

One Culture

Science and Literature

A series edited by George Levine

Essays in Science and Literature

Edited by George Levine
With the assistance of Alan Rauch

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selecting these texts, I have not attempted to offer a comprehensive history of any of the fields considered or even to include their most influential writers. Each discipline has its canonical texts, but my goal has been to illustrate the relationships between scientific and literary writing. While this anthology excludes some well-known figures, it offers readers an opportunity to discover some lesser-known writers whose work reveals the passage of ideas between science and fiction.

Because of the great diversity of nineteenth-century scientific issues, I have focused on British and American fiction writers and the scientists with whom they exchanged ideas. Since many nineteenth-century writers read French, German, and Italian, some of the scientific texts in those languages included here were not translated until the twentieth century. Wherever possible, I have used nineteenth-century translations so that today's readers can confront the same texts that nineteenth-century readers would have encountered.

This anthology aims to reveal dialogues and confluences, leaving it to readers to characterize and define them. None of these short selections can do justice to the writers' complex bodies of work, but I hope that they will invite readers to explore nineteenth-century literature and science in greater depth, leading to new discoveries about the affinities and distinctions of science and fiction.

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Future volumes will approach such questions from many different directions. We expect to publish studies not only of such philosophical and theoretical questions as those suggested above but of historical developments in the mutual relations of science and literature. The series will also include, among other things, analyses of the work of particular scientists and writers, feminist reconsiderations of the status of scientific discourse and its relation to women writers and scientists, and rhetorical studies of the language of professional science. Studies of literature *and* science, moreover, entail contextual cultural studies, and in certain respects the series may sometimes take on the look of an even more ambitious project: no less than a reconsideration of the relations between science and culture as a whole. This first volume is also intended to point in that direction.

The subject is enormous, its importance inescapable. Vague as the enterprise may occasionally seem when viewed in the abstract, its significances are clear when we get down to cases, as the authors of the several essays in this volume do. The range of questions they address intimates the ambitions of the series.

There are a great many people, aside from the authors of the particular essays, involved in the production of this volume. I want to thank them here. The most important is Alan Rauch, whose work on every aspect of the volume, from the most minute detail to its largest conception, has been a condition of its existence at all. Officially, he has been my "assistant" on the project. In fact, he has been my co-editor.

Patricia O'Hara has helped in research and editing through the later stages of the volume, and I am very grateful for her efficiency, intelligence, and warmth of friendship. Peter Givler, now of Ohio State University Press, was the first to discuss this project with me and to help get it off the ground. Rutgers University has provided important resources of space and supplies to allow the editorial work to proceed smoothly. My thanks also to Barbara Hanrahan, of the Press, who is always a pleasure to work with.

Part I

Introduction

G E O R G E L E V I N E

One Culture: Science and Literature

"One Culture": the title seems to make a promise that this book will not keep. It obviously echoes Snow's "two cultures," by now a not very helpful cliché, and promises a unity we will not find. Snow's analysis was inadequate in ways that more critics than F. R. Leavis have noted. The simple divergence between those who can gossip about literature and those who can gossip about science is not particularly interesting, nor does it matter very much that "literary" people can't tell us what the second law of thermodynamics is (a surprising number in fact certainly could, as I believe this book will testify). Nor does it matter that—alas!—some scientists haven't read any Shakespeare. These are not the terms of a serious debate.¹

This book is concerned not to reopen that old debate but to attempt to consider ways in which literature and science might indeed be embraced in the same discourse, ways in which they have been so embraced. I indulge the easy allusion to a well-known cultural war because Snow's formulation, which has caught on, implies a distinction that needs to be denied. Obviously, there are important distinctions between scientific and literary language, and obviously too the intricate specialization of the various sciences closes them to the lay public; but so, too, do the increasingly arcane operations of literary criticism. The distinction is one of degree, not of kind: science is no more exempt from the constraints of nonspecialist culture than literature is; nor has it ever been.

On the whole, this book adopts the position, endorsed by the main directions of contemporary criticism (yet still not unproblematic), that literature and science, whatever else they may be, are modes of discourse, neither of which is privileged except by the conventions of the cultures in which they are embedded. It offers, through a series of

various but, I believe, compatible essays, perspectives on the two modes that suggest that they can and should be studied as deriving from common cultural sources.

The "one culture" is not a unified science and literature. Indeed, one of the points that most needs elaboration—and that the opening essays of this volume explore—is the *nature* of the differences between literary and scientific language, and the implication of those differences for our sense of the two enterprises. With the transformation of science into "discourse," it has become increasingly difficult to define precisely what science is, as opposed to, say, literature. Both, as Thomas Kuhn has argued, are governed by at least ostensibly rational processes; and the distinction between the two cannot be sustained by "application of the classic dichotomies between, for example, the world of value and the world of fact, the subjective and the objective, or the intuitive and the inductive."² The problem, says Kuhn, without attempting to resolve it, is in the way we define the question, for while only subtle analysis causes us to lose the sense of distinction between artist and scientist, the "casual observer has no such difficulties" (p. 41).

Here I take up the position of the casual observer. Many of the essays in this volume will in fact be discussing points of convergence, but they do so in part because of a strong intuitive sense that the discourses and their products are very different. We need not so much worry the issue of whether there are differences between scientist and artist, or critic—of course there are; but it is worth attempting to understand those differences and perhaps discover ways that the enterprises can be seen as mutual. Where the discourses converge, it is important to consider precisely how they do, why they do, whether the convergence is fortuitous, whether it can lead to important illuminations, to something like real dialogue, to genuine "influence." The contributors to this volume, while agreeing that literature and science can fruitfully be studied as parts of the same cultural field, are concerned, that is to say, not so much with arguing the importance of establishing serious relations between science and literature, as with studying the nature of the relations that have always existed, and the usefulness of understanding them.

The test of the usefulness of this volume's various essays into convergence will, necessarily, be in the particularities of the arguments.

Throwing around comfortably such overwhelmingly complicated words as "science," "literature," "culture" might well indicate a radical failure to appreciate the multiplicity of meanings these words imply. To say that literature and science are products of the same culture is to say little until all three key terms are understood particularly. I have thus far, for instance, been talking about "literature" as though it meant only what we casually describe as "creative" writing. Putting aside the problem, so provocatively exploited by Terry Eagleton in his *Literary Theory*, that we have no adequate definition for "literature,"³ it probably makes sense to think of science as being on an analogy more with criticism than with "literature." That is, as science attempts to understand nature, so criticism attempts to understand literature. Science and criticism are methods of investigation; nature and literature are the objects.⁴ This is a little too easy also, although it points at a distinction that needs considerably more exploration and, I hope, will receive it in later volumes in this series. Certainly, one of the important historical developments in the past century has been the attempt—or, I should say, attempts—to give to criticism some of the authority of science, to see it as a mode of knowledge, incremental, verifiable, systematic. This hasn't worked, nor do I believe it can; and, ironically, it has happened at the same time that history, philosophy, and literary criticism itself have been converging to call into question the rationality, verifiability, and systematic nature of science.⁵

At the outset of these investigations, then, I concede that the questions are too big to evoke more than exploratory answers, localized investigations of aspects of the problems that might help toward larger answers later on. But for me and for the contributors to this volume, the subject of "science and literature" is a major one. It matters because the conjunction of the two sometimes radically separated worlds of discourse helps illuminate each, helps demystify each as they sit apart under cloaks of unmerited authority—objective or subjective. And it forces us to address issues of ultimate importance to the way our culture and our societies are currently shaping themselves.

It is one culture, then, in two senses: first, in that what happens in science matters inevitably to what happens everywhere else, literature included; and second, in that it is possible and fruitful to understand how literature and science are mutually shaped by their participation in

the culture at large—in the intellectual, moral, aesthetic, social, economic, and political communities which both generate and take their shape from them.

