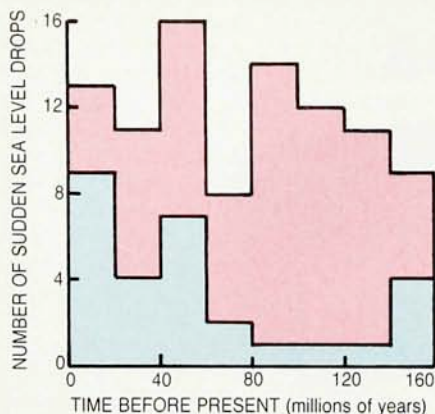




number of sharp (more than 10 meters) decreases in world sea level. The primary reason for the low number of sea level drops (which define geologic sequence boundaries) in the period from about 60 to 140 million years ago, however, is largely that Morris and Muller took their sea level data for this period (the Cretaceous Period) from a source³ that specifically omitted (for proprietary reasons) a detailed version of this part of the sea level curve. A new, more complete version of the sea level data has now appeared,⁴ and analysis of the newly released data shows that the numbers of sharp sea level drops detected during the Cretaceous are actually equivalent to those of more recent times, as shown in the figure above (where the blue region represents the Morris-Muller data, and the orange area the addition of the more current sea level data).

Although this puts in doubt the long-term geologic evidence for Morris and Muller's particular model of impact-induced reversals caused by sudden drops of global sea level, the close correlation of some geomagnetic reversals with evidence of large-body impacts, and the common periodicity among these phenomena, suggests some cause-and-effect relationship.

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3/87

I was fascinated by the Muller-Morris scenario for explaining reversals of the Earth's magnetic field.

Looking at the Earth as a closed system, it is certainly sufficient to state that due to a reduction of the crust's moment of inertia it begins to spin faster, but I found it interesting to examine internal mechanisms of that acceleration.

If we were to move all this water from Miami to Fairbanks by land transport and dump it to freeze, the Earth's crust would be accelerated by the transmission of the Coriolis force exerted through the vehicle to the rails and road surfaces.

The natural transportation of water to the poles might generate eastward forces on the crust through the following mechanisms:

- ▷ An increase in the strength and percentage of eastward surface winds
- ▷ Precipitation falling to the ground with an eastward velocity component
- ▷ A reduction in the flow of water toward the equator, which would reduce the westward Coriolis force those rivers and ocean currents exert on the ground.

If indeed these gentle forces, wind, rain, snow and rivers, can create all the havoc Muller and Morris postulate, one wonders if these forces, which are present today, but in global balance, are truly in balance for each segment of the Earth's surface. Could these forces be contributors to the movement of tectonic plates?

ANDREW BARDOS
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4/87

MULLER AND MORRIS REPLY: Andrew Bardos's identification of the Coriolis force as responsible for the spinning up of the Earth was also made by us in the original paper,¹ although it was omitted in the PHYSICS TODAY story.

The mechanism Michael Rampino prefers for quasiperiodic comet storms, the passage of the Solar System through the Galactic plane, can be ruled out. The original claim that the mass extinctions were correlated in time with the plane crossings² was based on an erroneous use of the correlation coefficient, as was correctly pointed out by Stephen M. Stigler.³ In a computer simulation, 46% of randomly generated data sets showed a stronger correlation with the extinction dates than did the Galactic plane crossings⁴; thus there is no statistically significant correlation between the two sets of data. In addition, the variation of density as the Earth moves through the Galactic plane is

known to be insufficient to cause comet showers.⁵ Even a close or penetrating encounter with a typical interstellar or giant molecular cloud is insufficient to trigger an intense comet shower,⁶ and such encounters are less frequent than close encounters with random stars.⁶

The new version of the sea level data shown by Rampino is subject to the same criticism that he makes of the earlier data—that is, it is incomplete and biased—and no strong conclusions should be drawn from it. That is why we relegated the apparent correlation to a single sentence (and no figure) in our original paper.¹

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10/87

Physics as Profession and as PhD Supplier

It is always depressing to read about the employment and salary woes of PhD physicists, and the May 1987 issue of PHYSICS TODAY was no exception. From my viewpoint as a former physicist who has transferred to a legal career, these stories are embarrassing, and virtually impossible to explain to people out there in the "real world."

