ing physics. For instance, at graduation this spring among the top twelve graduates from the physics department, a total of six are *not* attending physics graduate school. This has been an increasing trend in the recent months and I expect it to increase in the coming years. And unless the many, many physicists who isolate themselves in research come out for a while to assist in the crisis, they too may well be out of a job quite soon.

I hope you will be able to publish something soon to help inform the tenured physicist as well as the prospective physicist about the increasing problems facing the undergraduate physics major.

GREGORY B. LEONG
*Junior-year undergraduate*
*University of California at Los Angeles*

THE AUTHOR COMMENTS: These letters bring up several interesting points, one or two of which should have been more explicitly recognized in my original article; I welcome the opportunity to respond.

Divgi and others are right, of course, when they emphasize the need to develop reliable methods of estimating future demand for science PhD's. This requires, however, that we estimate the demand both for teaching and for other kinds of work. Cartter addressed himself solely to the teaching demand and demonstrated, I think convincingly, that this can be satisfactorily forecast for some years into the future. The reason Cartter's prediction was little heeded by policy makers, probably, was that in 1965 and for several years thereafter it was easy to believe that the nonteaching demands would readily absorb all available output. We now know better.

The situation differs considerably from one field of science to another. In some cases no trouble has yet developed. Possibly for this reason, a few well known authorities maintain that "supply creates its own demand" and that no real problem exists.

To make good estimates of the future demand for science PhD's in industry and government is extremely difficult. This demand is certain to depend strongly upon such unpredictable elements as general economic conditions, future technological developments, and future socio-political trends. A recent study sponsored by the National Planning Association provides an important illustration. Economic consequences of shifting $20 000 million per year in federal expenditures out of defense and aerospace categories and into consumer industry and social-welfare programs were examined. Under these conditions general employment would be estimated to increase by several hundred thousand jobs, but the prospect would be for a *net loss* of 78 000 jobs for engineers and 10 000 jobs for natural scientists. None of us knows when—or if—a social transformation of this kind will actually take place. These estimates assume continuation of the traditional patterns of research and development in the various economic sectors.

Even if we knew the future demand for science PhD's rather accurately, national policy makers would still face considerable difficulties. The federal government controls only part of the incentives that influence graduate students and faculty, and those which it does control are split up among at least nine agencies—and often over several programs within a single agency. I discussed some of these factors in an earlier paper on graduate-student stipends (*Science* **157**, no. 3796, 29 Sept. 1967, page 1530).

When a situation like the present one arises, the better federal administrators feel just as bad as a lawyer who has lost a case or a scientist whose published results have been found to be in error —and for the same reason. To cry *mea culpa,* as prescribed by Gilinsky, won't help though; as Raymond Bauer says: "Moralizing and generalizing are not the same thing as policy making. Worse, moralizing and generalizing are often done to avoid the responsibility of thinking concretely in policy terms."

Despite the thoughtful comments of the Buffalo group, I will adhere both to my conclusion (that physics PhD's will have to find unprecedented new kinds of employment) and to my exhortation (to approach this inescapable necessity with confidence and imagination) as originally offered. We need to develop attitudes and programs that will diversify the market for scientifically trained people and modify that specialized identification of science with military and aerospace activity that underlies the National Planning Association result cited above.

WAYNE R. GRUNER
*National Science Foundation*
*Washington, D.C.*

## Microfiche for third world

One major impediment to the further development of science and advanced technology in developing and underdeveloped nations is that scientific journals reach us much more slowly than they reach laboratories in the developed nations. There are two reasons for this. Our library budgets are small; thus to maintain a maximum coverage we are limited to sea-mail subscriptions. Secondly, in many cases the postal services are so bad that even after the journals reach the country they may be delayed several months before reaching the laboratory.

It has been suggested that the International Air Transport Association

might accept the shipment of scientific journals at reduced rates, but this piece of special pleading would, we suppose, be resisted because many other people may also feel that they merit special consideration.

We make the following proposal: that every scientific journal should be published in two forms simultaneously, in the present form and in microfiche (or microfilm). Any subscription to the journal would automatically consist of a subscription to one copy in each form. The microfiches could easily be sent by airmail letter-post (this would be much faster even than present airmail subscriptions, because letters receive very much higher priority than parcels or printed matter even when the latter are sent airmail) at a very low cost and if the conventionally bound journal took several months to arrive by sea it would not matter so much. The additional cost of making the microfiches centrally and in such numbers would be very small, and the problem of copyright would not be more acute than at present, since the microfiches would be sent only to people who receive the journal by subscription in the normal way.

We are aware that certain journals are already offered in both forms but with the subscriber having to make the choice between them. We believe that our proposal is superior and that the additional cost would be sufficiently small that the price of subscriptions need not be raised significantly.

Finally we feel that the proposal would also benefit science libraries with more favorable postal services, as they would need to keep the bound journals only for a year or two while keeping a complete record of the literature on microfiche.

ENRIQUE GRÜNBAUM
*President*
CLAUDIO GONZÁLEZ
*Secretary*
*Sociedad Chilena de Fisica*
*Santiago, Chile*

REPLY FOR AIP: The Institute is continuing to study and implement ways of speeding up the delivery of our scientific journals. In Europe, AIP journals and those we publish for our member societies are shipped by bulk airmail to Amsterdam and then mailed to individual subscribers. We are presently exploring the feasibility of this approach for Japan. However, in many areas of the world such as South America, Africa and the Middle East the number of subscribers is not large enough to make bulk airmail shipment an economical solution.

We are also investigating microform publishing including microfiche. The microfiche edition of a given journal can be produced simultaneously with the printed copy and then sent by airmail to subscribers desiring this type of fast service. Some subscribers may want to have both the conventionally bound journal and its microfiche edition. However, the additional cost for this "dual service" would probably result in most subscribers ordering only one or the other.

The microfiche technique presents some other interesting possibilities for the developing nations of the world. One approach involves the production of user-oriented packages of microfiche containing papers taken from a variety of journals covering the various disciplines of physics. The papers selected for these microfiche-user journals would reflect the special needs and interests of users in a particular country or geographical area. Additionally, abstracts of other papers could be added. This microfiche package would be produced on a regular basis, say every two weeks. Arrangements could be made to provide requested individual copies of papers from the abstract section for a nominal charge.

However, there is one major drawback. Microfiche subscribers must either own a microfiche reader or at least have easy access to one. At the present time available microfiche readers tend to be bulky and comparatively high priced. Several book-size microfiche readers, now in the development stage, are expected to be on the market by the middle of next year. The lower price of these units, in the range of $50 to $125, coupled with their compact size, promises to make microfiche journal editions more attractive to individual subscribers. We are following this development closely and will be ready to meet the expected demand for microfiche editions in the US and overseas when a compact, low-cost, high-performance microfiche reader becomes available.

R. H. MARKS
*Associate Director for Publishing and Information*
*American Institute of Physics*

## Tachyons revisited

I have read with great interest Olexa-Myron Bilaniuk's and George Sudarshan's article on "Particles Beyond the Light Barrier" (May 1969, page 43). I found it enlightening and instructive, and I admire the clarity of their presentation.

However, I wonder whether the names that were assigned to the particles they were discussing are the best that could be chosen. The term *tachyon* for a particle whose velocity is

*continued on page 79*