I

The formula "science and literature," which governs this series, announces, through the "and," a difference; the innocuous copula becomes yet more problematic than the difficult major terms. "And" implies relationship, of course, but (para)tactically refuses to define it. The "and" also intimates the oddity of the relationship: what can the two have to do with each other? It implies, moreover, that in spite of the conventions of literary hostility to science, and of scientific indifference to literature, the relationship matters.

"And" cloaks many different sorts of relationships. If we think of "influence" in this connection, we normally think of science influencing literature, and we have plenty of studies, for example, of the way Shelley used scientific thought, of how Tennyson's *In Memoriam* reflects the geological work of Lyell, or of how the idea of entropy informs literature from Hardy to Pynchon's *Crying of Lot 49*. But the influence works the other way, too, as strong developments in externalist history of science have been demonstrating, and as Gillian Beer has shown with Darwin, as Gerald Holton has shown with Niels Bohr.⁶ In a recent essay, Greg Myers describes not only how the rhetoric of science informed the prose of the great Victorian sages, but how the central social, religious, and cultural attitudes of their time informed the scientific thought of John Tyndall and James Clerk Maxwell, among many others.⁷ Again, Alfred North Whitehead, describing his experience when he heard that measurement of an eclipse had confirmed Einstein's prediction that rays of light are bent as they pass in the neighborhood of the sun, sees himself and his fellow scientists as like a Greek chorus, "commenting on the decree of destiny as disclosed in the development of a supreme incident." The remorseless inevitability of Greek drama, he says, pervades science, and the Greeks' "magnificent expression . . . deepened the stream of thought" from which grew "the concept of remorseless inevitability which we find in Newtonian theory."⁸

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Similarly, as he traces the foundations of science in the West, Whitehead finds that the development of "Naturalism" in art—the rise of interest in natural objects and in natural occurrences, for their own sakes (p. 16)—was a critical condition for the rise of science. And even the procedures of scholastic philosophy helped contribute to the development of a climate of opinion that encouraged scientific thought. The medieval habit of thinking that "every detailed occurrence can be correlated with its antecedents in a perfectly definite manner, exemplifying general principles," is, of course, closely parallel to the scientist's concern to read each fact into a general order of things (p. 13).

In a way that impressively anticipated recent developments in the history of science, Whitehead, in 1925, against the current of positivist movements to establish the timeless and cultureless authority of scientific knowledge, was already implicating science in the whole matrix of culture—including not only philosophy and literature, but law, art, religion, commerce. While his book has achieved the status of a classic, its implications have still not been fully explored, and the particular philosophy which it ultimately espoused may have helped divert attention from the centrality of its preoccupation with the relations of science to culture. Thus, the "and" can imply yet a third sort of relationship—kinship: science and literature reflect each other because they draw mutually on one culture, from the same sources, and they work out in different languages the same project.⁹

There are, of course, many more questions. Is there some connection between the technical language of professional scientific discourse and the rhetorical and metaphorical manipulations of fiction and poetry? Why is the language of literary criticism these days so full of allusions to science, or at least to discussions of science by historians and philosophers? Are the discontinuities so characteristic of modern literature in any way connected with the discontinuities that contemporary physics, for example, may be discovering in the physical world? Is the science we do find "in" literature—in its themes, its language, its structures—genuinely representative of what is going on in science, or a lay distortion, deliberate or otherwise? Does the difference matter for literature? Does "objective" science in any way learn from nonscientific discourses? Is it reasonable to suggest that science, like literature, is subject to the assumptions, ideologies, prejudices current in the societies from

which it grows? If so, how precisely do these manifest themselves? Can the tools of literary analysis, the strategies of literary theory, be usefully employed on scientific discourse? For whose use—the scientists? or the writers? or the critics?

The questions proliferate around the "and." This book obviously leans toward certain kinds of answers—ones that affirm the validity of literary analysis of science, that affirm the crossing of "influences," the blurring of boundaries between discourses; but it does so by addressing discrete problems. The writers of these essays were all independently undertaking projects related to these questions. In the course of their writing they became aware of one another's work and even ventured occasional critiques of it. Clearly, they did not begin working out of a unified vision, but the direction of their work is impressively parallel. All point toward tightening the connections implicit in "and." The margins between literature and science have been blurring, as Michel Serres has suggested, but for a very long time their relations have been closer than most of us are used to thinking.

Literature has been unable to avoid science because science asserts an epistemological authority so powerful that it can determine even how we allow ourselves to imagine the world, or to resist that authority. The authority of objectivity and disinterest, confirmed by the evidence of our senses and by technological developments that touch every part of our lives, demands our respect, answers to values central to our culture certainly since Descartes and Bacon. The long and well-publicized history of hostility to science in the West—particularly on the part of the literary world—reflects the power of the antagonist. Like it or not, we cannot ignore science. It percolates through our imaginations even if we don't know much about it. Our sense of the constitution of matter may be no more up to date than our high school science, our understanding of DNA shadowy, but our vocabularies are thick with the languages of science. Most of what we say has lost its scientific connotations. "Gravity" is no longer Newtonian. "relativity" Einsteinian, or "atomic" Daltonian. DNA gets into all the crossword puzzles. We accept unreflectingly the miracles of science of only a few years ago. Many of us can invoke some technical terms, like "plate tectonics," when we worry about moving to the West Coast.

Science is our new mythology, still close enough to feel like reality

rather than a story, yet distant enough to keep us unaware that it is constantly working on our sense of what is possible. It provides the images and language through which we know the material world, and it even shapes (often by indirection) our sense of what it means to be human. What we find credible or kooky depends in large measure on how far we have accepted the (at least ostensible) terms of scientific argument. And it is difficult not to believe that real problems in medicine or manufacture, in space travel or treatment of the common cold, will be solved eventually by careful men (and a few women) in white coats who patiently analyze, observe, experiment, find out. Every particular can be understood within some large general classification, every event is ultimately comprehensible, if we want to bother.

Science, of course, is not the exclusive, or in many cases even the primary, shaper of our imagination of the "real"; but its importance is inescapable, and our understanding of modern narrative and literature in general requires at least some conception of the connections between the assumptions writers make about continuity or discontinuity, causal movement, open-endedness, indeterminacy, what happens next, the ultimate constitution of things (and therefore what questions to ask about them), and the way contemporary science deals with similar problems.

In any case, Frankenstein's monster—perhaps the great popular metaphor of the hostility between science and literature—has been created and, as remake after remake testifies, will not die. He (or it) is implicit in Bacon's pronouncement that "the true and lawful goal of the sciences is none other than this: that human life be endowed with new discoveries and powers."¹⁰

The engagement of literature with science long preceded Mary Shelley (whose *Frankenstein* is, of course, far more complicated about the relation of science to literature and society than the popular adaptations imply). Since at least the seventeenth century, the peculiar authority of science has made it an intrinsic part of general culture, even when in its specialism it grew beyond the reach of popular understanding. Bacon's essays have become part of the common sense of the West:

One method of delivery alone remains to us; which is simply this: we must lead men to the particulars themselves, and their series and order;

while men on their side must force themselves for awhile to lay their notions by and begin to familiarise themselves with facts. (p. 53)

Ironically, literature itself, a mere construction of language, celebrates Bacon's liberation from words into facts. So Cowley's "Ode to the Royal Society" honors Bacon:

From words, which are but pictures of the thought
(Though we our thoughts from them perversely drew),
To things, the mind's right object, he it brought.

The rejection of inherited authority, the turn to facts, the wariness of the idols that distort knowledge—these are all deeply engrained conventions of Western thought, as is the parallel metaphysical leap away from metaphysics in Descartes's *cogito*. The poet will often agree that things, not words, are the mind's right object, and literature long remained in such a characteristically self-deprecating relation to these conventions. It has not been able to ignore them.