It seems to me that the physics community badly needs to get its house in order and, at least in the United States, emerge from childhood. For example, in the letter from Joseph E. Lang and colleagues on page 124, we read that the "underemployed include not only those who have marginal positions but also those highly educated scientists at

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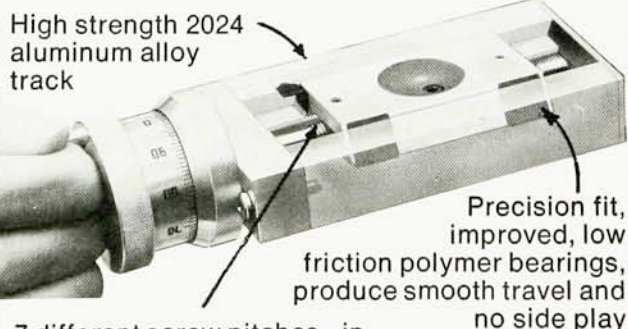
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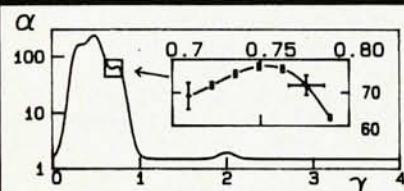
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prestigious research labs who do everything but science" and who "yearn to return to science and to make a respectable living at it." Where is it written that an advanced education is a guarantee that one will be paid to do what one yearns to do?

Lawrence Tyburski's comparisons of physics with professions such as law, business or medicine in his letter on page 126 are inapposite. Those professions have clearly defined roles based on goals of direct service to people. Lawyers are bombarded daily with input on how they should conduct themselves in relation to the social fabric. The physics community has yet to develop a clear notion of its relationship to humanity, and physicists therefore have trouble "selling themselves" in terms of continuing employment opportunities and salaries. As one nonphysicist colleague put it, physics is not a profession, but an intellectual discipline. The comparison should be with people holding advanced degrees in English, history and art, all of whom have similar stories to tell about their employment difficulties.

To many people, if physics is to become a profession it is as a calling that centers around teaching. This means that teaching is not something one does because jobs are scarce, or because it pays the rent while one devotes primary energy to one's research interests. Rather, it is the *raison d'être*, the very reason one chooses to become a physicist. Unfortunately, this is not a point of view that many physicists have, including those with employment problems. If the physics community remains a closed circle, interacting only with itself, it will ineluctably be subject to the fickleness and whims of its patrons, such as the Federal government.

Physicists must develop a concept of service to the community and stop begging for support based solely on the proposition that discovery of new things is good for humanity. In a world where humanity suffers from hunger, I'm not sure this argument will persuade many people that some acres of rich California farmland should be devoted to building an even larger accelerator.

I, for one, would like to hear more from physicists who have turned their education and energies toward forms of service other than their personal research interests, and less from those whose pet projects are not being supported in the style to which they would like to become accustomed. It would be refreshing to see a little more humility in the letters column

of PHYSICS TODAY. To paraphrase a famous author, "The fault, dear Brutus, lies not in our stars, nor in our funding sources, but in ourselves."

FRANCIS H. LEWIS
Alameda, California

6/87

LANG AND HIS COAUTHORS REPLY: It is difficult to believe that a person in the legal profession would find it "embarrassing, and virtually impossible to explain to people out there in the 'real world,'" professional concerns. Perhaps the difficulty lies in an inability to accept physics as a profession with legitimate professional concerns on the same level as law. Webster's second edition does not limit the definition of the term "profession" to the traditional "learned professions" of medicine, law and theology. Physics as a profession does have legitimate concerns related to the education, economic status and career development of its members.

In this age of instant gratification, it is hard for "many people" to appreciate the important contribution that physics research, with its long-term effects, has made to the progress of humanity. Physicists engage in many activities, some of "direct service to people," and some whose effects will be indirect and will be felt only a century hence. To expect our profession to justify itself through only its short-term and direct effects would be to deny physics some of its most spectacular contributions and to misuse the national resource that our profession represents.

Since the physics profession makes such a profound contribution to society (be it ever so indirect and long term), physicists should partake of the financial rewards of their labors consistent with that contribution. The physics profession is not a monastic order; its members have dependents who should not be deprived so that society can reap the benefits of the members' labor. It is, therefore, appropriate that we offer our talents and energies and "sell" our profession to the government and those foundations that can and should take a long-range view. Just as the quality of life in the 20th century has benefited from the "pet projects" of physicists in earlier centuries, the quality of life in the future will benefit from ours. We do a disservice to humanity when we do not call attention to the benefits of our activities. It is incumbent upon our profession to educate the public and its elected representatives about science and what it can do for society. This education should begin in grade school and continue throughout life so that we can have a scientifically

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literate public. If we can share with everyone the excitement of our discoveries, there will be a greater understanding of the function of science. Perhaps only then will we no longer be asked why we do what we do, but instead why we cannot do more of what we do.

The physics community is neither childish nor naive. We are (or as our original letter pointed out, should be) aware of the dynamics of employment and funding. In the past, these have had long-term cycles that adversely affected the health of the physics profession. We ignore these at our peril.

