THE DIABOLICAL ASPECT OF STINKS

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for professors B. Crasemann
and Minoru Harada

In one of his not infrequent moments of verbal nastiness, Gore Vidal makes this demeaning comparison:

> Like so many of today's academic critics, Barthes resorts to formulas, diagrams; the result, no doubt, of teaching in classrooms equipped with blackboards and chalk. Envious of the half-erased theorems—the prestigious *signs*—of the physicists, English teachers now compete by chalking up theorems and theories of their own, words having failed them yet again.
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> *Matters of Fact and Fiction*
> (New York: Random, 1977), p. 102.

If this were just another of Vidal's attacks upon academic critics, the professors of literature that he elsewhere scorns as "the hacks of academe," it could be shrugged off as spite—with, no doubt, a sigh of grateful relief that Vidal had not unleashed his pen on one personally. Unfortunately, Vidal's remark is not *merely* nasty, for it contains a truth that cannot be shrugged off. The chalking up takes place and the envy exists, but the envy is actually of what the physicists' signs represent: a systematic body of knowledge. As Tzvetan Todorov notes:

> the study of literature has never been considered as a science in and of itself; of course, I am merely repeating a trivial fact. But its very triviality is a good starting point for me since the structural analysis of literature is nothing other than an attempt to transform literary studies into a scientific discipline. By this term, "scientific," I do not mean, of course, the use of a laboratory with white mice or of computers; I rather refer to its larger sense: a coherent body of concepts and methods aiming at the knowledge of underlying laws.
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> *Approaches to Poetics,* ed. Seymour Chatman (New York: Columbia Univ. Press, 1973), p. 154.

Thus, more than two decades after Northrop Frye lamented the lack of any systematic approach to criticism as a coherent body of knowledge, the critics are still undisciplined and still envious. Frye tried to provide a schematic basis for criticism, but he anticipated (and in this he was right) a misplaced resistance to his effort: "The strong emotional repugnance felt by many critics toward any form of schematization in poetics is again the result of a failure to distinguish criticism as a body of knowledge from the direct experience of literature" (*Anatomy of Criticism* [Princeton, New Jersey: Princeton Univ. Press, 1957], p. 29). The oft-voiced criticism (though seldom was anyone foolish enough to commit the notion to print) was that Frye's attempts at schematization were "pigeon-holing" literature, somehow reducing and diminishing it. One cannot imagine the same reaction by scientists to, say, Mendeleyev's elaboration of the periodic table of elements. Critics have only themselves to blame for the undisciplined state of their science.

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Literary critics have reason for envy on another, more embarrassing point, and that is the verbal facility the physicists display in coining new terms. As Frye has pointed out, without the Greeks, the critics are in trouble: "The Greeks gave us the names of three of our four genres: they did not give us a genre that addresses a reader through a book, and naturally we have not invented one of our own" (***Anatomy,*** p. 248). The physicists have no such trouble (though so many Greek names had to be used for the proliferating particles in the "nuclear zoo" that Enrico Fermi was quoted as complaining: "If I could remember the names of all these particles I would have been a botanist"). The physicists: serious, esoteric, remote; the elite high priests of that other culture—yet they have displayed a wit and verbal playfulness sadly lacking in criticism. The best examples come from that strangest of all realms, the world of subatomic particles. When it was first suspected that perhaps protons and neutrons were not basic particles after all, but were themselves comprised of constituent elements, Murray Gell-Mann of Cal Tech supplied the name for the hypothesized particles, taking it from—surprise!—***Finnegans Wake.*** He called them "quarks," after the mocking cry of the gulls: "Three quarks for Muster Mark."

At first it was thought that there were two types of quarks, and they were called "up" and "down." When some heavy relatives of protons were discovered to have curiously long lifetimes, Gell-Mann (again) named the quality which affected the lifetimes of particles "strangeness," and "strange" quarks were added to up and down. The particle which was theorized to carry the quark exchange force was called a "gluon," as it would "glue" the quarks together inside a proton. This new super-strong binding force was termed the "color" force, since the analogy with mixing colors provided a vivid way of picturing quark combinations. Sheldon Lee Glashow named the fourth quark "charm"—"in the sense of a magical device to avert evil," as he explained—for a "charmed" quark was necessary to prevent a failure in quark theory.

When a predicted particle was first discovered simultaneously on both coasts, there were at first two new names: Samuel Ting of MIT called the particle "J," whereas Burton Richter of Stanford named it "psi." Colleagues began calling it "J/psi" to share out the honors equally, and this label soon evolved into the "gipsy" particle. Two more quarks were proposed, "top" and "bottom," but Nigel Calder says that "some physicists, already disgruntled about 'up' and 'down' and finding more euphony in 'strangeness' and 'charm,' began calling the supposed new qualities...'truth' and 'beauty'" (*The Key to the Universe: A Report on the New Physics* [New York: Viking, 1977], p. 128. I follow Calder's account of the naming of the quarks. The Glashow quotation appears on p. 99). Charmed quarks break down into strange quarks, and Calder proposes that this is the "Garbo effect"—charm in decline changing into strangeness (p. 114). Another literary reference in particle physics is in the name of a giant instrument installed at CERN and designed to track neutrinos. As it has a "belly" containing ten tons of freon, it was named Gargamelle, after the mother of Gargantua. Physicists are essentially concerned with measurement, and, extending this concern for precision to human behavior, they have proposed a "dirac" to be a unit of volubility equal to one word a year. His Cambridge colleagues in this way honored Paul Dirac's notorious taciturnity.