"Science," says Whitehead, "has practically recoloured our mentality so that modes of thought which in former times were exceptions are now broadly spread through the educated world." He is talking here about the slow vast sweep of science through the consciousness of the West from the sixteenth century to the present, and he means in particular the new Baconian preoccupation with "fact": "a vehement and passionate interest in the relation of general principles to irreducible and stubborn facts" (p. 2). That preoccupation, as the Cowley ode makes clear, is an aspect of a deep resistance to traditional authority, to the tyranny of words, and what at any moment the words might deceitfully disguise. The shift is from language to experience: words matter only as they correspond to fact. To draw thoughts from them otherwise is "perverse." It is not, however, only the commitment to "fact" and the ordering principles for fact that distinguishes the impact of science on the cultural consciousness or on literature. The "coloring" Whitehead talks about tinges everything from our conception of matter to our conception of self. We are easy (if hopelessly imprecise) when "atoms" and "ego" color our vocabulary. As G. H. Lewes argued a century ago (but with a happy optimism about where this would take us), "Science is penetrating everywhere."¹¹

But relations between humanists and scientists were not always so

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happy. Science established itself professionally in England in part by rejecting literature—at least those excesses of literature that seemed to the Royal Society to corrupt thought. So the even-tempered Sprat, in his *History of the Royal Society*, notoriously loses his temper when talking about rhetoric:

And, in few words, I dare say: that of all the Studies of men, nothing may be sooner obtain'd, than this vicious abundance of *Phrase*, this trick of *Metaphor*, this volubility of *Tongue*, which make so great a noise in the World. But I spend words in vain; for the evil is now so inveterate, that it is hard to know whom to *blame*, or where to begin to *reform*. We all value one another so much, upon this beautiful deceit; and labour so long after it, in the years of our education: that we cannot but ever after think kinder of it, than it deserves. And indeed, in most other parts of Learning, I look on it to be a thing almost utterly desperate in its cure: and I think it may be plac'd amongst those *general mischiefs*; such as the *dissention* of Christian Princes, the *want of practice* in Religion, and the like.¹²

Rhetorical excess does not, of course, equal literature: but the insistence on things, the unease with mere ornament or rhetoric, suggest an almost Puritan distrust of literary discourse that seems to make truth claims, for it impedes the severe, disciplined, and patient study of nature requisite for natural philosophy.

Objections to science in literature tend to vary, although I believe they derive from similar reservations. Swift's Laputans are evidence of the total impracticability of scientific knowledge. Leavis' attack on Snow entailed a rejection of the exclusively material orientation of science. The Faust myths, in all their varieties, from Dr. Faustus to Godzilla, imply the dangers of unrestricted pursuit of knowledge. But what all attacks have in common is a deeply uncomfortable sense that science fails to keep touch with the full richness and particularity of human experience. It reduces, abstracts, works impersonally. Its knowledge, whether practical or not, does not address itself to moral or aesthetic issues.

The divergence of scientific and literary discourse remains critically important because of the question of authority. Descartes reached back beyond all inherited cultural assumptions and built knowledge from its base in the perceiving self; and upon that base secular culture ultimately established an authority perhaps even more potent than that of the

religious authority it displaced. Western science is constructed on a denial: "The improver of natural knowledge," said T. H. Huxley, the late-Victorian spokesman for the authority of science, "absolutely refuses to acknowledge authority, as such."¹³ But Huxley was ready to extend the authority of science to all knowledge and thus—as Bernard Lightman has implied in an essay on "Pope Huxley"¹⁴—incorporate into science the structure (if not the content) of what it was displacing.

It achieves its authority by standing outside of human interest. Objectivity is a nonhuman condition. And it is not merely a sentimental humanism that has had difficulty with the idea of objectivity. How can we, as Bacon required, "lay our notions by?" The great authority science has achieved derives largely, I believe, from the way it persuades us that its practitioners are disinterested. Such a condition was one of the great aspirations of perhaps the most famous English antagonist to the displacement of humanist by scientific education—Matthew Arnold. Being able to believe by virtue of the sheer power of fact and reason is the ideal condition, and ironically enough it looked as though science, not literature, had attained it. Once achieve disinterest, and objectivity would follow. Reality would come rushing in, unprompted by the distortions of politics, economics, or any ideology.¹⁵ But much of modern thought has been preoccupied with the impossibility of achieving that disinterest, and only science has, until recently, seemed at all available for exemption.

Thus, we have become used to thinking (or at least feeling) that science tells the truth. On the other hand, much of the history of criticism in the twentieth century has been concerned to ask what it is—since it's certainly not "truth," the province of science—that literature tells.¹⁶ For obvious reasons, then, science felt no corresponding need to attend to literature, and when scientists do so it is rather more for diversion than for illumination. So it is almost with glee that literary critics discover that serious people are wondering in public what it is that science actually tells. And with a sophistication and complexity that too often attempt to emulate science itself, literature is settling for the view that it tells nothing but literature. The great wave of skepticism that, over the course of three centuries, was establishing the scientific method as the only means to truth, and science as its only voice, has been spreading to science itself. Literature, in this regard, has had

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nothing to lose since even its own practitioners had early developed the Puritan habit of thinking of it as lying or—in better modern dress—myth. Now it turns out that literature is a discourse that simply makes no truth claims. What if it also turned out that all-powerful science, whose clarity and precision and practical results had been demonstrating its epistemological superiority to all other modes of investigation and discourse, was itself only an elaborate myth? What if scientists worked by intuition rather than by the hypothetico-deductive method? What if induction were an *ex post facto* explanation that rationalized irrational intellectual leaps? What if important scientific discoveries were often made because the scientist *wanted* something to be true rather than because he or she had evidence to prove it true? What if "verification" or, in Popper's terms, the possibility of falsification did not, finally, distinguish the scientific project? What if much important scientific work could never be verified?¹⁷ What if falsification did not finally determine whether a scientific statement were to be accepted?

Philosophers of science, in different ways that have led to some acerbic battles,¹⁸ have been arguing for each of these possibilities. Whatever the details of the battles, Thomas Kuhn's enormously influential theory of scientific revolutions seemed to speak directly to the needs and interests of the literary-critical community and was fairly quickly absorbed into its discourse. "Paradigm," in a Kuhnian sense, or in literary versions of a Kuhnian sense, is part of the critical vocabulary. Despite some grouchy realist dissenters¹⁹ who insist on the possibility of representation and on a correspondence theory of truth, we are in the midst of a pervasive assault on all foundationalist positions, and as one consequence literary people are increasingly taking the risk of contending with scientific texts as if they were literature and are turning with interest to historians of science whose study of their subject is "externalist," rather than "internalist." How much of the history of science can be accounted for in terms of a consistent development of the ideas pertaining directly to the subject? How "rational" are the arguments for, say, natural selection or quantum theory? And how much depends upon social, political, and economic factors—on the pervasive ideology of the scientist's culture? Different as they are, deconstructionist and reader-response theories of literature (combined as they can be with Marxist and Freudian or Lacanian interpretation), Kuhnian theories of

the history and philosophy of science, developments in the sociology of science, philosophical hermeneutics—all of these seem to be participating in the same disruption (now we can call it "demystification") of the commonsense notions (often condemned as "positivist") according to which scientific propositions, or indeed any propositions, carry their authority.

