physics.

After 10 years (including a PhD) in "applied" thin-film physics, I revolted and began doing research in "real" physics. I have seen both sides close-up and have the distinct impression that they are fundamentally different worlds. A generation ago, there were *basic* unknown aspects in nature that could be studied in condensed-matter processes. The division into physics versus chemistry was quite natural. Today we understand the general structure of non-relativistic, quasi-particle phenomena, though the detailed calculations are quite difficult and challenge the best minds. This "in principle" understanding, however, has moved these studies from the realm of physics toward the realm of chemistry, where we also understand, "in principle," how atoms bond. These general areas, based upon many-body non-relativistic quantum theory with electromagnetic coupling, should be called something other than the study of physics, perhaps "physistry" (to be practiced by physists). This includes materials science, plasmas, much astrophysics, all biophysics, solid-state, and chemical physics.

Only in cosmology, gravity theory, nuclear and subnuclear studies do we find basic open questions of fundamental principle, like those that occupied physicists a hundred years ago. Probably none of these open questions has any usefulness to the GNP, if and when they are answered, with the possible exception of nuclear phenomenology. The practical level of information about nuclei is far from the level of possible quark structures for protons and neutrons.

A graduate student should choose between physics and physistry; they are not philosophically alike nor have comparable economic prospects. Their present common bond is Feynman diagrams, but this will probably fade, I think, when strongly coupled systems are eventually properly and successfully developed, theoretically.

Making this split is a good idea, philosophically, but not financially. Obviously, our society finances physics largely because it hopes to make some money. It is, therefore, a great advantage for people to think of thin-film semiconductor devices and particle accelerators as part of one structure. The American Physical Society supports this blurring of images, even though most of its members share more common interests, and perspective, with chemists than with physicists.

Writing these observations can only make people angry and be counter-productive, unless we stop kidding ourselves and our students, and recognize the profound changes that have been wrought by the advances in basic physical understanding over the past 50 years. Our institutional structures should adjust to this reality, and I think that some of the institutions that Lazarus condemns are just beginning to do this. The trend should continue, not be reversed.

JAMES D. EDMONDS, JR
Bucknell University
Lewisburg, Penna.
9/20/76

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I read the letter by David Lazarus with amused interest. It would appear that David has put the horse behind the cart! It will not be long before a new and correct model of the physical universe will be found. When it is . . . the goal of theoretical physics will have been completely achieved. At that moment, "pure" physics will cease and *only* applied research will continue to exist.

If David will but wait patiently a few more years, the "real" physicists will disappear and only real ones will be left. Once the accurate model has been found, its teaching will return to the province of the philosophy departments—whose members have temporarily abandoned the search for physical understanding, but will eagerly reattach that "metaphysics" to its natural parent, philosophy.

Accordingly, unless today's "pure" physicists are content to be known as "philosophers" and "metaphysicians," they will have no remaining role at all!

GERALD LEBAU
Elizabeth, N.J.
9/24/76

Support for young theorists

In September it was reported that plans were being made to fund through the NSF an institute of theoretical physics (page 79). Thirty positions would be created, and the bulk would go to one-year visitors on leave from their home institutions, while there would be a core of permanent people.

The most serious problem facing theoretical physics today is the lack of permanent positions for theorists who received their PhD's since 1968 or so. Many excellent and productive theorists have had their careers smashed after several years in the postdoctoral holding pattern led nowhere. To use new funds for positions so that established people can have a year's break seems wasteful, since the recipients would be pursuing physics anyway.