This final example is mere whimsy, true, but this playful attitude combined with verbal creativity has at times been carried out by physicists on a surprisingly large scale. To the literary eye, the most astonishing part of George Gamow's *Thirty Years that Shook Physics* (Garden City, New York: Anchor-Doubleday, 1966), his story of the development of quantum theory, is the appended "Blegdamsvej *Faust*" (pp. 165-218). It is an elaborate parody of Goethe, written and performed at the spring conference at Niels Bohr's Institute of Theoretical Physics in 1932. It has to do with a then recent development in physics, Chadwick's discovery of the neutron and the consequent need for a new name for Pauli's hypothetical massless and chargeless particle. At Fermi's suggestion, it was called a neutrino (little neutral one), though many physicists were skeptical of its existence. Thus the theme of the "Blegdamsvej *Faust*," as Gamow describes it, "has Pauli (*Mephistopheles*) trying to sell the unbelieving Ehrenfest (*Faust*) the idea of the weightless neutrino (*Gretchen*)" (p. 168). Even if one knows but little about the important quantities in quantum physics and nothing at all of the personal quirks of the famous physicists who are spoofed, the play is a delight to read. That it remains a parody of *Faust*—the final chorus hymns "*Eternal Neutrality*/Pulls us along!"—is not the least of its charms. Surely it is a safe bet—say, dollars to dactyls—that nothing approaching it for wit and creativity has emerged from dozens of Modern Language Association conventions. Wit, in fact, is in short supply among critics these days, having seemingly diminished along with the shrinking enrollments and vanishing job opportunities in what this culture is pleased to call "the humanities."

Nigel Calder complains at times of the jargon of physics, as when he refers to "up" and "down" as being ungraceful terms and "flavor dynamics" perplexing (pp. 37, 99). He can count himself fortunate that he has not been reading literary criticism. In a recent book by Mas'ud Zavarzadeh, *The Mythopoeic Reality* (Urbana, Ill.: Univ. of Illinois Press, 1976), there appear such newly-coined critical terms as *factoids* ("fact-like details of empirical reality which help to create a fictional likeness to the real world" [p. 60]), *acteme* ("the minimal unit of unfolding acts" [p. 80]), and *actant* and *actee* ("to distinguish between two important functions of people in a nonfiction novel...actant for the initiator of actemes...and actee for the recipient of ideas or actions" [pp. 83-84]). Zavarzadeh is concerned with a recent phenomenon in literature, the nonfiction novel (an example of literary "strangeness," perhaps), and his work is basically theoretical, so possibly new terms are legitimately required, though these neologisms seem both gratuitous and gauche. No concern for euphony here.

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The physicists, then, are far from being inarticulate louts, cramped in verbal expressiveness by their traffic in formulas and diagrams, and seem to be quite at ease with a variety of tropes. John McPhee catches theoretical physicist Theodore Taylor developing a remarkable analogy while listening to Bach's *Variations on a Theme of Frederick the Great:*

"Such a simple theme...The variations must have been the

> product of a very clear thinker, because the patterns are such a systematic exploration of a lot of different possibilities. Up pyramids. Down pyramids. There's a periodicity to it. Structural patterns like those are the kinds of things that appeal to a theoretical physicist—the combination of predictability and surprises...The way I like to think about physics is that there is an exact analogue to the composer, the creator—the knack Bach had for putting the world together in a way that is somewhat predictable but also full of surprises."
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> *The Curve of Binding Energy* (New York: Ballantine-Random, 1975), p. 40.

Astrophysicist John Gribbin begins *White Holes: Cosmic Gushers in the Sky* (St. Albans, England: Paladin-Granada, 1977) with an elaborate allusion to Blake's "The Tyger": "Things are not as they seem in the jungle of our universe, where every shadow contains some mysterious tiger (not always burning bright), and astronomers struggle with inadequate senses, supported by the cruches of electronic equipment, to fathom just what immortal hand or eye *did* shape the cosmos" (p. 7). And Carl Sagan, *The Cosmic Connection: An Extraterrestrial Perspective* (New York: Dell, 1973), in referring to Harold Urey's remark that the space program is a kind of modern pyramid-building, elaborates the analogy with an image of his own: "Perhaps a better analogy is with the ziggurats, the terraced towers of the Summerians and Babylonians—the places where the gods came down to Earth and the population as a whole transcended everyday life" (p. 67).

This is not to suggest that the muse *never* nods for the scientists; that would be too much to ask or expect. The scientists are not always so felicitous in expression, not always in full possession of the finer tone. James Watson, *The Double Helix* (New York: Signet-NAL, 1968), in describing his and Crick's dissatisfaction with their early helical models based on sugar-phosphate cores, manages a real howler: "No matter how we looked at them, they smelled bad" (p. 69). *The Cosmic Connection* is marred by a faintly hip jargon and faddish buzz-words—"when the Sun turned on" (p. 3), "experimental societies" (p. 37), "cosmic hookup" (p. 190), to give a few examples—that suggest Sagan was pandering to the counter-culture consciousness of the '60s. He also includes that geometric impossibility, "centered around" (p. 68). Sagan's later book, *The Dragons of Eden: Speculations on the Evolution of Human Intelligence* (New York: Random, 1977), is shot through with computer jargon, perhaps understandably as he is considering the brain's structure and workings. Still, all the talk of "accessing" (p. 75), "buffer-dumping" and "memory-storage" (p. 142), and of the brain being "packaged and programmed" (p. 212) makes me uneasy. The inevitable result of this jargon is that we—scientists and literary folk alike—are just so much "humanware," the least reliable component, ranking a poor third behind "hardware" and "software" in a world of computers.

