

on hiring and termination of American scientists. I feel sorry for those poor bright American scientists and students who have spent time, money and effort to become outstanding professionals, only to find out that no one is willing to hire them. Few of these scientists even know what Congress was busy doing to them last fall.

Scientists need to support such groups as the Young Scientists' Network to protect their employment rights! By the way, Dr. Aylesworth, America's scientists are retraining out of the sciences and into secondary education and law. Perhaps they also ought to run for political office in the US House or Senate. The salaries are great; you are employed for 2–6 years at a time; and you get lots of staff to do your work for you. With fewer lawyers and career politicians in office, perhaps more funding could be spent on research and development programs and on working with business to develop tax incentives for in-house research by private industry.

CYNTHIA A. WALSH

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CLAERBOUT REPLIES: I cannot speak on behalf of all 25 companies that sent representatives to our job fair to recruit students with MS and PhD degrees in geophysics, but I do know that some of those companies offered jobs that were accepted by some of our students. Several of the recruiters did express to me their concern that so few of our graduates are American citizens. Our problem is that despite the availability of fine fellowships and good employment prospects, we receive few applications from qualified American students.

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7/91

Young Faculty's Plight, Older Faculty's 'Shame'

The article on the difficulties young university researchers face in obtaining funding and surviving in the academic physics community (February 1991, page 37) marks at least the 20th year of similar reporting in *PHYSICS TODAY*. A logical conclusion after all this time is that a decent-sized senior-level university constituency likes or at least doesn't mind the current overall system.

A production rate of PhDs that far exceeds steady state is guaranteed by the practice of having at least several graduate students study with each professor. Most of these PhD reci-

pients envision a teaching career, and many will give this course a try, regardless of salary or working conditions. And with an oversupply of willing participants, the university accommodates by maintaining an oversupply of faculty positions compared with an equilibrium case where positions are in balance with funding and other opportunities—hence the scramble for funding.

For years now the senior academic community has said "Tis a shame" regarding the situation. Then why does the production rate continue? Is it the pleasure of lecturing to large classes on esoteric subjects, the idea that at your retirement dinner it will be said that your name appears on hundreds of papers—mostly drafted by others—or a sense of worth from propagating knowledge on one's narrow interests? For many the rationale is a feeling that this approach is the only one that will assure adequate cream to reach the top, regardless of broader losses to society and the individual.

There is something senior faculty can do beyond saying "Tis a shame." You could advise your students of the probability of success in the academic community—you could advise them to get a parallel degree in engineering—you could advise them to marry someone rich. Any and all of these approaches are better than simply saying "Tis a shame" over another story in *PHYSICS TODAY*.

STEPHEN SACKS
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3/91

ELF Effects: Paradigm Shift or Fabric Rip?

I was surprised to see *Currents of Death*, by Paul Brodeur, and *Cross Currents*, by Robert Becker, reviewed by Indira Nair in *PHYSICS TODAY* (December 1990, page 70). In my library those books sit next to the works of Immanuel Velikovsky, J. B. Rhine and the latest on flying saucers.

Becker, an MD schooled in physics, he says, by one elementary college course, attributes all the ills of mankind—from AIDS through depression on to zymosis—to the minute electromagnetic fields in our environment. Similar views are expressed by Brodeur, whose science education seems to be even less extensive. Nair, whose accomplishments in science I consider no greater than Brodeur's, takes much the same line, praising the books of Becker and Brodeur by faint damnation.

In the course of presenting her own version of the Becker-Brodeur thesis, Nair wildly misstates the reasons why good scientists hold these very weak 60-Hz fields harmless. In fact, such fields are considered harmless because their effects on the cellular level are very, very much smaller than kT and thermal noise. And over larger regions, the fields are very, very much smaller than other, indigenous noise fields in the body.

No one has been able to reproduce the "cellular level" experiments that Nair claims have demonstrated the existence of biological effects of such weak fields. The epidemiological studies that she says link weak fields with leukemia and other cancers are neither statistically significant nor free from systematic biases—and there are many negative studies.

I find it ironic that this review is in the same issue where Philip Anderson (page 9) says, "Results that rip the fabric [of science] to shreds must be expected to be almost invariably wrong." But Nair and her colleagues explain the "rip in the fabric" by Becker, Brodeur and herself as a "paradigm shift," thus kidnapping Thomas Kuhn's interesting concept to justify illegitimate science.