One is reminded of the NSF's elimination of the postdoctoral-fellowship program a few years back, while retaining the summer-salaries program for established physicists. The NSF postdoctoral-fellowship program was the only opportunity a new PhD had to write a research proposal of his choosing and get funds to pursue it. One has the feeling that the major effect of the summer-salaries program was to raise the standard of living of

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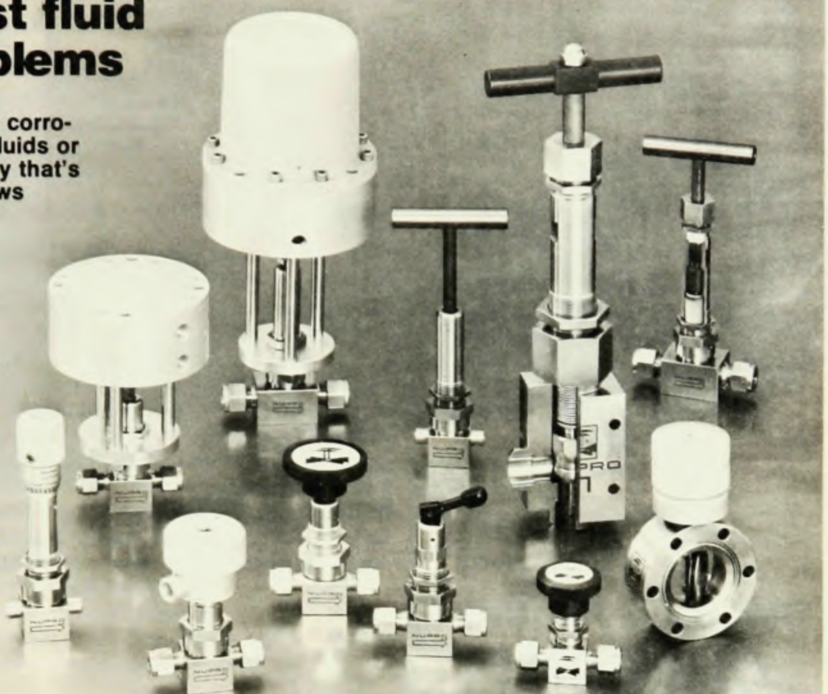

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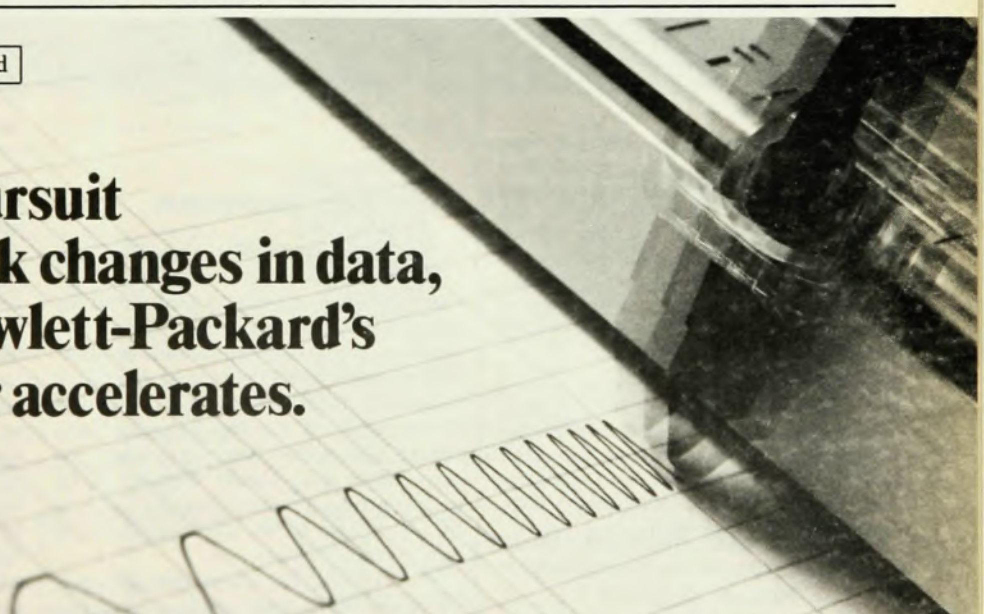

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physicists with adequate incomes who would have spent their summers doing research anyway.

WILLIAM J. MEGGS
Champlain College
10/14/76 *Lennoxville, Quebec*

More on Bell Labs

By sheer coincidence I read H. A. Loehman's letter "Split up Bell Labs?" in the October issue (page 15) on Halloween night. How fitting: "If the whole Bell System were fragmented, then the basic research portion of Bell Labs could be supported either by the communications industry as a whole or by the federal government." Who's he kidding? Destroying one of the nation's best fundamental research organizations, a national resource if there ever was one, for reasons of ideological baloney—what a thought!