Sagan writes a very confusing sentence at one point. He suggests that schizophrenia might be "what happens when the dragons are no longer safely chained at night; when they break the left-hemisphere shackles and burst forth in daylight" (p. 199). The "dragons" are Sagan's metaphor for the phylogenetically oldest part of the forebrain, a part he calls the "reptillian component" (p. 53) or "R-complex" (p. 56). Sagan postulates that the later-evolving limbic system and neocortex usually predominate—that "an inhibition center" turns off much of the functioning of the reptilian brain during waking hours, but that it is activated harmlessly during sleep (pp. 149-151). In other words, the dragons are *unchained* at night and let free to roam in our dreams. Perhaps the confusion is after all an apparently minor point of language, remedied by writing "what happens when the dragons are no longer chained *up* at *the end of* night." At any rate, the sentence is confusing, and Sagan certainly does not mean what he says.

Even something as basic as verb tense can cause problems. Nigel Calder writes that "ways of achieving nuclear fusion on Earth for peaceful purposes *were sought* in many countries. A variety of techniques to bring about collisions of sufficient energy between the nuclei of heavy-hydrogen fuel seemed promising, but a practical fusion reactor *was* slow to appear" (p. 68, itallics mine). The past tense indicates that the action was completed in the past. In this case, the implications are that a means of controlling a fusion reaction is no longer being sought and that a practical fusion reactor has appeared, neither of which is true. Language makes its own demands. Unlike mathematics, language is flexible and can be ambiguous. This is particularly true when language is being used creatively, for images, analogies, and metaphors take on lives of their own, extending their boundaries and propagating their implications in ways not always controlled or forseen by the writer. It is this quality of language that makes it interesting—as well as instructive—to take note of the rhetoric of science writing.

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Fritjof Capra, *The Tao of Physics* (New York: Bantam, 1975), has written a very different sort of book for a physicist. As the subtitle explains, the book is "An Exploration of the Parallels Between Modern Physics and Eastern Mysticism," and Capra's claim is that modern physics is bringing about changes in our world-view that lead toward "a view of the world which is very similar to the views held in Eastern mysticism" (p. 4). Instead of the usual task of trying to explain physics to the non-scientific, Capra is trying to "save" physics for those who regard it as "an unimaginative, narrow-minded discipline" by linking it to "Eastern ways of liberation" (p. 12). It is a case of improving the image, and, as with Sagan's *Cosmic Connection*, the echoes of the '60s—the genesis of Capra's book was "a beautiful experience" by the sea (p. xv), and it begins with an epigraph from Castaneda (p. 2)—trigger suspicion about the audience he is trying to reach and suggest his own biases. Capra states his position clearly by setting up an East/West opposition: the West is characterized by a Cartesian dualism which has produced a mechanistic, fragmented view of the world; the East has an organic, ecological world view, one stressing the unity and interrelatedness of all phenomena and the dynamic nature of the universe (pp. 10-12). In short, the Eastern view is good (organic-ecological-dynamic), the Western view is bad (mechanistic-fragmented). To separate the sheep from the goats is a useful and familiar rhetorical device, but it is worth noting that Capra's terms are emotionally loaded ones. For balance, one might do well to hazard a glance at the reality. Here, for instance, is V. S. Naipaul on the dynamic East:

> [Gandhi] looked at India as no Indian was able to; his vision was direct, and this directness was, and is, revolutionary. He sees exactly what the visitor sees; he does not ignore the obvious...He sees the Indian callousness, the Indian refusal to see. No Indian attitude escapes him, no Indian problem; he looks down to the roots of the static, decayed society. And the picture of India which comes out of his writings and exhortations of more than thirty years still holds: this is the measure of his failure...His failure is there, in his writings: he is still the best guide to India. It is as if, in England, Florence Nightingale had become a saint, honoured by statues everywhere, her name on every lip; and the hospitals had remained as she had described them.
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> *An Area of Darkness*
> (London: Penguin, 1974), pp. 73, 81.

Of course, Capra is talking about philosophies, not the actual conditions of societies, but the oppositions posed by his rhetoric are too pat, too simplistic. Capra is fond of quoting Alfred Korzybski's caution, "'The map is not the territory'" (p. 16); neither, in this case, is the rhetoric the reality.

Capra pursues his basic theme with determination, frequently restating his main point "that the principles and models of modern physics lead to a view of the world which is internally consistent and in perfect harmony with the views of Eastern mysticism" (p. 294). For Capra, the key tenet of Eastern mysticism is the unification of opposites, the notion "that light and dark, winning and losing, good and evil, are merely different aspects of the same phenomenon" (p. 131), and he stresses the idea throughout, frequently citing the

Bhagavad Gita. "Unity" certainly sounds better than "fragmented," but here again Naipaul provides a cautionary corrective by showing the problems of this philosophy on a human scale: "Indians have been known to go on picknicking on a river bank while a stranger drowned. Every man is an island; each man to his function, his private contact with God. This is the realization of the Gita's selfless action. This is caste" (p. 78). But possibly I am being too literal, too intellectual, hampered by my Western predilection for rational, abstract, and linear thought to the neglect of Eastern intuition (pp. 14–15). Capra insists that absolute knowledge—the direct experience of reality—is "an entirely nonintellectual experience" (p. 16). Ultimate reality "cannot be grasped with concepts and ideas" (p. 87), but only by means of "a direct nonintellectual experience" which requires "nonordinary states of consciousness" (p. 116, 158). In this case, however, one can argue with Capra on his own terms, using his own example. Dividing the world into separate objects and events, while practical, is not fundamentally true, says Capra: "It is an abstraction devised by our discriminating and categorizing intellect. To believe that our abstract concepts of separate 'things' and 'events' are realities of nature is an illusion." Hence, "the principal aim of the Eastern mystical traditions" is to "readjust the mind...through meditation" (p. 117). This is interesting, for it is an admission that Eastern philosophy is not "natural," but a discipline, a "readjustment." Could it be that the "natural" mind is Cartesian after all, and that it is a fundamental feature of minds to make distinctions? Capra's answer would be that we all fall under the spell of *maya,* or illusion, but it appears that even Eastern minds fall naturally under that spell.