Before considering further the consequences of this skepticism, it would be useful briefly to lay out its terms a bit more precisely, if only because literary critics, in their pleasure at the disruption of the concept of traditional objectivity, often play fast and unphilosophically loose with very complex ideas. The contention prevalent in the philosophical community over Kuhn's idea of paradigms occasions embarrassment when one sees how easily the idea of paradigms has been taken over by literary critics. (This volume itself may be occasionally vulnerable to such criticism.) A recent commentator puts it this way:

It has become fashionable for humanists and social scientists to talk about science as just another "mode of discourse," propelled by its rhetoric and by the social organization of its practitioners, being, ultimately, a nonreferential, constructed reality comparable to the arts. This view belittles science's ability to manipulate nature and asserts that science is defined by its unique authority relation, i.e., by the fact that scientific statements must be certified by the "discourse community" that has assumed the guardianship of science.²⁰

Clearly, the rejoicing at our liberation from the authority of science is misguided as long as it fails to confront our commonsense perception of the power of science to manipulate reality (just as, from Kuhn's point of view, it is absurd to identify scientific with artistic activity because of theoretical parallels that do not take into account the commonsense perception of their difference).

Partly for this reason, "scientific realism" remains alive. However theoretically exciting the antifoundationalist position is, most scientists and some philosophers of science are still committed to the notion that scientific statements are "true," or, at least, that science aspires to a true description of the world. "Like the Equal Rights Movement," writes one such philosopher, "scientific realism is a majority position whose advocates are so divided as to appear a minority."²¹ The divisions among the realists are, from my point of view, reflections as much of the

problems "realism" has in explaining the historical phenomenon of science, as of the epistemological difficulties of the position. Any realist account would itself have to take into account the approximate nature of so much once-confident scientific fact, the unsystematic way in which evidence is gathered and used, the erratic and possibly not progressive movement of science, the unverifiability of the existential reality affirmed by scientific claims, the possibility of the predictive success and theoretical error of any given theory, the fact that much of what science claims is true is not observable, and so on. The sheer common sense that leads one to believe that if a theory is empirically adequate, it must be true, helps sustain realism; and considerable very important work has gone into contemporary defenses of realism. Nevertheless, as Bas van Fraassen, perhaps now the most influential of the younger philosophers of science, has put it, "acceptance is not belief":²² one may, that is to say, accept the empirical adequacy of a scientific theory without believing that the theory describes accurately the physical world. "As far as the enterprise of science is concerned," says van Fraassen, "belief in the truth of its theories is supererogatory." In scientific practice, of course, it is likely that most scientists will work with an unconscious confidence that they are in the business of describing the real. Philosophers and literary critics, for many reasons, including pleasure in the deflation of scientific authority, are pleased to think that they are not. But in fact, van Fraassen's full argument does not at all endorse the kinds of relativistic free-for-alls often engaged in by literary critics as a consequence of liberation from foundationalism. Philosophers of science, if they are to honor their subject, must account for the procedures by which, at least, empirical adequacy is determined.

In any case, what philosophers of science—even scientific realists—have been ready to junk for a long time (and in this, of course, they belong to the same movement that has been dominating critical theory for ten or twenty years) is the convention of naive realism. Mary Hesse lays out the assumptions that underlay traditional conceptions of science:

There is an external world which can in principle be exhaustively described in scientific language. The scientist, as both observer and language-user, can capture the external facts of the world in propositions that are true if they correspond to the facts and false if they do not.

Science is ideally a linguistic system in which true propositions are in one-to-one relation to facts, including facts that are not directly observed because they involve hidden entities or properties, or past events or far distant events. These hidden events are described in theories, and theories can be inferred from observation, that is, the hidden explanatory mechanism of the world can be discovered from what is open to observation. Man as scientist is regarded as standing apart from the world and able to experiment and theorize about it objectively and dispassionately.²¹

The powerful counterthrusts to these philosophical assumptions range from science fiction films, with their radical distrust of intellectual activity not directly aimed at human improvement, to contemporary philosophy and theory, insisting on disruption, discontinuity, indeterminacy, and the destructive narrowness of Western scientific activity and the epistemologies that underlie it. The counterthrusts have their ideological purposes. In particular, they seem to be designed to bring to wider awareness the nature and power of the quasipositivist assumptions that govern most (at least official) thinking and that authorize the social and economic direction of our culture.

The antirealist argument reverses almost all of the assumptions Hesse describes, and it will probably be most efficient to quote her summary of these, as well:

1. In natural science data are not detachable from theory, for what count as data are determined in the light of some theoretical interpretation, and the facts themselves have to be reconstructed in the light of interpretation.
2. In natural science theories are not models externally compared to nature in a hypothetico-deductive schema, they are the way the facts themselves are seen.
3. In natural science the lawlike relations asserted of experience are internal, because what count as facts are constituted by what the theory says about their interrelations with one another.
4. The language of natural science is irreducibly metaphorical and inexact, and formulizable only at the cost of distortion of the historical dynamics of scientific development and of the imaginative constructions in terms of which nature is interpreted by science.
5. Meanings in natural science are determined by theory; they are understood by theoretical coherence rather than by correspondence with facts. (pp. 172-73)²²

We need not attempt to follow here the various arguments by which Hesse and other philosophers attempt to reauthorize scientific discourse. The hermeneutics of Habermas and Gadamer often figure importantly in such analysis. Hesse will try not to reject the positions just quoted but to show that "the logic of science implied in the account is virtuously rather than viciously circular" (p. 174).

It is obvious, however, how this kind of analysis of scientific statement moves into the literary fold, particularly because of several significant effects. First, the observer no longer stands "apart from the world," dispassionately and objectively commenting upon it. Second, the subjects of science are infused with the consciousness of the perceiver and the constraints of the scientists' culture. Third, science's authority over "fact," so significant in the development of its power, is compromised in the destruction of the correspondence theory of truth: like fiction, like poetry, science, on this account, achieves its status by virtue of its "coherence" rather than its correspondence to external reality. Fourth, science becomes not so much the systematic and cumulative process of discovery as an activity of the creative imagination. And finally, scientific language, with its claims to univocality and precision of correspondence, is understood to be, like literature itself, metaphorical.²³

The shattering of the myths of disinterestedness and objectivity, or the view that all perception and knowledge are "interested" and historically conditioned, changes the authoritative relations of science to literature. Certainly, in implicitly denying the priority of science over other cultural expressions, it opens (or encourages) the way toward a richer and more complex reading of interchanges between discourses. Nevertheless, critics ought to be proceeding with considerable caution, first because, as Hesse herself and philosophers like van Frassen, Richard Rorty, and Richard Bernstein have been arguing, the rejection of foundationalism entails the subversion only of what they regard as a false tradition of objectivity, not objectivity itself.²⁴ Antifoundationalism for these thinkers does not endorse an intellectual free-for-all, or make for equivalence between literary and scientific "fictions." Nor does it subvert scientific activity. It historicizes and humanizes it. Second, whatever the philosophical positions now being argued within humanist communities, the historical condition of science's authority within con-

temporary culture has not radically changed. Frankenstein's monster is still loose, and science continues to exercise its authority in the culture at large. And that suggests that we need within the academy more serious and detailed studies of the relations between science and culture, science and literature.

II

Near the end of *Philosophy and the Mirror of Nature*, Richard Rorty writes:

The tear of science, of "scientism," of "naturalism," of self-objectivation, of being turned by too much knowledge into a thing rather than a person, is the fear . . . that there will be objectively true or false answers to every question we ask, so that human worth will consist in knowing truths, and human virtue will be merely justified true belief. This is frightening because it cuts off the possibility of something new under the sun, of human life as poetic rather than merely contemplative.

But the dangers to abnormal discourse do not come from science or naturalistic philosophy. They come from the scarcity of food and from the secret police . . . (p. 389)

Rorty's philosophy, by thrusting knowledge into social context, changes philosophy's nature and significance. To consider the relations between science and literature, that shift is crucial, but the change in the theoretical relation of scientific knowledge to ordinary knowledge, of scientific language to ordinary language, is a matter of real import not only for the subject "science and literature" but for the culture at large. Whatever else current theory (or antitheory) has done, it has opened the possibility of a serious critique of science that is not merely sentimental or alarmist. Seeing science not as an absolute authority in the areas of knowledge, but as one (really several) among competing discourses is no longer a particularly daring move, but it remains a healthy one.