HERBERT KROEMER
University of California
11/9/76 *Santa Barbara, California*

Oz expert finds error

I have read all of L. Frank Baum's books, and there isn't any land of Ozma in them like you say there is in your May issue (page 18). Ozma was the ruler of the land called Oz. I think your readers would like to know this.

DANA ENGVEHARD
Bonny Doon Elementary School
9/14/76 *Santa Cruza, Calif.*

Vitreous vs. amorphous

In his recent article (May, page 28), Alan Chynoweth has stated that, contrary to the band-edge tail effects postulated for amorphous semiconductors, optical absorption in SiO_2-lased glasses is not limited by such effects; instead, it can be attributed to residual impurities. I should like to point out that this behavior is expected, rather than being surprising, because silica glass (fused, vitreous SiO_2) and amorphous semiconductors (such as Si, Ge) belong to two distinct classes of noncrystalline solids.

H. R. Philipp has shown that the optical properties of noncrystalline (vitreous) and crystalline (quartz) forms of SiO_2 are almost identical, whereas the difference between amorphous and crystalline silicon is substantial.[1] He suggested that distinction should be made between "optically ordered" and "optically amorphous" classes of noncrystalline solids; SiO_2 and Si being typical examples of these two classes, respectively. This classification is similar to that suggested earlier, namely, that noncrystalline solids with and without a high degree of short-range order should be called "vitreous" and "amorphous," respectively.[2]

Many properties, including optical absorption, of vitreous solids are determined by the short-range order. In the case of SiO_2, for instance, the observed very small difference between the absorption edges of quartz and fused silica (about 0.3 eV) is due to the fact that the noncrystallinity in vitreous SiO_2 arises from the wide distribution (120°–180°) of the Si–O–Si bond angles connecting the $SiO_{4/2}$ tetrahedra,[3] but the structure of these tetrahedra is the same as in crystalline SiO_2. In accordance with the above observation, quantum chemical considerations have demonstrated that the calculated separation between bonding and antibonding orbitals (i.e. the optical bandgap) in SiO_2 increases by about 0.5 eV as the Si–O–Si bond angle increases from 120° to 145°, which is the peak of the distribution in vitreous silica and the value characteristic of alpha-quartz (the increase from 145° to 180° has a much smaller effect).[4]

It is interesting to mention that Ta_2O_5 films used as waveguides in integrated optical circuits, in capacitors and as antireflection films in solar cells are also vitreous. Also, it is well known that vitreous SiO_2 films play an essential role in semiconductor devices and integrated circuits; the flexibility of the noncrystalline structure of SiO_2 makes it possible to produce a very perfect Si/SiO_2 interface (density of interface states is not greater than about 10^{10} cm^{-2} eV). Since there are no grain boundaries in vitreous solids, they do not exhibit those harmful effects that are associated with polycrystalline solids (that is, light scattering, instability due to grain-boundary diffusion of impurities). On the other hand, the short-range order ensures that optical absorption of vitreous solids is similar to that of the corresponding crystal. In contrast with amorphous solids, vitreous solids can be prepared with great reproducibility in high perfection (the density of impurities, traps, etc. can be less than about 10^{15} cm^{-3}). These applications of vitreous solids confirm the point made earlier that studying vitreous solids (e.g. fused SiO_2) appears to be more rewarding from the viewpoint of fundamental understanding and more fruitful from the viewpoint of application than studying amorphous solids (Si, Ge, SiO_x [$x \approx 1$], etc.), which are plagued by poor reproducibility and by other undesired properties (for example, increased optical absorption).[5]

Chynoweth's remark that "from the point of view of the physicist, it is rather sobering to realize how few quantitative answers he could provide" is true not only for glasses used as light guides but also for the various applications of vitreous solids mentioned above. I think that the responsibility, at least partially, lies in the inadequacy of applying the band theory to vitreous solids; the bond description (as