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There is an inherent irony in anyone writing at such length about an ultimate reality he insists is beyond language. And despite the hundreds of pages he has written to convey his beautiful experience of the vision of cosmic harmony, Capra frequently expresses his distrust of language—a lack of trust perhaps natural to the mathematical scientist. Words, for Capra, are never precise, and while "inaccuracy and ambiguity" are fine for the poet, they just will not do for science (p. 19). Words, in fact, can only "clothe" truths in myth and metaphor, images and allegories, rendering an embodiment which is never precise (p. 29). Further—and somewhat paradoxically—language imposes linear limitations (p. 30), as though the clothing were at once too shapeless and too confining. Moreover, Capra believes that language cannot deal with the paradoxical reality of atomic physics as exemplified by the wave-particle duality of electromagnetic radiation (pp. 34–35). Despite his own use of metaphor, Capra cannot have thought about the nature of this figure of speech, for that is precisely the reality that metaphor embodies and expresses. Metaphor violates the logical postulate of non-contradiction because it says that *a* is both *b* and *not-b* in the same sense and at the same time. That is, metaphor is essentially paradoxical. As a matter of fact, the literary culture can manage a rather nice statement of the question posed by wave-particle duality (metaphorically, of course), as when Yeats asks, at the end of "Among School Children": "O body swayed to music, O brightening glance, / How can we know the dancer from the dance?"

In his enthusiasm for Eastern mysticism, Capra takes a narrow view of the West. He admits that Western philosophy has a few mystical elements, but insists they are marginal, not the mainstream as in the East (p. 5). Yet the idea of the unity and interrelatedness of all things in a living universe is not merely a tributary concept, but a basic assumption of English Romanticism. The notion of the unity of all is repeatedly stated by Wordsworth, for example, whether writ large (the culminating vision on Snowden in *The Prelude*) or small (the sonnet "Composed Upon Westminster Bridge"). Capra also displays a two-cultures ignorance of what is shared intellectual currency, as when he writes: "This notion of complementarity has become an essential part of the way physicists think about nature, and Bohr has often suggested that it might be a useful concept also outside the field of physics" (p. 145). The implication, as I read him, is that the idea of complementarity has not been found useful outside of physics, but this is not true. Norman Rabkin, *Shakespeare and the Common Understanding* (New York: Free Press, 1967), begins his book with a discussion of complementarity and how that concept can be applied usefully to dramatic paradox. Rabkin refers to Bohr and Oppenheimer frequently, even paying homage to Oppenheimer's *Science and the Common Understanding* in his title. Not that I expect physicists to keep abreast of Shakespeare criticism, but I think Capra might have suspected that such significant concepts as complementarity and uncertainty have not been ignored by the literary world.

Capra's greatest lapse as a physicist is his failure to emphasize the vast scale differences involved in atomic physics. Scientists usually delight in finding analogies for the nearly unimaginable differences in size, saying, for instance, that "the size of an electron is to a dust speck as the dust speck is to the entire earth," and that "if the outer shell of electrons in the atom were the size of the Astrodome...the nucleus would be a Ping-Pong ball in the center of the stadium" (these examples are from Robert Jastrow, *Red Giants and White Dwarfs* [New York: Signet-NAL, 1969], pp. 11, 14), but it does not suit Capra's argument to stress the differences. At the atomic level, it is quite true, "the solid material objects of classical physics dissolve into patterns of probabilities...probabilities of interconnections" (p. 124). Quantum mechanics had to be developed to describe events on an atomic scale, for at extremely high velocities and extremely small masses, particles have a wave function, but to generalize about the macroscopic world from this basis is misleading. As the literary culture would put it, "Things as they are / Are changed upon the blue guitar." Here, the blue guitar which changes things is the vast difference of scale factors involved. Yes, in quantum mechanics, subatomic particles must be described as probability patterns, as "dynamic patterns which have a space aspect and a time aspect" (p. 188). Yet Capra is filled with admiration for the Eastern mystics who "seem to be aware of the interpenetration of space and time at a macroscopic level, and thus...see the macroscopic objects in a way which is very similar to the physicists' conception of subatomic particles" (p. 189). But is this good? Is it useful? ("Western" questions, to be sure.) Is it true?

Norman Rabkin is much more cautious in making the far smaller leap between the two cultures: "It would be wrong to extrapolate from the physicist's predicament to grandiose generalizations about the split nature of reality" (p. 25). Capra feels no such inhibitions. He extrapolates freely from particle physics to the macrocosm, as when, invoking Mach's principle of inertia, he declares that "modern physics shows us...that material objects are not distinct entities" (p. 195). Yes, but....Here, one longs to imitate Samuel Johnson, who, in answer to Berkeley's idealist argument against the existence of matter, kicked a stone, saying "I refute it *thus*." Is it legitimate to extrapolate in Capra's fashion? And if from the subatomic realm, why not from the other end of the scale? The galaxies are, apparently, self-consuming artifacts which are rushing away from one another at tremendous speed. What philosophical implications are we to draw from that model?

