Trading Information

Elementary particle physicists have developed 'languages' that allow them to communicate with one another.

IMAGE AND LOGIC

A Material Culture of Microphysics.
By Peter Galison.
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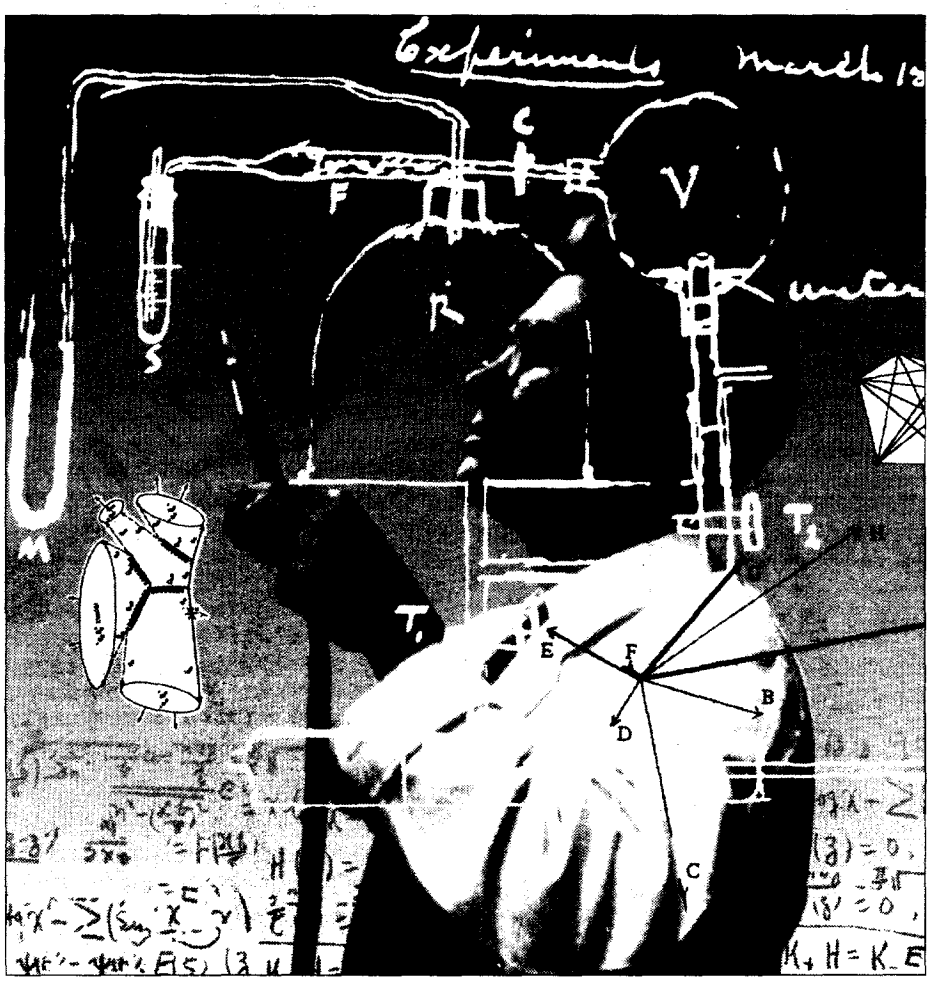

COLLAGE BY KANDY LITTRELL/IMAGES FROM "IMAGE AND LOGIC"

BLAME Alan Sokal. Ever since the publication of his cunning spoof of science studies in Social Text last year, which fooled even the editors of that journal, a vociferous battle has raged, pitting scientists — particularly physicists — against historians, philosophers and sociologists who study what they do and evaluate its impact on the wider culture. So far both sides seem to be shouting past their adversaries in baffling dialects.

Into this supercharged atmosphere comes an important new book by Peter Galison that should add some much-needed rationality to these debates. The result of over a decade's study on the research practices of elementary particle physicists, "Image and Logic: A Material Culture of Microphysics" concentrates on the gritty instruments used to extract (some would say "construct") information about nature's innermost recesses. "I want to get at the blown glass of the early cloud chambers and the oozing noodles of wet nuclear emulsion; the insistent hiss of venting nitrogen gas from the liquefiers of a bubble chamber; the resounding crack of a high-voltage spark arcing across a high-tension chamber and leaving the lab stinking of ozone," he declares.

He does not view the physics community as a monolithic whole. To him it is fragmented into diverse cultures and even subcultures (I can almost hear my physicist colleagues cringing at these words) trading information at the margins between their peculiar practices. Instrument makers build particle detectors that experimenters use to probe nature, while theorists try to figure out what their data mean in terms of abstract concepts and equations.

