannot guess;
    But tho' I seem in star and flower
    To feel thee some diffusive power,
I do not therefore love thee less.[69]

The links are not lost; Hallam's "diffusive power" can still be felt. It is "bound" on the ground—in flower as well as in star—and is marked by a love that is not less. In this way, Tennyson even anticipates the notion of "bound energy" that refers to energy beyond our reach. (Like the enormous amount of heat energy within the world's oceans, "bound energy" is there, but we can't do any work with it. I will talk more about free and bound energy when I get to Dickens.)

Meanwhile, I want to point out once more how—when it comes to Romantic poetry—*In Memoriam* proves once again the-same-thing-only-different. Tennyson's phrasing above certainly retains traces of William Wordsworth's "Ode on Intimations of Immortality from Recollections of Early Childhood," but with important differences; Tennyson, it seems, *can* bring back "the splendour in the grass [and] glory in the flower"[70] through his distinctive deployment of the notion of diffusion. Though profoundly implicated in the development of the second law (a precursor to which may readily be found in Fourier's diffusion equation), diffusion nonetheless allows Tennyson to conceptualize transformation without loss. All he need do now is imagine a system that, though it may (as in Clausius) encompass the whole of the universe, is nonetheless closed. Where once "Nature's ancient power was lost," Hallam's is conserved, and Nature as well as Hallam persist in a threefold mixing with God:

My love involves the love before;
    My love is vaster passion now;
    Tho' mix'd with God and Nature thou,
I seem to love thee more and more.[71]

The critical shift from *waste* to *vast*ness—etymologically linked words sharing the Latin source *vastus*—marks a rethinking of the universe, not as waste space, but as a very large, closed system in which things are never actually lost, but merely diffused. In an 1876 address to the Royal Institution of Great Britain, the brilliant physicist James Clerk Maxwell would find a similarly consolatory metaphor, effecting a similar transition from waste to vastness, within his conception of the ether that fills all space: "The vast interplanetary and vast interstellar regions will no longer be regarded as waste places in the universe, which the creator has not seen fit to fill with the symbols of the manifold order of His kingdom. We shall find them to be already full of this wonderful medium; so full that no human power can remove it from the smallest portion of space, or produce the slightest flaw in its infinite continuity."[72] Tennyson's vastness goes even further, ultimately proving not only conservative, but also productive, as "star and system rolling past,/A soul shall draw from out the vast/And strike his being into bounds"[73]—a counterentropic development hardly conceivable in science until the advent of chaos theory.

The Consolation of Physics

Tennyson's development of thermodynamic concepts within and from a tradition of poetic elegy raises a complementary question: To what extent do we find elegiac traces in the development of physical theory? Indeed, there are striking analogies between the conceptual work done by Tennyson and that done by Victorian energy physicists. In addition to the prominent place of analogical reasoning in both, we can see the significant workings and reworkings of faith and faithlike convictions in the development of thermodynamic concepts among physicists—processes strongly reminiscent of the religious consolation for which *In Memoriam* is so well known. All of these reworkings, moreover, seem to circulate around the reconciliation of apparently contradictory uses of *heat*—a reconciliation effected by the reconception of loss (and generation) as transformation, and accompanied, as in Tennyson, by the restoration of faith.

Although the belief "that God [is] love indeed"[74] is not explicitly at issue in their scientific investigations, both Thomson and Joule repeatedly evoke a Creator, distinguished by the unique capacity to generate or annihilate matter. Joule's 1847 lecture, "On Matter, Living Force and Heat" (presented at St. Ann's Church Reading Room), is emphatic regarding the place of God in scientific reasoning: "We might reason, *a priori*, that such absolute destruction of living force cannot possibly take place, because it is 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."[75] Much of Thomson's language is less explicitly religious but undoubtedly faithlike in its structure. While he cannot say with Carnot (regarding his belief that any heat loss is precisely compensated for by an equivalent gain) that "this fact has never been doubted," he does observe that "the truth of this principle is considered as axiomatic by Carnot" and that in spite of doubts raised by Joule's work, "I shall refer to Carnot's fundamental principle . . . as if its truth were thoroughly established."[76] However, where Carnot's confidence rests on his contention that heat is a substance—called *caloric*—and therefore subject to conservation laws associated with matter, Thomson's belief has no such backing. By mid century, the caloric view of heat is well on the wane, and belief in the conservation of what would eventually be comprehended within energy—heat, force, *vis viva*—must be sustained as faith, indeed, as faith under siege by increasingly visible evidence in nature.