It is not surprising that Capra favors Geoffrey Chew's "bootstrap" hypothesis, which, to simplify, implies that structures observed in nature are only mental creations, and thus sees the universe as a web of interrelated events in which no property is fundamental. "The bootstrap hypothesis not only denies the existence of fundamental constituents of matter, but accepts no fundamental entities whatsoever" (p. 276), declares Capra. The moral and ecological implications of an emphasis on interrelatedness seem fine, but are the bootstrap hypothesis and Capra's vision acceptable models for science? Are the physicists likely to give up their search for the basic building blocks of the universe and contemplate instead—in a nonordinary state of consciousness—the harmonious interrelatedness of the suchness (p. 84)?

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Probably not. Nigel Calder's report on the new physics is that the search for the basic building blocks of matter (an idea that Capra finds to be "no longer tenable" [p. 275]) is going forward. *The Key to the Universe* is in large part a survey of the development of quark theory, and is in spirit and tone the antithesis of *The Tao of Physics*. (Indeed, were Capra's and Calder's works shorter, it would be impossible to resist the feeble pun that they provide each other's anti-article.) Calder credits the role of imaginative leaps in science, referring frequently to the "crazy ideas" necessary to progress in physics, but his basic belief, that science is "the most powerful engine ever conceived for the advancement of knowledge" (p. 14), is couched in a distinctly Western metaphor. Calder also distinguishes the two approaches to modern physics in terms of the East/West dichotomy, though this time the West is good, and so he writes that "quark theory and the rise of colour promised to rescue Western science from Oriental despair" (p. 92). For Calder, Chew's bootstrap and Capra's *tao* would be "very bad news indeed for Western philosophy and science, with their objectives of trying to dispel needless mystery from the universe by discovering its fundamental units and laws" (p. 93), if Chew were right. One physicist's ultimate truth beyond the reach of language and science is another physicist's needless mystery to be dispelled, and Calder is convinced that "bootstrap theory...was a refuge in the 1960s, when the known particles and forces made little sense," but that the quark has cleared things up: "The rigmarole about the many guises of the pion lost its mystery once you accepted that pions and protons and neutrons were all composed of quarks" (p. 93). The special importance of quarks is nicely expressed in Abdus Salam's paraphrase of the famous commandment in *Animal Farm*: "'All particles are elementary but some are more elementary than others'" (p. 94).

The allusion to Orwell's political fable reminds us that political philosophy can intrude into science, usually with disastrous results for science, and Calder informs us that Chairman Mao "was said to have taken [the view that the subdivision of matter must go on for ever] and it was favored among Chinese high-energy physicists, who called quarks 'stratons' to indicate that they were just a layer or stratum in the scheme of the universe. But in the West there was a widespread suspicion that quarks were the bedrock" (p. 131). In this case, imposed upon physics from without, the Eastern philosophy is not the liberating force that Capra claims. Calder provides the opposite philosophical and rhetorical stance to Capra—bedrock rather than bootstraps, stern hierarchy rather than dynamic oneness—and at the moment quark theory seems to be gaining strength, for an international team of physicists has just reported evidence of the gluon ("To Catch a Fleeting Gluon," *Time*, 10 Sept. 1979, p. 44). It is certainly fitting that we once more face a paradox, for the "Western" search for the basic building blocks of matter will, if successful, give strong impetus to the hope of developing a unified field theory, the mathematical equivalent of Capra's cosmic dance of harmonious interrelatedness.

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Capra voices what I take to be a fairly standard attitude among the scientists when he says that "the inaccuracy and ambiguity of our language is essential for poets," but that "science, on the other hand, aims for clear definitions and unambiguous connections" and so prefers mathematics (p. 19). Hence, it is comforting to read a scientist who knows something more about the nature of language and who finds linguistic value where none is seen. Lewis Thomas, *The Lives of a Cell* (New York: Viking, 1974), is certainly aware of the difference between mathematics and language. Our DNA, for example, is an information system, as is language, but the replication system of DNA does not allow deviations from the pattern. It is quite otherwise with language, as Thomas notes: "Ambiguity seems to be an essential, indispensable element for the transfer of information from one place to another by words...It is often necessary, for meaning to come through, that there be an almost vague sense of strangeness and askewness" (p. 94). Convinced that humans share a basic urge to exchange information (p. 112), Thomas sees language as an essentially social enterprise (p. 129). Nevertheless, we would get nowhere, unable to manage all the levels of improbability in human society, if our language and brains lacked "the capacity for ambiguity" (pp. 94, 113). Fortunately, our minds are designed to work this way when dealing with language. Without that capacity, Thomas believes, "we would have no way of recognizing the layers of counterpoint in meaning, and we might be spending all our time sitting on stone fences, staring into the sun" (pp. 94-95). Ambiguity and the capacity to handle ambiguity are essential to our humanity, our creativity, but this does not mean that language cannot be controlled or directed; *contra* Capra, poetic language is the most precise use of language, though it may well express itself in apparent ambiguity or paradox. How *can* you tell the dancer from the dance? At certain times and under certain conditions and in certain ways of thinking, you cannot—and *that* is precisely the point.