One of the growing traditions in history of science, though still somewhat against the grain of more philosophically inclined practitioners, attempts to look more intently and broadly at the full social and political contexts in which particular scientific achievements are made. While addressing itself to the ideological forces that more or less self-consciously shape science, this kind of study is often itself outspokenly ideological. The tradition is, I believe, in harmony with the philosophi-

cal developments I have been discussing, but the texture of its work often feels very different. Perhaps the most aggressively outspoken practitioner of this form of history of science is Robert Young, whose essay on biographies of Darwin also appears in this volume. Young makes an unembarrassed personal case for his method in essay after essay, and willingly places his work within a radical political program for change.

A recent collection of his essays on Darwin²⁷ manifests this method very clearly. While he has a political program, he believes that to make his case he must demonstrate in great detail how scientific ideas that are normally treated "intrinsically," with reference only to their internal logic and the nature of the evidence available, were in fact developments from ideas very clearly related to the major moral and religious concerns of society. Science, on Young's account, is embedded deeply and inherently in cultural materials, with all their ideological implications. The pressures these exert on scientific thought significantly affect the shape of scientific thinking in spite of their apparent irrelevance to the intrinsic coherence of experiment and theory. Young's particular subject is Darwin and the nineteenth-century concern with the place of the human in nature. "I remain certain," he contends, "that it is not right to separate the Darwinian debate from broader cultural, ideological, political, and economic issues" (p. xiii).²⁸

But the real strength of Young's position is that it never remains very long at the level of polemic. He looks, as he says, for the "fine texture" of scientific work and debate in his period, and he traces meticulously the way scientific debate reflects theological debate, the way, for example, Darwin is clearly using the language of Malthus, and the relation between Malthus' language and Paley's (whose whole way of thinking was also deeply influential on Darwin), and their mutual implication in the tradition of natural theology. Young tries to show how much Darwin's work was part of the established way of looking at things, how easily it was assimilable to secular versions of the natural theology that it seemed, at first, to be rejecting. The conclusions are, to be sure, arguable; but the demonstration of Darwin's embedding in broad cultural movements that he seemed not to be addressing in his work is a powerful one.

Once the move has been made to see science as another cultural

product, its language opens up for investigation in ways that are of particular interest to students of literature. Perhaps the richest analysis we have of the nature of Darwin's language is in Gillian Beer's *Darwin's Plots*, where Beer attends to the metaphorical profusion of Darwin's text and demonstrates the impossibility of univocal reading and the importance, for Darwin, of the multiple possibilities of meaning. (In her essay in this volume, Beer further pursues the idea of the importance of multivocal language for scientific discourse that would seem to require univocal meaning.) Young, in one of the most interesting essays we have on Darwin (written originally in 1971), pursues Darwin's use of the metaphor of "selection" and considers, in the context of Darwin's quite self-conscious decision to retain the metaphor after fully understanding its difficulties, what the scientific and ideological implications are. To be an externalist critic of the sort Young wants, one needs also to be a literary critic, or at least a rhetorician, to understand the way metaphor works, to locate particular metaphors in a wide range of literature. In other words, Young pursues the objective of his kind of externalist history of science by risking engagement with the full range of intellectual activity of Victorian culture. To read Darwin, he shows, one must know how to read metaphor and how particular metaphors were historically read, and one must be willing to get one's hands dirty in social and cultural history.

There are many others doing Young's sort of work, if usually less polemically. One of the most interesting and effective is Stephen Jay Gould, in his study of psychometrics. Describing his work as "negative science," since it is designed to disprove certain scientific arguments, Gould tries to show how biological determinism, allied to psychometrics, worked for political ends. But, he says,

I do not intend to contrast evil determinists who stray from the path of scientific objectivity with enlightened antideterminists who approach data with an open mind and therefore see truth. Rather, I criticize the myth that science itself is an objective enterprise, done properly only when scientists can shuck the constraints of their culture and view the world as it really is.²⁹

Despite its obvious compatibility with the philosophies of science I have been looking at, Gould's is not a speculative work about a theory of science. It is a study of a particular development within science which

can serve as an example strengthening the case against the traditional realist view Mary Hesse outlined above. We can see in Gould's analysis once again that a heightened sensitivity to metaphor is required for an understanding of science itself. He needs to show, for example, that one of the fallacies leading to a biologically determinist position is "reification," in this case the translation of the abstraction "intelligence" into an entity (p. 24). Similarly, Gould shows how the idea of "ranking" belongs to the metaphors of "progress and gradualism" that have had such unfortunate social utility in the West. The battle over "objectivity," and over the question of whether one can learn anything about science by seeing scientific ideas as embedded in culture and its ideologies, loses some of its rarefied abstractness. Gould's analysis has serious extraphilosophical consequences. He confesses that he "was inspired to write this book because biological determinism is rising in popularity again, as it always does in time of political retrenchment" (p. 28).

A very recent example of the kind of history of science Young would seem to be looking for is of major importance in its relations to the philosophical questions raised earlier. Shapin and Schaffer, in *Leviathan and the Air-Pump*, raise their questions about scientific knowledge within a firmly historical context. They reexamine the development of arguments for what is perhaps the source of the whole tradition of experimental science in the West, Boyle's experimental method, which remains canonical. They demonstrate its implication in the polity of Restoration England, and they thus treat experiment, not as the "true way" to scientific knowledge, but as a set of communally accepted conventions, much as "realism" is conventional in Svetlana Alpers' *The Art of Describing*.

"The solution to the problem of knowledge," they claim, "is political; it is predicated upon laying down rules and conventions of relations between men in the intellectual polity" (p. 342). This will not sound particularly stunning to those who have followed the critical wars or learned from Marxist, feminist, and reader response criticism. But Shapin and Schaffer are far from imitative in their analyses, and their demonstration of the social constitution of science, at least at this crucial point in the development of Western science, is likely to gather its own community of readers. At least it ought to.

Thus Young is far from unique in his enterprise, but his work may be

the most obvious reflection of the historicizing of ideas that is more abstractly affirmed in the debates among Kuhn, Lakatos, Hesse, Bernstein, the hermeneuticists, van Frassen, and so on. Once one is committed to the view that science is not so clearly separable from the human sciences (a separation on which even Habermas insists) or from other humanist enterprises, history of science begins to blur in with social history. Literature becomes part of the history of science. Science is reflected in literature. And the tools of literary criticism become instruments in the understanding of scientific discourse.

III

Although I have emphasized here elements of the literary critique of science, and, indeed, of scientists' critique of science, another emphasis is possible and necessary, certainly for purposes of this book. Science is a risk-taking enterprise, but, as we have seen, it is also an imaginative one. The relation of literature to science has been one not simply of hostility, rather more of love-hate. Even the myth of Frankenstein includes a fascination with, an attraction to, the enormous possibilities of science that it would be absurd to ignore. We can ignore it only if we take that famous novel as a simple moral parable against intellectual overreaching. Remember that Victor Frankenstein's last words are not "seek happiness in tranquility, and avoid ambition," but "yet another may succeed."²⁰

Nineteenth-century English literature is by no means a continuous litany of romantic complaints against science. Ruskin himself—that campaigner against modern science, Darwinism, and the fruits of technology—wanted to be president of the Geological Society. His hostility to science and particularly to John Tyndall had to do with his very peculiar reading of the ways science reduces the human to the merely material and is responsible for the disruptions of his favored landscapes. Ruskin's is the romantic response, which always included, as with Shelley, deep respect for the scientific enterprise and even scientific ambition. Much of his later work was an attempt to make a better science, or at least better natural history. He was fighting the professionalization of science, the way its language was splitting off from the language available to the common reader, and he proposed a new

system of naming birds and flowers, incorporating into our scientific understanding the way human culture had perceived these things. For Ruskin, true science included the history of human experience with natural phenomena; but he longed for true science. Or again, George Eliot takes science as a kind of model for moral and intellectual growth, and the notorious failure of her scientist-doctor Lydgate is a failure to live up to science, not a failure of science itself. Even Dickens, whose attitudes toward science we might think are summed up in his satire in *Hard Times*, was favorably disposed to science, filled the pages of his weekly journals with popularizations of scientific thought, celebrated the scientific spirit in Daniel Doyce of *Little Dorrit*. Perhaps more important, we can find throughout nineteenth-century literature frequent reflections of scientific thought, even in the very texture of narrative. One need only consider the splendid analyses of Gillian Beer in her study of Darwin to recognize how complexly enmeshed in the general understanding Darwin's theories were and in how many and how far-reaching ways those theories were manifested (and resisted) in literature.