Embryonic thermodynamic theory went through a phase that one very influential philosopher and historian of science would call "resistance"—during which even its eventual proponents didn't know what to make of it and, in many ways, didn't much like it. Thomas Kuhn identified such resistance as characteristic of periods that precede what he called "scientific revolutions." Contemporary historians of science would frame the phenomenon rather differently—saying, perhaps, that the fact of entropy had not yet been given "the contours that [would] provide assent."[77] Some scholars might borrow an analogy from psychology, suggesting that both Thomson and Joule seemed to go through a kind of denial stage before they were ready to move to acceptance. Thomson, it seems, wanted to adopt what he took to be Carnot's view of the conservation of heat, but the contradictory implications of Joule's work surface irrepressibly. Thomson included Joule's view first as a footnote: "This opinion seems to be nearly universally held by those who have written on the subject. A contrary opinion however has been advocated by Mr Joule of Manchester."[78] A similar observation, promoted from the footnotes to the main body of the text, appeared the following year in his "Account of Carnot's Theory": "The extremely important discoveries recently made by Mr Joule of Manchester, that heat is evolved in every part of a closed electric conductor, moving in the neighbourhood of a magnet, and that heat is *generated* by the friction of fluids in motion, seem to overturn the opinion that heat cannot be generated."[79] Significantly, however, the most troubling—and the most provocative—part of this discussion was again relegated to the margins:

When "thermal agency" is thus *spent* in conducting heat through a solid, what becomes of the mechanical effect which it might produce? Nothing can be *lost* in the operations of nature—no energy can be *destroyed*. What effect then is produced in place of the mechanical effect which is lost? A perfect theory of heat imperatively demands an answer to this question; yet no answer can be given in the present state of science.[80]

Why footnote such an elegant assertion of the conservation of energy—and such a clear imperative for the goals of energy physics? For one thing, it had become increasingly clear that this was a reassertion of faith, rather than an assertion of well-substantiated scientific principles. Even the assertion that "no energy can be destroyed" is deceptively simple—and deceptively assured—since it was not clear what energy comprehends. That Thomson still sought a "perfect theory of heat" suggests that the relation between heat and energy was as yet unsettled. And of course, this moment was emphatically about the absence of answers. It is noteworthy that though generation and loss threaten the principle of conservation in logically equivalent ways, this latter moment was marked at once by greater anxiety and by the dominance of the language of loss.

No one, it seems, wanted to be responsible for loss. Even Joule—whose researches pointed Thomson so inexorably toward loss—dissociated himself from this position. Indeed, Joule interpreted Carnot rather differently than Thomson did, for he worried that Carnot implied too much loss:

I conceive that this theory, however ingenious, is opposed to the recognized principles of philosophy, because it leads to the conclusion that *vis viva* may be destroyed by an improper disposition of the apparatus. . . . Believing that the power to destroy belongs to the Creator alone, I entirely coincide with Roget and Faraday in the opinion that any theory which, when carried out, demands the annihilation of force, is necessarily erroneous.[81]

That Joule's objection was to the loss of *vis viva* (living force, or kinetic energy), whereas Thomson's was to the loss of mechanical effect or, alternately, to the generation of heat, suggests the definitional challenges central to the consolidation of energy physics, especially the shifting uses of *heat*.

For Joule, it was precisely heat that resolved the threat to conservation. In Joule, as in Tennyson, heat made it possible to reconceive loss as transformation: "Wherever living force is *apparently* destroyed, an equivalent is produced which in process of time may be reconverted into living force. This equivalent is *heat*." Thus reconciled, Joule expressed a faith fully in keeping with the workings of the physical world: "We find a vast variety of phenomena connected with the conversion of living force and heat into one another, which speak in language which cannot be misunderstood of the wisdom and beneficence of the Great Architect of nature."[82] As Joule evoked the metaphor of language, these interconversions became themselves the physical metaphor that attested to the goodness of God. As for Tennyson, "large elements [are] in order brought";[83] loss and disorder prove merely superficial, subordinated to the larger truth: "Thus it is that order is maintained in the universe—nothing is deranged, nothing ever lost, but the entire machinery, complicated as it is, works smoothly and harmoniously . . . everything may appear complicated . . . yet is the most perfect regularity preserved—the whole being governed by the sovereign will of God."[84]