Thomas rightly maintains that language is liberating, but, as I have cautioned, language will also take on a life of its own and work in its own ways. Seemingly, language at times wants to make its own point. In his account of the Apollo 11 mission, *Of a Fire on the Moon* (New York: Signet-NAL, 1970), Norman Mailer provides the following instructive parable to illustrate the concept of interface—"that no-man's-land where you joined the mouth of one bag to the mouth of a very different bag" (p. 160)—and the gap between physics and engineering, theory and practice:

> Think of a marriage created by computer, a couple found instrumentally suited to one another: the computer, having studied the questionnaires they filled out, had joined them. But the computer, being new at this variety of human engineering, did not necessarily conceive of every requisite detail and property. Some characteristics are buried. So the couple were perfectly suited except that the husband had a body odor which was repugnant to the wife. Across

> the interface, physics was immediately consulted.
> "Unfortunately," said Physics, "there is no acceptable science of smell."
> "Shouldn't a simultaneity of all other compatible attributes tend to suggest a compatible odor?" asks Engineering.
> "That is the diabolical aspect of all these stinks," confesses the doctor of Physics. "Sometimes a smell is in concert with the collective attribute, sometimes it is out of phase. You will have to solve your dilemma with no help from viable theory" (p. 162).

Cold comfort, this last, but by no great extension the parable can be seen to apply pointedly to the gap between thought and expression —to language, that slippery interface between the physicist and his audience.

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In his writing, John G. Taylor, mathematical physicist at Kings College, London, demonstrates the opposite of a literary bootstrap effect, as he repeatedly pulls the verbal rug out from under his own feet. If nothing else, *Black Holes* (New York: Avon, 1973) demonstrates the diabolical aspect of rampant rhetoric, language out of control and going its own way. Examples are rife. Here is how Taylor begins his book, singing the praises of science, which protects us from the cruel world:

> the results of science are used to provide an artificial environment giving safety and comfort from the buffetings of nature. It is as if man departs from his mother's womb to enter straight into another one created by the scientists ...His final demise can be long delayed. He may even spend his final years as a vegetable, his body being almost completely run by automatic machinery keeping his blood circulating, his lungs still breathing, his vital organs functioning correctly and his bowels satisfactorily empty (pp. 11-12).

Two questions immediately arise: Is he unaware of what he has done? Or does he actually find this image of the womb of science to be a comforting one? It is hard to credit that someone does not perceive the idea of a "human vegetable" to be an image of horror —and here a distinctly scientific horror, at that. One might suspect that he approved of the image and let it go as nothing more than a quirky idea of a happy ending, if Taylor did not keep on arguing against himself in this fashion, without, apparently, any conscious awareness of what he is doing. He can confound his rhetorical stance in a single sentence: "The only hope is to turn to science to get mankind out of the present chaos, especially because science can be blamed for a lot of it" (p. 22). Not especially the best of reasons, I would think.

He also manages this verbal self-betrayal on a grand scale, setting whole chapters against each other. In chapter 1, Taylor lauds "science and the life of reason" (p. 14). He praises the "men of science" (p. 11), the "many-colored wonders" of science and technology (p. 13), and the "scientific method" (p. 16). Opposed to scientific endeavor is what Taylor calls "man's worship of the mysterious" (p. 11), and mystery here includes astrology, anti-scientific activities, fantasy, witchcraft, and orthodox religions (pp. 13-14). Those who are anti-scientific are "the fanatics" (p. 15), members of "the other side" who believe in remote powers and supernatural forces (p. 17). For Taylor, this opposition is dangerous, since he finds historical evidence that mystery-worshipping non-scientific civilizations end in ruin (pp. 18-19). If modern civilization is in a dangerous period, as he believes, facing the threat of "racial suicide," it cannot be saved by ritual. Only science can "face the mysteries of existence" and "rend the veil from the face of the temple of the unknown" (pp. 21-22). This is a clear, though rather strident, demarcation, similar to what Capra does at the beginning of his book.

Capra, however, is consistent. In chapter 2, Taylor refers to the nine-hundred-year life spans recorded in Genesis as evidence of either a biological feature which has died out or a knowledge of time control we have lost; cites Genesis references to "giants" and "sons of God" to speculate about visitors from space; finds archeological evidence that mankind's development has been helped along by extra-terrestrial visitors; suggests the description of the destruction of Sodom and Gomorrah fits an atomic explosion; and notes numerous graphic accounts "describing the visitation of alien space-craft" in the Bible and sacred writings of Asia (pp. 25–34). Taylor admits that Lot's wife turning into a pillar of salt must be metaphorical (p. 33), but he treats the other Old Testament references as scientific fact. This, mind you, immediately after he has spent a chapter attacking religious "mystery." Rhetorically, Taylor has performed a violent about-face: he has gone over to "the other side" and now presents himself as a "fanatic." Language may well be ambiguous by nature, but here it is merely confused and out of control.

If Capra gives us a physics of the laid-back '60s, Taylor recalls the ugly aspect of that decade in his physics of confrontation. His book is pervaded by a militaristic rhetoric whose key terms are power and control, and whose basic posture is confrontation. In earlier times, according to Taylor, it was control of mystery which provided power (p. 41), but now "we must understand our surroundings to gain power over them" (p. 53). We cannot accomplish this, though, unless we are "prepared to look the real world in the face" (p. 40), even to the extent of looking "the infinite in the face as long as we can without flinching and turning tail" (p. 131). Small wonder, then, that imbued as he is with this fine aggressive fervor, Taylor sees a hostile universe of terror and death, epitomized by the black hole, that "most fearsome object" (p. 11). The black hole is Taylor's "ultimate danger" (p. 55), and numbers of them may be "lurking around out there in space ready to trap us" (p. 64). A "cannibalistic black hole on the rampage" may pose serious psychological and physical threats to man (p. 89), but it is no more than can be expected in a universe "full of violent actions and...horrors unfolded" (p. 187).