The attack on science that we have witnessed from so many quarters was, of course, partly a consequence of science's power, and of the special status it seemed to claim within the world of philosophy. The main target has been an imperialist positivism which claimed that in the scientific method, as it defined that method, we have our only way to truth, and at its most extreme dismissed all others forms of statement as "nonsense," since they could not be verified according to "scientific method." Positivism, which in the nineteenth century was in part a reaction to the claim by "authority" to the status of objective truth—a claim unsupported by any but verbal evidence—ultimately incorporated the structure of the displaced authority into itself. I would argue, however, that by questioning authority as it did and insisting on the necessity for constant skepticism about authority claims, it made its own authority vulnerable. Most of the more powerful attacks on positivism in fact assimilate its antimetaphysical stance and incorporate its critique of metaphysics as a disguise for interest. "Objectivity" itself was seen as such a disguise. But positivism is not the form in which the truth claims of science are now most seriously affirmed, and recent developments in science and scientific theory have made them even

more attractive and important to the arts and literature than they were in the promising days of the third quarter of the nineteenth century when it seemed to many very intelligent people that science was, at last, going to transform the world into a new and better place.

John Tyndall wanted to claim that science was among the greatest achievements of the human imagination (he used the term "imagination").³¹ In his famous Belfast Address he claimed science's kinship with literature:

It has been said by its opponents that science divorces itself from literature; but the statement, like so many others, arises from lack of knowledge. A glance at the less technical writing of its leaders—of its Helmholtz, its Huxley, and its Du Bois Reymond—would show what breadth of literary culture they command. Where among modern writers can you find their superiors in clearness and vigour of literary style? Science desires not isolation, but freely combines with every effort towards the bettering of man's estate. (2: 198-99)

We can still, I believe, agree with Tyndall that science is a great imaginative achievement, although our terms may not mean what he intended; and we can, if we read those writers he named, agree that they wrote brilliantly. We cannot, to be sure, accept his intellectual imperialism, but it is certainly worth bringing to bear on his writing the literary sophistication of modern criticism. Surely we can allow him that participation in the general culture that he wanted for science.

That great Victorian moment has itself been subjected to radical critiques. Victorian scientific naturalism has been "exposed" both as an incoherent philosophy and as an attempt as much to establish science as a respectable profession as to bring the gospel of the new truth to fellow scientists and the society as a whole.³² But that exposure neither diminishes the importance of the scientific work (and its popularization) for literature, nor entails any reduction of respect for the scientific enterprise.

This volume, that is to say, is not in the business of debunking. It takes seriously the view that science is one of the great achievements of the human mind, that it matters powerfully to us, for better or worse, in the way we live, the way we think, and the way we imagine. There is no literature more important. And even if we accept now the view that it is merely one of many competing discourses, that it is no more grounded

in a foundation of reality that gives special authority to its language than the language of literature, we need nevertheless to consider the nature of that discourse in great detail, to understand the ways in which the "and" genuinely connects science and literature, genuinely marks difference.

George Steiner has argued that "a view of post-classic civilization must, increasingly, imply a vision of the sciences."³³ and he talks of science as though it were the greatest of literatures:

At seminal levels of metaphor, of myth, of laughter, where the arts and the worn scaffolding of philosophic systems fail us, science is active. Touch on even its more abstruse regions and a deep elegance, a quickness and merriment of the spirit come through. . . . That "poetry of facts" and realization of the miraculous delicacies of perception in contemporary science, already informs literature at those nerve points where it is both disciplined and under the stress of the future. It is no accident that Musil was trained as an engineer, that Ernst Junger and Nabokov should be serious entomologists, that Broch and Canetti are writers schooled in the exact and mathematical sciences. . . . (pp. 98-99)

And so on. There is something perhaps a little show-offy in Steiner's celebration of the great imaginative achievements of science and of the centrality of science to the imagination of modern artists. Yet there is no denying either the centrality of science to contemporary literature, or the literary power of the great modern scientific discoveries. What matters for this volume is that these discoveries make their claims in the same way as great literature does, that to get to the heart of the culture one can travel the road of science, the road of literature, or—better—both.

IV

This volume, then, assumes that science is embedded in culture. It accepts the analysis that empirical statements can never produce determinate meaning, for "there are in principle always an indefinite number of theories that fit the observed facts more or less adequately" (Hesse, p. viii). Beyond that, it accepts the impossibility of disinterest in any investigation and recognizes that developments in science are closely related to developments in the culture at large. Thus it builds on the

assumption that science does not make "universal" statements, that its discourse is as historical as that of literature (and the assumption, of course, is that literature too is historical, not universal). It proceeds then by accepting the demystification of science that has been so much the object of antipositivist philosophy in the twentieth century, and therefore the view that the history of science entails as well a sociology of science. Science is socially constituted: knowledge is culturally constituted.

In a sense this is all very old news. Yet the exploration of the implications of this widely shared view is in a relatively primitive state. When scientific texts become texts, wrenched from the correspondence theory of truth and denied universality, they become subject to the sorts of analyses Gould, and Young, and Beer practice. In this volume, the essays move back and forth, from scientific to literary texts, examining them in their complex relationships, assuming those relationships, working from the assumptions we have just outlined. As a collection, they make what I believe to be an important contribution to the understanding of what it means in practice to accept these views, the consequence for the study of literature and the consequence for the study of science.

In Part II, the essays attempt to deal with aspects of the language that constitute the different discourses of science and literature. In an essay which offers a speculative overview of the relations between scientific and literary language, Gillian Beer identifies a critical difference in the attitude toward univocality, and locates, too, in both discourses an ultimate need for multivalence if either is to break from the constraints of language itself into something new. James Paradis, working more historically, attempts to trace the history of the divergence of the two discourses, the increasing specialization of scientific language. Yet both opening essays assume a common base, which Beer locates in a historical past, Paradis in the nature of language itself. I have included Peter Dale's essay on G. H. Lewes in this section because it presents a fascinating example of the way the two discourses, apparently at odds, seem to reconverge in the career of this Victorian polymath. Lewes provides an example of how even the most extreme polarities—positivism on the one hand, modernist symbolism on the other—can be shown to work into each other. The divergence, to be sure, is there: but the

possibility of connection in minds of exceptional brilliance is there also.

In Part III, four essays explore differently, but with a unanimity of general view that I could not have anticipated, ways in which literature and science can be seen in conjunction fruitfully. All of them assume the cultural embedding we have been talking about, and all of them are enabled by that assumption. N. Katherine Hayles in fact offers a theory of such conjunction, using the metaphor of the unified field theory as a method, and juxtaposes to remarkable effect Barthes's criticism with Shannon's information theory. Donald Benson talks about the conjunction as "illustration," avoiding (as do all the essayists here) the idea of influence, but showing how the theory of ether illuminates Pater's work and that of the impressionists. Richard Pearce considers in several of its artistic manifestations the culture's interest in symmetry and disruption. And David Bell not only explores the problem of "chance," but suggests that Balzac's handling of it representatively in a short novel actually anticipates later scientific uses.