Once Thomson had reconciled Carnot with Joule via the dynamical theory of heat (the theory that understood heat not as substance but as molecular motion), he too reconceived loss—here "waste"—as transformation. And as in Tennyson, this reconceptualization enabled the restoration of faith: "As it is most certain that Creative Power alone can either call into existence or annihilate mechanical energy, the 'waste' referred to cannot be annihilation, but must be some transformation of energy."[85] This assertion marks a moment of transition for Thomson, regarding the affective resonance of thermodynamics. For this clear statement of faith—now consistent with physical theory—is his opening to a surprisingly short but resonant piece marking the beginning of the end of his thermodynamic optimism: "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy."

Diffusing Ambivalence: Sexuality, Gender, and Evolution

This concept of *dissipation*—or its frequent synonym in physical discourse, *diffusion*—treated Tennyson rather more gently. As we have seen, the concept of diffusion enabled Tennyson to conceive of conservation in the face of apparent loss. The poet's capacity "to feel thee some diffusive power," moreover, suggests the usefulness of Tennyson's energetics for diffusing the explosive potential of his feelings for Hallam. For all that Tennyson may "seem to love [him] more and more," the poet's passion for Hallam, however vast, is not without ambivalence. Identifying the poem's "strategic equivocation," one scholar explores how *In Memoriam*'s "elegiac mode disciplines the desire it also enables," at once articulating and sublimating Tennyson's longing for Hallam.[86] Another locates the poem's homoerotics as what the Victorians (and Freud) considered a stage in the sexual evolution of the individual—an early phase that the individual was thought to leave behind on reaching (hetero)sexual maturity.[87] I would argue that the poet's capacity "to feel thee some diffusive power"—a capacity that speaks to the conservation of both energy and love—intersects with these important readings of the text's homoerotics. For this passage is both conservative and dissipative, not only thermodynamically, but also sexually. By diffusing the power of Hallam's attraction, thermodynamics consoles the poet for the loss of his friend, even as it disperses his uneasiness about the nature of his affection. Though not lost, Hallam's power is diffused; it is spread out and therefore less useful, more entropic. Similarly, the poet's passion may be "vaster," but it is certainly less usable. Providing a way for Hallam to survive pointedly disembodied, the mechanics of energy transformation allow the poet to insist that Hallam's attraction is eternal, even as he renders it lukewarm.

Nor is Hallam's the only disconcerting power diffused in this way. Ultimately, Tennyson will also diffuse the power of a fiercely feminized Mother Nature, who is not only "red in tooth and claw," but also ravenous and, though reproductive, distinctly unmotherly. It is no wonder, then, that in his early cosmology, Tennyson retroactively endows "Nature" with power, only in the moment that he imaginatively divests her of that power (recall "Nature's ancient power is lost"). But by the end of the poem, Tennyson manages to diffuse the power of this frightful female without the gloomy sacrifice of spring. When in his diffusion, Hallam becomes "mix'd with God and Nature," he enters an androgynous being already in progress. And this blending is marked by Tennyson's prethermodynamic studies, for, formerly "at strife," when God and Nature do meet, they do so "in light."[88]

Thus, the consolation of physics proves remarkably adaptable, and the principles of simultaneous conservation and dissipation that permeate Tennyson's personal consolation are reiterated in the poem's popular consolation. Conserving Hallam's love while diffusing the power of his attraction, and dissipating

Nature's frightful femininity through a mixing with God, Tennyson's thermodynamic solution—his answer to death and the second law—also heals the rift between science and faith wrought by science's depiction of a ruthless nature. And insofar as this picture of nature reinforces the poem's evolutionary angst, the consolation of thermodynamics enables Tennyson's reformulation of the implications of evolution as well. For if "literature is especially designated in a society . . . to express and shape affective meanings,"[89] *In Memoriam* forces us to revise our picture of an antagonistic relationship between Victorian thermodynamic and evolutionary narrative. A poem driven, at the outset, by a sense of overwhelming loss, *In Memoriam* will be able to produce a narrative of evolutionary progress only through the kind of willed optimism that attaches, as I have argued, to Tennyson's maintenance of a first-law sensibility. Such a narrative must derive from the same capacity to imagine conservation in the face of dissipation, transformation in the place of loss. *In Memoriam* manifests this capacity abundantly—even in its geological narrative. For while early in the poem, geology is marked by waste and decay as the speaker hears erosion in "the sound of streams that swift or slow/Draw down Aeonian hills and sow/The dust of continents to be,"[90] this geological image gives way to another:

The hills are shadows, and they flow
        From form to form, and nothing stands:
        They melt like mist, the solid lands,
Like clouds, they shape themselves and go.[91]

In this latter image, geology is marked by the dominance of change over loss. Hills no longer erode into dust; they flow from form to form, from a solid to a mist, perhaps, but still present, still shaping themselves, and like clouds, increasingly capable of transformation. The poem's ability to reshape anxieties of (here, geological) loss and dissipation into hopes of transformation and conservation, suggests the power of Tennyson's increasingly present first-law optimism, a discourse sufficiently powerful that it could not fail to inform the poem's evolutionary narrative as well.

As these two scientific subtexts become entangled, physics—counter to late-century expectations—offers a solution to the problems of waste wrought by biology, for in biology, too, the earlier parts of the poem imply no progress and much waste. Manifestly concerned with the careless waste of resources in the reproduction of species, the speaker fixes on the profligacy of Mother Nature and "find[s] that of fifty seeds, she often brings but one to bear."[92] But evolutionary biology, the poem suggests, is able to transform waste into progress because it grows up alongside of and in conversation with the notion of transformation central to the development of thermodynamics—especially its first law. *In Memoriam's* evolutionary thinking follows a pattern that is by now familiar as this early vision of waste is eventually replaced by a vision of progress, a vision wherein man—the species and the individual—"move[s] upward, working out the beast,/And let[s] the ape and tiger die."[93] We can then see in Tennysonian evolution—"evolution as transformation, maintaining identity but bringing about change"—the undertones of the first and second laws of thermodynamics. If "Tennyson's concept demanded transformation,"[94] the nascent principles of thermodynamics provided a mechanism for answering that demand, for finding transformation where the senses perceived loss and waste. Thus, the triumph at the end of the poem of a progressivist evolutionary narrative is identically the triumph of first-law optimism and the fantasy of transformation over second-law anxieties of inevitable loss.

These simultaneous triumphs merge with the renewal of faith and the reconciliation of science and religion on which the poem ends. Transformation explains apparent loss; religious, evolutionary, and thermodynamic optimism converge in the final lines of the poem: "One God, one law, one element,/And one far off divine event,/To which the whole creation moves." This passage marks, once more, Tennyson's debt to and divergence from his Romantic predecessors. Like and unlike Coleridge, Tennyson expresses a belief in divine unity, but one that has become—like Maxwell's "infinite continuity"—markedly scientific. Romantic wholeness has been reconciled with Victorian science. Undoubtedly the confirmation of faith that readers have always taken it to be, the "one far off divine event" is emphatically overdetermined. While it undoubtedly represents a union with God, this union is also figured as the culmination of upward evolutionary progress, a time when, having "moved through life of lower phase," we will evolve into a species "no longer half akin to brute," the "crowning race" for whom Hallam was the herald "appearing ere the times were ripe." But when read in light of the poem's thermodynamic concerns, God comes to look remarkably like a heat sink. No longer "somewhere in the waste" or even lost "in light," the poet decides "that friend of mine [now] lives *in* God."[95] Nature's power safely diffused, God alone remains, the repository of all energy that has passed irrecoverably to the other side.

"One law," moreover, reemphasizes the wish—characteristic of *In Memoriam* and thermodynamics alike—for the widespread application of physical principles. As first-law optimism pervades the poem's cosmology, "one far off divine event" (the flip side of "Spring no more") suggests a moment in which currently interconvertible elements—heat, electricity, work, light, and life—merge as one divine undifferentiated element. A very optimistic take on heat death! Tennyson, then, closes the system, as he closes the poem—both vast enough to encompass what once seemed lost—even as he expresses religious and scientific hope for universal applicability. For the monotheistic mission of "one God, one law, one element" suggests a scientific aspiration as well: the desire, attached to the discovery of energy transformation, that we will discover a single law that governs all natural processes—a grand unified theory for the nineteenth century, a hope that nineteenth-century energy physics will hold close to the heart.