For Taylor, the threat and payoff of this fearsome object is the immeasurable power it contains, since "a large enough supply will allow us to 'conquer the world'" (p. 91). One feels he puts the phrase in quotation marks only because he really desires to conquer the universe. The frightening thing about such a nakedly eager desire for immense power is that the sought-for energy becomes so quickly equated with the power of destruction. In speaking about energy as "the motive power of the Universe" (p. 90), Taylor misquotes Blake in an ominous, revealing fashion:

> Energy is the only life and is
> from the Body;
> and reason is the bound or outward
> circumference of Energy.
> Energy is Eternal Death.

These are rather well-known lines from *The Marriage of Heaven and Hell,* and the last line is, correctly, "Energy is Eternal Delight." Again Taylor has performed his rug-jerk flip-flop—energy is life/energy is death—but this slip in quoting or recalling Blake's lines underscores to what extent Taylor's mind is tangled in dreams of power and fears of destruction. Consequently, it is with not quite so much surprise that one learns that the black hole is Taylor's "ultimate doomsday weapon," though it is still hard to cope with the extent of his fears: "If a small one made on earth was carelessly—or purposely—dropped it would sink rapidly to the earth's center, where it would promptly proceed to devour the earth with great violence" (p. 190). One can only protest in Watson's terms: no matter how you read this, it smells bad. No matter what a black hole can devour, this fear is hard to swallow. A home-made black hole would seem to be a far more remote threat than the ice-9 of Vonnegut's *Cat's Cradle.*

* * *

Taylor believes that it is good "to have one's mind boggled at least once per day" (p. 103), although he means by the immensity of discovery and scope of thought, not by a staggering use of language. Sadly, Taylor becomes an object lesson in language going its own uncontrolled way. Perhaps it is not fair to single out Taylor, since for his later book on the Uri Geller phenomenon, *Superminds: A Scientist Looks at the Paranormal* (New York: Viking, 1975), Martin Gardner bluntly declares that Taylor "now runs the risk of being remembered only as the British boob of the century" ("Paranonsense," *NYRB*, 30 Oct. 1975, pp. 14–15). It could be that *Black Holes* catches a scientist just slipping over the edge of a mental event horizon. Nevertheless, if the use of language smells bad, how can it be fixed up? Mailer tells us that Engineering has its means in the earlier dilemma: "A deodorant is used" (p. 162). What kind of deodorant can be used with language? How is it possible to exorcise the diabolical aspect of this sort of stink?

Isaac Asimov demonstrates one remedy in his story of black holes, *The Collapsing Universe* (New York: Pocket Books, 1977). Asimov does not deny the universe is violent—there is no other way to describe the causes of a nova, for example (p. 126)—but he finds the universe is also exciting and mysterious (p. 1). Despite the hyperbole demanded by the most extreme phenomenon in the known universe, Asimov's tone is always restrained and backed-off, emphasizing the astronomical distances and time-scales involved: "Will [black holes] swallow up everything eventually? Theoretically, yes, but the rate of doing so may be very small. The universe is 15 billion years old, and yet globular clusters and galaxies still exist unswallowed" (p. 191). If there is a black hole at the center of our galaxy, 30,000 light-years is a "comfortable distance" away (p. 192). Not limited by visions of death and destruction, Asimov can suggest a positive aspect of black holes: they may more nearly be "the creators of clusters and galaxies rather than their devourers," each one capable of having "served as a 'seed,' gathering stars about itself" (pp. 191–192). Here is a reversal of the usual rhetorical expectation, with American Asimov restrained and understated, and Englishman Taylor the hysterical one. By frequently reminding us that much is still speculation and conjecture, "very uncertain and iffy," and that astronomers are not in agreement about black holes (e. g., pp. 207, 218, 227), Asimov makes the recent extraordinary cosmological findings not quite so mind-boggling or threatening, and the universe not so hostile.

For Taylor, it is grimly otherwise: "we must understand our surroundings to gain power over them. If we do not we may be snuffed out at some time in the future" (p. 53). It is unlikely that any true understanding can come out of the attitude of confrontation and domination. A different rhetoric allows a different approach and illuminates a different point of view. For Lewis Thomas, the dominant image is cell fusion, which dramatically reveals the tendency of living things to join up and get along (p. 126). Though we are the dominant feature of our environment right now, we should never forget that we are a part of the system (pp. 104–105). So say Jastrow (p. 64) and Sagan (*Connection*, p. 262), who extend the range of the system and describe man as a child of the stars. So says Asimov, who can imagine a universe-sized breathing cycle (pp. 140, 234). And so says Capra, throughout: we fit into the cosmic choreography, along with black holes and subatomic particles, though we must learn to hear the music and see the dance.