ROBERT K. ADAIR
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1/91

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BECKER REPLIES: It is evident that Robert K. Adair's rejection of any biological effects from low-level electromagnetic fields rests entirely on the outmoded concept that kT must be exceeded for such effects to occur. This concept in turn rests upon the also outmoded biological concept that living things are simply chemical machines all of whose functions result from chemical reactions in an aqueous medium. The primary events in detection of light by the retina and in photosynthesis have for a long time clearly indicated that this is not so. Over the past few decades, additional capabilities of living things have been discovered that also violate the kT concept. These include microcrystalline magnetite deposits existing in conjunction with elements of the central nervous system that provide a sensing ability for very weak magnetic fields, and the sensitivity of the retina-pineal system to diurnal fluctuations in the geomagnetic field. At the cellular level, the evidence that extremely-low-frequency fields far below kT influence the kinetics of the cell cycle is overwhelming. Many thousands of humans with bone fractures that have failed to heal have

had the healing process "restarted" by exposure to pulsed magnetic fields or low-level electrical currents, both also well below kT . These and other changes in biological knowledge are discussed and referenced in my book *Cross Currents*. Apparently Adair did not bother to read it.

Clearly biological organisms are more than chemical machines, and the paradigm shift referred to by Indira Nair is in biology, not in physics or engineering. The new biological paradigm is far richer than the old and offers great opportunities for medical therapies as well as cautions for our ever expanding use of electromagnetic energy. Both urgently require full exploration. I regret that Adair apparently feels threatened by these changes, but I reject his arrogance in requiring that living organisms conform to his concept of reality. We have not "kidnapped" Thomas Kuhn's concepts. Adair's invocation of dogma is the inevitable counterpoint of all paradigm shifts.

ROBERT O. BECKER
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9/91

Metric's Man in Congress

The news story on the selection of California Democratic Representative George Brown as chair of the House Committee on Science, Space and Technology (February 1991, page 78) omitted one of Brown's major contributions. Representative Brown has been one of the leading proponents in Congress for the adoption of the metric system of measurement in the US. We can hope that as chair of the House science committee he will see to it that government agencies continue to receive Congressional pressure to obey the metric section of the 1988 Omnibus Trade and Competitiveness Act. That act requires all Federal agencies to do business in metric by 1992. There is clear evidence that most agencies are dragging their feet on this and will need the kind of pressure that Representative Brown's committee can exert.

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2/91

One More Sage from the SEER Project

We are writing to comment on "St. Louis Program Pitches Science to

Girls and Minorities" (May 1991, page 54). We commend PHYSICS TODAY for its lively reporting of a project directed to the solution of a national problem.

At the same time, we deeply regret that the contributions of our coworker and equal partner Clara T. McCrary were not mentioned. McCrary, an elementary school reading specialist, has been an integral member of the SEER (Science Education for Equity Reform) team since the beginning of the project.

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7/91

Missing References on Request

In his review (August, page 59) of the book *1989 Lectures in Complex Systems*, edited by Erica Jen, Philip Holmes notes that part of the reference list of my own article was missing. In fact, the second page of references was printed blank. When I found this in the copy I was sent, and later discovered it to be an error in the whole print run, I too was mortified. (It was in the proof!) If any of your readers would like to receive a copy of the complete list I would be happy to provide it; please note that my address is no longer that given in the book.

Of course the issue of the relation between complexity and physics is a debate you have already exposed in the recent Reference Frame column by Philip Anderson (July, page 9). No doubt it will be discussed for some time to come.

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9/91

Pave a Faster Track for High-Energy Papers

In high-energy physics the current choices for publishing in APS journals are *Physical Review Letters* (fast, four-page limit), *Rapid Communications in Physical Review D* (relatively fast, five-page limit) and *Physical Review D* itself (very slow, no page

limit). What is missing is the analog of *Physics Letters*—something fast but with a longer page limit, so that an experiment can be described in more than the cryptic way imposed by the *PRL* page limit. In particular more room for figures and tables would be appreciated.

What would be great to have is a fast track in *Phys. Rev. D* with, say, a ten-page limit. The current *Rapid Communications* structure is in fact ideal, except that the five-page limit tends to make it a consolation prize for not appearing in *PRL* rather than a first choice in its own right. One could even imagine making most of *Phys. Rev. D* into this format. Could APS lengthen the page limit of *Rapid Communications* and exploit electronic communication with referees to accelerate publication even further?

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3/91

Scientists Who Defied Dictators

It was fascinating to read the various views expressed in the letters on the appropriateness of the National Academy of Engineering's decision to name its award for "contributing to the advancement of human welfare and freedom" after Charles Stark Draper, who developed inertial guidance systems for military applications (November 1990, page 124). But I think enough has been written about those scientists who participated in defense-related projects in different countries throughout the years, in various situations and conditions. Not enough has been said about a few silent heroes, namely those scientists who refused to obey dictators, such as Peter Kapitza, who defied Stalin, or Max von Laue, who defied Hitler. Such people, in my opinion, also deserve mention, for their courage and moral strength.

Questions such as "Is science a discipline capable of inspiring in those who practice it a sense of communal responsibility?" or "Can scientists be moved, as a body, to accept the moral decisions that their key position in this civilization has thrust upon them?" are discussed very nicely by the late British mathematician of Polish origin Jacob Bronowski in his book *A Sense of the Future* (MIT Press, 1977), in an essay entitled "The Disestablishment of Science."

IGOR FODOR
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1/91