He cleaves the instrument makers into two major subcultures. There are those whose devices yield visual images — elaborate pictures of particle interactions, in which multiple tracks appear, allowing one to reconstruct in detail what happened in a single event. Others fashion electronic gizmos to register the passage of particles by generating electrical blips or sparks; logic circuitry then records these telltale pulsations as discrete counts. Image-producing detectors supply copious information about individual events, but they are extremely difficult to control. One usually just sets them up in front of a source of high-energy particles (such as cosmic rays or a particle beam) and opens the shutter, hoping for the best. However sparing their information about any one event, logic devices have the advantage of being easily controlled. And they make up for their scarcity of detail by allowing experimenters to record far more events, from which conclusions can be drawn statistically.

Galison, the Mallinckrodt Professor of the History of Science and of Physics at Harvard University, burst on the scene in 1983 as a *Wunderkind.* That year he published a perceptive analysis of pivotal experiments performed in the early 70's that used the mammoth bubble chamber Gargamelle — which photographed particle tracks in thousands of liters of liquid propane — at the European Center for Nuclear Physics (CERN), near Geneva. His focus on such image devices is also evident in his 1987 book, "How Experiments End," which examined how arguments are framed and questions resolved in the laboratory. "Image and Logic" continues his fascination with the visual forms of experimentation as opposed to the electronic ones; it gives short shrift to logic devices, conceding them but half a chapter. And he mentions another important group of particle physicists, the accelerator builders, hardly at all.

He contends that almost all experimenters spend their entire professional careers in just one of these material subcultures. So complex and technologically fragmented has their practice become that few can muster the courage to cross the image-logic divide. Nobody now seems to have the sheer brilliance of an Einstein or the great breadth of a Fermi. While such specialization may be the lot of the average scientist, however, I can think of at least four experimenters — Jerome Friedman, Martin Perl, Melvin Schwartz and Jack Steinberger — who jumped or straddled this chasm during their careers and recently headed off to Stockholm.

As Galison observes, the image and logic traditions have gradually merged during the last two decades: in the powerful colliders now dominating the high-energy frontier, gargantuan industrial-scale detectors completely surround the regions of the colliders where particle beams clash. These goliaths, which he calls "post-modern machines," combine many different elements in multifaceted detectors that yield electronic pictures of particle collisions viewed on computer screens. From the intricately arcing debris, which resembles the explosions of a fireworks display, physicists have managed to deduce the existence of such invisible, ephemeral beasts as charm quarks, tau leptons, colored gluons and Z bosons.

The advent of such factory-style experimentation has had far-reaching implications for the sociology of particle physics and the knowledge it creates. Whereas 30 physicists made a large group during the early 70's, now hundreds of authors' names appear on typical publications — for example, those that recently announced the discovery of the top quark, the heaviest elementary particle known so far. How can such diverse, polyglot collaborations of theorists, experimenters, instrument makers, accelerator builders, engineers, computer programmers and bewildered graduate students ever manage to communicate and reach consensus about the implications of their data?

Not by speaking in a single, universal tongue, Galison argues, but by developing "pidgins" and "creoles" that allow these subcultures to swap their necessary information at the "local trading zones" that crop up among various disciplines. Drawing on recent insights from the anthropology of language, he notes that these groups develop "trading languages" that "bind the diverse subcultures of physics into a larger, intercalated and more resilient whole."

From my own experience as a member of this community, I have to say he has an excellent point. For the "Feynman diagrams" and "parton models" that help us understand the inner workings of subatomic particles — for example — are but illustrative shorthands for deeper, more abstract and far more rigorous theories; these coarse tools permit experimenters and theorists to discourse meaningfully in common, if limited, tongues.

Galison wisely confines his discussion to the sociology of particle physics. He adroitly sidesteps one of the most contentious issues at the heart of current science wars — whether or not scientific practices produce objective truth about nature. And he uses his new vision of particle physics to dispute Thomas Kuhn's well-known idea about how science lurches from one paradigm to the next. At issue is whether scientific measurements stand on their own as arbiters of reality, as the positivists insist. Or are they so "theory laden," as the relativists counter, that they predominantly reflect the biases of the culture that constructed them? Finding serious fault with both viewpoints, Galison stakes out his own bold position based on his polycultural picture of the measurement process.

I only wish he had published a book more accessible to a wider audience than the scholarly readership this one will have. For I suspect his ideas may have broader application to the sociology of knowledge in the Babel that academic culture has become. This is a book that forces its readers to chew and savor, taking time to digest its propositions. I worry that many people outside of particle physics or science studies will not have sufficient patience to forge their way through this rewarding, if ponderous, volume. But "Image and Logic" is a work that cannot be ignored by anyone seriously interested in current debates about the nature of scientific knowledge. With its publication, Galison takes a mighty stand in the middle of these debates, a richly philosophical voice of moderation with which both extremes now must reckon. □

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