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9/87

I would like to comment on the recent articles concerning the supply and demand of physics research manpower. In the June 1986 issue of *PHYSICS TODAY*, there was much discussion and hand-wringing about the decline in PhD production and the possibility of a "shortage" of PhDs. Let me point out that there is no shortage of PhDs in physics nor is one likely to emerge in this century. The reasons are as follows:

▷ Employment in physics is volatile. For example, during 1969–76, most of the opportunities evaporated. Consequently many people trained in physics found it necessary to retrain and become engineers, physicians, taxi drivers or television repairmen. Another consequence was that many young people wisely chose to avoid the study of physics. No direct mention of these events was made in the June 1986 issue.

▷ Military research is volatile. The emphasis on new weapon development depends on the national mood and on the Administration in power. Both can change abruptly. Yet many physics PhDs are currently employed in military research.

▷ Research funding is limited. Bruce Schechter (April 1986, page 32) points out that "it is vital that the most talented young graduates who elect university careers obtain support for their research," but that "the trends in funding, however, run in the opposite direction." Obtain the number of viable university jobs by dividing the total available funding in "small scale" research by \$100 000. Since most university administrators seem to expect such a level of external funding from their faculty, this calcu-

lation is reasonable. Based on such arguments, it appears there is a surplus of physicists.

▷ A surplus of physicists may be deliberately created. A situation may develop analogous to the one in engineering. D. E. Marlowe, executive director of the American Society for Engineering Education and past president of the American Society of Mechanical Engineers, wrote the following in an article, "Engineering Education: Issues and Answers," in *Mechanical Engineering* (December 1980, page 26): "We may have to create a deliberate surplus in the late 1980s and a pool 'holding' of 'postdocs' in the early 1990s to properly meet the nation's requirements for high-technology engineering in the 1990s."

▷ A current surplus of PhDs is suggested by the fact that about half of the new PhDs take postdoctoral positions. As for more experienced PhDs, many are in soft money positions. As Malcolm R. Beasley and Lawrence W. Jones (June 1986, page 36) indicated, it is in the interest of the universities to make "these positions dignified and rewarding, with reasonable long-term job security," which implies that these positions are now undignified and unrewarding, and have poor job security.

I conclude with two suggestions. Those faculty advisers who seek to behave ethically should inform potential graduate students of the historical aspects of physics employment and unemployment. And if a shortage of PhDs develops, let us alleviate it by recruiting those who abandoned physics for medicine, engineering, carpentry or other fields due to lack of opportunity in the 1970s.

RODERIC LAKES
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7/86

SDI: When Defenses Turn Offensive

There is a hidden assumption underlying many published discussions on the merits of SDI. Simply stated (and in the language of physics), defensive and offensive weapons are presumed to be independent degrees of freedom whose consequences can be independently calculated. This assumption may lead to seductively "obvious" conclusions, for example, "How can anyone be against a defensive system that increases our own safety without threatening the safety of others?" This presumed separability is a forced and artificial distinction. Arguments based on this distinction are immediately suspect, and may indeed have

serious consequences.

One difficulty with presuming a "decoupling" is subsequent, unintended imbalances of power. A good example may be found in the history of the aircraft carrier. During World War I, the airplane was used to gather intelligence, and as such was viewed primarily as a defensive weapon. After the war, many people experimented with modifying battleships to carry and launch airplanes for land and sea reconnaissance. The aircraft carrier, large and lumbering, was viewed purely as a defensive platform unlikely to be an offensive threat. Indeed, under the terms of the Washington Naval Treaty of 1922 battleships could be traded in for aircraft carriers as a way of "disarming" the world powers. However, a small change—the addition of bombs attached to the aircraft—catapulted the purely defensive aircraft carrier into an extremely powerful offensive weapon, one we had encouraged Japan to build. America nearly lost the war in the Pacific by placing its trust in the independence of these two modes of waging war. Thus, the first problem with assuming a decoupling between offense and defense is to underestimate how quickly these roles can be reversed.

The fact that these roles could be interchanged might lead one to believe that offense and defense are manifestations of the same underlying phenomenon, and that treating them separately obscures the true "symmetry" of the problem. Consider two adversaries A and B, armed with offensive weapons (guns). These weapons and their rough equality of strength dictate a particular style of warfare—for example, ambush is an effective strategy. Consider the consequences when A invents bulletproof clothing. By any standard, bulletproof clothing cannot by itself cause harm. It is a defensive weapon designed solely to increase the personal safety of the wearer. But what a difference it makes! Now A can attack B directly, with no fear for his life and able to absorb as many bullets as may come his way. He can move boldly and with a much broader range of available tactics; the same gun is now a much more effective offensive weapon purely through the addition of a defensive technology. Considering whether A would be generous in victory, or whether B might shift the balance by inventing penetrating bullets, shows once again that the tradeoff between offense and defense is illusory.

The real question is not the offensive or defensive nature of the weap-