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

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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!

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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.

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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