But the large computer is seldom needed for problem solving by the typical college physics department. In those instances where additional computational power is required, the total resources of the minicomputer system can be dedicated to a single problem. After the "tough" problem is solved, there are three or more off-line teletypewriters—depending on the system—immediately available for on-line applications. If the dedicated small computer is unable to run the program, then time can be rented from a commercial utility.

A far better alternative than purchasing time from a commercial time-sharing utility is to buy your own time-sharing system. It is very low-cost, and the system can be expanded as the need arises and financial resources are allocated. Hundreds of educational institutions throughout this country are starting off with smaller systems and gradually expanding them. For example, a single-user configuration costs approximately \$8500. This system is expandable to a four-user time-sharing configuration for less than an additional \$16 000. Alternatively, an initial investment of approximately \$13 000 permits the institution to expand its single-user system to a multilanguage 16-user configuration whenever the need arises or financial resources are allocated.

In comparison with a commercial time-sharing utility the costs of a four-user time-sharing system are about the same over a three-year period but more on-line terminals are available to students and faculty when a computer system is owned (four terminals instead of one). And the school owns a computer system at the end of the time period instead of having a pile of worthless rent receipts.

I might also add that if you don't have a physicist in your department with a computer background, don't worry. All computer systems come complete with instruction booklets, training courses, and sales experts.

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Solid-state biology?

Freeman Dyson seems to equate theoreticians and snobs in his stimulating article, "The Future of Physics" (September, page 23). With regard to molecular biophysics, at least, I prefer his phrase "scorn of snobs" to Bragg's "scorn of theoreticians." There is plenty of room for both theoreticians and experimentalists in this still relatively new field.

One important area not mentioned by Dyson in his admittedly brief survey, and of great current ignorance, is the solid-state physics of biological materials with high pi-electron densities. (The pi-electrons are those whose wave functions extend significantly out-of-plane in organic ring compounds.) Two examples of such materials are native DNA with its stacked bases, and the chlorophyll-protein complexes in photosynthetic lamellar structures. In fact, the pi-electron density along a single strand of stacked DNA is an order of magnitude greater than that in crystalline anthracene, a favorite object of study among organic solid-staters. Philip Rosen[1] has constructed a Kronig–Penney model for DNA from which he calculates single-electron bandwidths that are between one and two orders of magnitude greater than those for anthracene. Transport kinetics in anthracene is a matter of controversy concerning narrow-band conduction versus phonon-assisted hopping; what of DNA, with its much broader bands? The question is wide open. There is a whole new solid-state physics involving DNA alone.

While a true "solid-state biology," if it ever comes, is still far off, a band-theoretic approach to the properties of the macromolecular structures of biology may be just as important a complement to the currently hegemonic valence-bond approach as it has been to the properties of crystalline inorganic solids. Life, after all, is probably just as much a game for electrons as for molecules.

The physics of biological materials is also of interest in its own right, regardless of applications to biology *per se*. The reason is that study of these materials may lead to new, not-necessarily-biological, technologies. This point is not itself new, of course, most notably having been recognized by Bell Telephone Laboratories some years ago. Possibilities for DNA, with its variety of conformational states, range from highly compact and reliable information storage to room-temperature superconductivity.[2]

The great barrier to progress at present in this new branch of solid-state physics is the lack of significant and substantial confrontation of theory and experiment—theoreticians and experimentalists are still going their separate ways. The situation is rather like that in which metallic solid-state physicists found themselves before they came together on the Fermi-surface problem (Walter Harrison, October 1969, page 23). A certain amount of water is essential for the structural integrity of most functional biological materials, a fact which has thus far severely hindered experimentalists. Theoreticians have concentrated on calculating properties, such as dc conductivity, that have small hope of reliable experimental verification. Solid-state biophysics has not yet found

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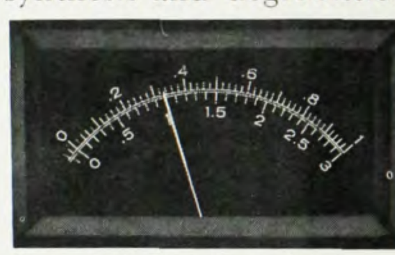

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Finally, I observe the interesting juxtaposition of Dyson's and Bryce DeWitt's (September, page 30) articles. Dyson points out the suitability of particle experimentalists for dealing with the problem of sequencing quantum mechanics in conjunction with consciousness—a presumptive property of certain biological systems. The possibility of a need for a nonlinear generalization of quantum mechanics (distinct from Wigner's proposal) has also been mentioned[3] in connection with certain aspects of particle theory. Perhaps, then, molecular biology calls for the talents not only of solid-state physicists and high-energy experimentalists, but even of high-energy theoreticians!

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Jobs for Negro physicists

In a nation that has at least 10% of its population Negro there are, at most, 1% of the physics community who are Black Americans. Many direct and indirect efforts are under way to redress this gross misbalance. As a consequence colored physicists do not have the difficulties their white brothers experience in obtaining posts.

To correct this imbalance caused by the long racist bias against Negroes in the US such discrimination in favor of nonwhite scientists certainly should, and probably will, continue for some time. Negroes should therefore be encouraged to pursue studies in physics and physics-related fields.

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Vote for microfiche

I wish to support wholeheartedly the suggestion by Enrique Grünbaum and Claudio Gonzalez in their letter (October, page 13) for simultaneous distribution of journals and a microfiche, or microfilm, copy. Their reason is primarily to speed the mailing of publications. The additional argument they give in their last paragraph is, however, of paramount importance to us and, I suspect, to many others. As the journals and the size of each journal in-

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