* * *

Richard Feynman, theoretical physicist and Nobel Prize winner, begins *The Character of Physical Law* (Cambridge, Mass.: M. I. T. Press, 1965) with the definition required by his title. Using the law of gravitation as his example, Feynman shows how its characteristics are typical of other physical laws: they are mathematical in expression; they may require modification due to the development of relativity and quantum theory; they are simple in basic pattern, though complex in actual actions; they enjoy a universality of application (pp. 33–34). Since gravitation can be expressed in three ways—as Newton's law, in terms of field theory, and in terms of a minimum principle—another characteristic is the interrelationship of various mathematical statements of the same law (pp. 51–53). In fact, the metaphor which pervades the book is that of *weaving*, for Feynman insists time and again on the apparently fundamental interconnectedness of the laws:

> [A physicist] has only to remember the rules to get him from one place to another and he is all right, because all the various statements about equal times, the force being in the direction of the radius, and so on, are all interconnected by reasoning (p. 45).
>
> We have these wide principles which sweep across the different laws, and if we take the derivation too seriously, and feel that one is only valid because another is valid, then we cannot understand the interconnections of the different branches of physics (p. 49).
>
> with a more profound understanding of the various principles there appear deep interconnections between the concepts, each one implying others in some way (p. 81).
>
> It is extremely interesting that there seems to be a deep connection between the conservation laws and the symmetry laws (p. 103).

Despite this feeling for a texture of interconnections among the physical laws, a discordant note is sounded in counterpoint, serving as a somber reminder of the two cultures polarization. Feynman frequently disparages what he calls "philosophers":

> People may come along and argue philosophically that they like one [way nature actually chooses to do it] better than another; but we have learned from much experience that all philosophical intuitions about what nature is going to do fail (p. 53).
>
> In fact it is necessary for the very existence of science that minds exist which do not allow that nature must satisfy some preconceived conditions, like those of our

> philosopher (p. 148).
>
> The philosophers who are always on the outside making stupid remarks will be able to close in (p. 173).

This is an unfortunate attitude. It is contrary to the implications of his weaving image, and it goes directly against another of Feynman's stated beliefs: "Everybody who reasons carefully about anything is making a contribution to the knowledge of what happens when you think about something" (p. 45). If it is true that "Nature, as a matter of fact, seems to be so designed that the most important things in the real world appear to be a kind of complicated accidental result of a lot of laws" (p. 122), and that in the real world there exist "hierarchies of complexity" (p. 125), why may not the philosopher be afforded the legitimacy of his own methods? After all, it is certainly possible to consider the language of science as a metaphor for a limited realm of experience. If Feynman must have the imagination in a "terrible strait-jacket" of rigorous computation and experimentation, and so put down the "inexperienced, and crackpots, and people like that" (p. 171), I have to side with that more ambiguous mental state in which the imagination is unfettered to stray from the point, to hazard new connections, to think Calder's crazy ideas. And one can hope that that the "vague," "philosophical," and "aesthetic" imagination of the literary world will be free of the prejudice which classifies the uninitiate as the "inexperienced, and crackpots, and people like that."

I much prefer Feynman when he tends to his weaving, when he connects the two strands:

> Which end is nearer to God...Beauty and hope, or the fundamental laws? I think that the right way, of course, is to say that what we have to look at is the whole structural interconnection of the thing; and that all the sciences, and not just the sciences but all the efforts of intellectual kinds, are an endeavour to see the connections of the

> hierarchies, to connect beauty to history, to connect history to man's brain, the brain to the neural impulse, the neural impulse to the chemistry, and so forth, up and down, both ways (p. 125).

The whole structural interconnection of the thing is a shared idea about the nature of the universe that the scientists express in various metaphors. For Lewis Thomas, "Man is embedded in nature" (p. 3), while Jastrow finds a "thread of evidence" and "a chain of cause and effect" linking man to the atom and the stars (p. 8). For Sagan, it is our "deep connectedness" with the rest of the cosmos that is important (*Connection*, p. 52). In a legendary golden age, Sagan reminds us, we were "perfectly interwoven with the other beasts and vegetables," a state that still remains in the brain, where "the R–complex is woven so intimately into the fabric of the brain," one manifestation of "the deep fabric of life" (*Dragons*, pp. 57, 94, 150). Calder refers to the physicist's "cardinal assumption that the very large and the very small were thoroughly connected" (p. 19), and Capra wants us to achieve his vision of the universe as "a web of relations" which exist in "harmonious interrelatedness" (pp. 178, 298). The physicists might well collectively adopt the epigraph E. M. Forster affixed to *Howards End:* "Only connect..."

I take it as an encouraging sign that Feynman avoids the strait–jacket of rigorous proof long enough to end his book with what are most decidedly philosophical and aesthetic notions:

> It is possible to know when you are right way ahead of checking all the consequences. You can recognize truth by its beauty and simplicity...What is it about nature that lets this happen, that it is possible to guess from one part what the rest is going to do? That is an unscientific question: I do not know how to answer it, and therefore I am going to give an unscientific answer. I think it is because nature has a simplicity and therefore a great beauty (pp. 171, 173).

An unscientific question, perhaps. An unscientific answer, certainly, since beauty, like metaphor, is a concern of aesthetics rather than of science. But what happens when a scientist chooses—for whatever reason—to break out of the terrible strait-jacket of mathematics and clothe his truth in words? How is one to body forth the truth in a medium as chancy as language? In a recent essay on "Why Two Cells Fuse," (*Newsweek*, 20 Aug. 1979, pp. 44–45), Lewis Thomas shows us how: "Cell fusion could be used as a metaphor for the way the whole place actually works: we live as the working parts of a planetary system of life in which the urge to join up in partnerships is the underlying driving force in nature." When the metaphor is apt and carefully managed, when the scientist is in as much control of his rhetoric as of his facts, then science and aesthetics are fused in an expression that has all the force of mathematics while still keeping the open-endedness of language. And when this rhetorical fusion is achieved, the literary critics, Gore Vidal's hacks of academe, can only transform any misdirected envy into honest admiration, for a scientist writing well offers up a potent combination of depth of truth and grace of expression. Or, to invoke the last-named quarks, he gives us truth and beauty.