In the final two sections, there are two different kinds of critique of the scientific enterprise. Part IV examines the question without direct recourse to theory. It examines some biographical and historical consequences of the convergence of scientific and social discourse. The essays are not concerned with literary analysis, yet demonstrate vividly ways in which science and literature are combined in the texture of individual lives, how the ideologies of science help define at any given moment what constitutes imagination, what lies beyond the margins of social acceptability. Robert Young discusses the genre of biography, through the example of Darwin, to suggest once again how the history of science entails a thickening of the subject beyond the rational coherence of scientific argument. Biography, Young suggests, is an aspect of scientific theory that should not be ignored. So here again literature becomes a part of science. Roy Porter examines the curious connections between the idea of madness and its actuality in the eighteenth century; and James Moore offers a fascinating case study of a now neglected Victorian woman poet, whose life and thought manifest an extraordinary crossing of the scientific and the poetic and the culture's "scientific" assumptions about the nature of woman.

Part V offers two readings of novels by women which demonstrate the centrality to those texts of the scientific literature of the time. But both

Anne Mellor with *Frankenstein* and Sally Shuttleworth with *Villette* attempt to disentangle various of the scientific elements and demonstrate how the novels mount strong criticisms of a scientific enterprise that implies in its very constitution male domination. The essays, then, provide us with further evidence of the ideological implications of science, the literary involvement with science and preoccupation with its ideologies.

Notes

1. For two very different responses to Snow's Rede Lecture on the two cultures, see *Two Cultures: The Significance of C. P. Snow* by F. R. Leavis (New York: Pantheon, 1963), which includes an essay, "Sir Charles Snow's Rede Lecture," by Michael Yudkin. Yudkin makes a telling case for the irrelevance of Snow's formulation and for the impossibility of training nonscientists in science in the same way that one can expose scientists to great literature.
2. Thomas Kuhn, "Comment on the Relations of Science and Art," *The Essential Tension: Selected Studies in Scientific Tradition and Change* (Chicago: University of Chicago Press, 1977), p. 340.
3. See Terry Eagleton, *Literary Theory: An Introduction* (Oxford: Basil Blackwell, 1983). "We have still not discovered the secret, then, of why Lamb, Macaulay and Mill are literature but not, generally speaking, Bentham, Marx and Darwin" (p. 10). Eagleton denies that literature is an "objective" category, and links its status to "assumptions by which certain social groups exercise and maintain power over others" (p. 16). The battle over the definition of literature is millennia long, and I don't propose to enter it here, except insofar as I want to suggest that the questioning of the boundaries of literature healthily breaks down the artificial barriers that constructed the two cultures in the first place and reminds us that any construction of human language can be usefully submitted to critical interrogation.
4. For an interesting discussion of this point, see Alexander Nehamas, "Convergence and Methodology in Science and Criticism," *New Literary History* 17 (Autumn 1985): 81-87.
5. Hayden White has recently made forcefully a point that has been crucial in the way literature has attempted to define itself against or to turn itself into science in the twentieth century: "The problem has to do with the fragmenting of humanistic studies into discrete disciplines which must feign to aspire to the status of sciences without any hope of achieving the kind of procedures developed in the physical sciences for the resolution of conflicting interpretations of the specified objects of study. The result of this circumstance is that, in order to enable research in any field of humanistic studies, investigators must presuppose that at least one other field of study or discipline is effectively secured, that

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- is to say, is effectively free of the kind of epistemological and methodological disputes that agitate their own area of inquiry." "Historical Pluralism," *Critical Inquiry* 12 (Spring 1986): 484.
6. See Gillian Beer, *Darwin's Plots: Evolutionary Narrative in Darwin, George Eliot, and Nineteenth-Century Fiction* (London: Routledge Kegan Paul, 1983), and Gerald Holton, *The Thematic Origins of Scientific Thought: Kepler to Einstein* (Cambridge, Mass.: Harvard University Press, 1973).
 7. Greg Myers, "Nineteenth-Century Popularizations of Thermodynamics and the Rhetoric of Social Prophecy," *Victorian Studies* 29 (Autumn 1985): 35-66.
 8. A. N. Whitehead, *Science and the Modern World* (New York: New American Library, 1948), p. 11.
 9. For Michel Serres, the model of one culture leading to diverse discourses is too simple. Science is a kind of myth, has no priority over other kinds, exists variously at different intersections with other discourses. Serres is also brilliant in his discussion of the way in which the dialectical ideal, initiated by Plato, as a way to exclude "noise" or any interference in the transference of meaning from speaker to listener, is actually a way "to supplant a third man and to seek to exclude him." The mathematical ideal excludes any empirical interruption; so, we may infer, modern science, seeming to aspire to the ideal of generalization discussed by Whitehead, above, seeks to exclude the third man, the lay public. In the nineteenth century, despite a commitment to empirical investigation, science did indeed aspire to that kind of authoritative—one might almost say authoritarian—exclusion of nonspecialists, who might interrupt the flow of meaning and implicitly challenge the authority of scientific discourse. Serres' whole enterprise is such a challenge, as he talks about the way the dialectician and mathematician close their eyes and cover their ears "to the song and the beauty of the sirens." See *Hermes: Literature, Science, Philosophy*, ed. Josue V. Harari and David F. Bell (Baltimore: Johns Hopkins University Press, 1982). The editors' introduction lays out lucidly the central elements of Serres' thought. Note, for example, the following: "Science is the totality of the world's legends. The world is the space of their inscription. To read and to journey are one and the same act" (p. xxi). And "The domains of myth, science, and literature oscillate frantically back and forth into one another, so that the idea of ever distinguishing between them becomes more and more chimerical" (p. xxix).
 10. Francis Bacon, *The New Organon*, vol. 4 of *The Works of Francis Bacon*, ed. James Spedding, Robert Leslie Ellis, Douglas Devon Heath (London: Longman, 1860), p. 79.
 11. G. H. Lewes, *Problems of Life and Mind*, 2 vols. (London: Trubner, 1874), 1: 1.
 12. Thomas Sprat, *History of the Royal Society*, ed. Jackson Cope and Harold Whitmore Jones (St. Louis: Washington University Studies), pp. 112-13.
 13. T. H. Huxley, "On the Advantages of Improving Natural Knowledge," *Methods and Results* (London, 1893), p. 40.
 14. Bernard Lightman, "Pope Huxley and the Church Agnostic: The Religion of Science," *Historical Papers* (1983), pp. 150-63. Lightman points out that "by

severely limiting knowledge the agnostics inadvertently created problems for themselves in their attempt to justify the validity of scientific principles. Some of these principles were in fact closely connected to the belief in a natural order which was the basis of the agnostic religion." This belief Huxley—self-contradictorily, to be sure, and inconsistently with his Cartesianism—was to call a "postulate," not, "strictly speaking, demonstrable" (p. 162).

15. For an interesting discussion of this idea in Arnold and in Hazlitt and earlier romantic thought, see David Bromwich, "The Genealogy of Disinterestedness," *Raritan Review* 1 (1982): 62–92.

16. Scientific, or quasi-scientific, models have been offered frequently. Obviously, I. A. Richards, bearing a rich but essentially positivistic notion of language and communication, tried to define literature in terms that would keep it from conflict with science. Leavis' program was, in part, to affirm an Arnoldian, deliberately antiscientific notion of literary truth, and required literature to offer moral wisdom. Northrop Frye has tried to order literature scientifically, discriminating criticism from mere reading by arguing that it is concerned with an order of language. The key text here is *Anatomy of Criticism* (Princeton: Princeton University Press, 1957).

17. See Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985). This remarkable detailed study of Boyle's experiment against the background of Restoration society is too complicated in its analysis and in the questions it raises to be summarized here. But the social constitution of science, at least at this crucial point in the development of Western science, is impressively demonstrated. The authors conclude: "As we come to recognize the conventional and artifactual status of our forms of knowing, we put ourselves in a position to realize that it is ourselves and not reality that is responsible for what we know" (p. 344).

18. For an interesting collection of essays by many of the major contenders in the battles—Kuhn, Popper, Lakatos, Feyerabend, for example—see *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave (Cambridge: Cambridge University Press, 1970). The essays all deal with Kuhn's conception of normal and revolutionary science, most of them more or less negatively. Yet most of them subscribe to the view that the naive realism of traditional empiricism cannot hold. Witness, for example, Lakatos: "the direction of science is determined primarily by human creative imagination and not by the universe of facts which surrounds us" (p. 187).

19. It is not at all fair to call all contemporary philosophical "realists" merely grouch. There are, indeed, some extremely interesting and important philosophers of science who are attempting to work out ways to recuperate the real. Mary Hesse's work, alluded to elsewhere in this essay, attempts, as she says, "to steer a course between the extremes of metaphysical realism and relativism" (p. xiv) and goes outside of science, even to theology, to resist the powerful assault on realism and empiricism. The work of Roy Bhaskar builds on current debate in a very different way, and argues for a concept of the real that he

believes is the only way to account for the fact that scientific thought actually succeeds. Using many of the techniques of contemporary philosophy with strong relativist implications, Bhaskar is moving in an original way to break the hermeneutic circle with which most critics and many philosophers are now living so comfortably. See Roy Bhaskar, *A Realist Theory of Science* (Sussex: Harvester Press, 1978).

20. John Neubauer, "Models for the History of Science and Literature," in Harry R. Garvin, ed., *Science and Literature* (Lewisburg, Pa.: Bucknell University Press, 1983), p. 32.

21. Jarrett Leplin, ed., *Scientific Realism* (Berkeley: University of California Press, 1984), p. 1.

22. Bas C. van Frassen, "Empiricism in the Philosophy of Science," in Paul M. Churchland and Clifford A. Hooker, ed., *Images of Science* (Chicago: University of Chicago Press, 1985), p. 247. Van Frassen's theory of "Constructive Empiricism" is antirealist, but attempts to account for the success of science by, among other things, demonstrating the irrelevance of truth claims to scientific argument, whose acceptance does not require belief.

23. Mary Hesse, *Revolutions and Reconstructions in the Philosophy of Science* (Bloomington: Indiana University Press, 1980), p. vii.

24. It is interesting that Hesse describes these positions in an essay called "In Defence of Objectivity." Like many philosophers, she is concerned to avoid the easy relativism that is often assumed to follow, and adopts, as many others do, aspects of the hermeneutic tradition, and particularly the work of Habermas, for her purposes.

25. It is important to note that Ernan McMullin not only recognizes the metaphysical nature of science but as a scientific realist finds no difficulty in assimilating that view to realism: "The language of theoretical explanation is of a quite special sort. It is open-ended and ever capable of further development. It is metaphoric in the sense in which the poetry of the symbolists is metaphoric, not because it uses explicit analogy or because it is imprecise, but because it has resources of suggestion that are the most immediate testimony of its ontological worth." *Scientific Realism*, p. 36.

26. The obvious text for Rorty is *Philosophy and the Mirror of Nature* (Princeton: Princeton University Press, 1979). An inadequate summary of what Rorty does with the idea of objectivity might be suggested by this quotation: "To be behaviorist in epistemology . . . is to look at the normal scientific discourse of our day bifocally, both as patterns adopted for various historical reasons and as the achievement of objective truth, when 'objective truth' is no more and no less than the best idea we currently have about how to explain what is going on." Rorty's relaxation into historicizing knowledge has the curious possible effect of simply reinforcing the current structure of authority, allowing only for a great deal of conversation about it. Richard Bernstein's *Beyond Objectivism and Relativism* (Philadelphia: University of Pennsylvania Press, 1983) provides an exceptionally lucid analysis of developments in philosophy and philosophy of science that put foundationalism to question. Bernstein, using hermeneutics, tries to

show that the anxiety produced by the fear of the loss of any "foundation" for knowledge derives from a Cartesian antithesis, and that one can move beyond that anxiety, and the antithesis itself, through the construction and recognition of "dialogical communities."

27. Robert M. Young, *Darwin's Metaphor: Nature's Place in Victorian Culture* (Cambridge: Cambridge University Press, 1985).

28. Part of the interest of Young's work is that he tries to place himself within a cultural and ideological framework, and much of this book is devoted to explaining both how he developed his interest in the particular areas he discusses and how the profession he worked in regarded those interests and his method then—and now. This is a very personal reading of his battles with the intellectual establishment, but it remains interesting both as narrative and as exemplification of a rounded, socially contextual view of history of ideas.

29. Stephen Jay Gould, *Mismeasure of Man* (New York: W. W. Norton, 1981), p. 21.

30. Mary Shelley, *Frankenstein; or, The Modern Prometheus*, ed. M. K. Joseph (New York: Oxford University Press, 1971), p. 218.

31. See John Tyndall, "On the Scientific Uses of the Imagination," *Fragments of Science*, 2 vols. (New York: Appleton, 1899).

32. See the work of Frank Turner, *Between Science and Religion: The Reaction to Scientific Naturalism in Late Victorian England* (New Haven: Yale University Press, 1974); "Public Science in Britain, 1880-1919," *Isis* 71 (1980): 589-608; "The Victorian Conflict between Science and Religion: A Professional Dimension," *Isis* 69 (1978): 356-76. For a splendid discussion of the mixture of professional and scientific motives in a scientific debate between Huxley and Richard Owen, see Adrian Desmond, *Archetypes and Ancestors: Palaeontology in Victorian London, 1850-1875* (Chicago: University of Chicago Press, 1982). This book strikes me as very much the kind of work Young has been asking for in his own essays.

33. George Steiner, *In Bluebeard's Castle: Some Notes towards the Redefinition of Culture* (London: Faber and Faber, 1971), p. 98.

Part II

Diverging and Converging Languages

A N N E K. M E L L O R

Frankenstein: A Feminist Critique of Science

From a feminist perspective, the most significant dimension of the relationship between literature and science is the degree to which both enterprises are grounded on the use of metaphor and image. The explanatory models of science, like the plots of literary works, depend on linguistic structures which are shaped by metaphor and metonymy. The feminist reader is perhaps most sensitized to those symbolic structures which employ gender as a major variable or value. When Francis Bacon announced, "I am come in very truth leading to you Nature with all her children to bind her to your service and make her your slave,"¹ he identified the pursuit of modern science with a form of sexual politics: the aggressive, virile male scientist legitimately captures and enslaves a passive, fertile female nature. Mary Shelley was one of the first to comprehend and illustrate the dangers inherent in the use of sexist metaphors in the seventeenth-century scientific revolution.

Mary Shelley grounded her fiction of the scientist who creates a monster he can't control upon an extensive understanding of the most recent scientific developments of her day. More important, she used this knowledge both to analyze and to criticize the more dangerous implications of both the scientific method and its practical results. Implicitly, she contrasted what she considered "good" science—the detailed and reverent description of the workings of nature—to "bad" science, the hubristic manipulation of the forces of nature to serve man's private ends. In *Frankenstein, or the Modern Prometheus*, she illustrated the potential evils of scientific hubris and at the same time challenged any conception of science and the scientific method that rested on a gendered definition of nature as female. Fully to appreciate the significance of Mary Shelley's feminist critique of modern science,