

letters

I wonder if Jordan realizes that those who use this kind of argument are proposing a whole new concept in our scheme of assessing an entity's obligation towards society: "If the other fellow commits a more heinous crime than mine, go after him, not me." Without entering into long arguments about food-chain concentration, x-ray dosages, and so on, we easily see that the introduction of a "punishment of the worst . . . only" concept is more dangerous to our already strained society than any of the other dangers he gleefully mentioned. Secondly, Jordan informed us (at the IEEE meeting) that a panel of 65 experts had set the safety limits (on reactors), and it is time we all work within them rather than keep on arguing.

I do not believe, as Jordan does, that the burden of the proof is on those of the public and scientific community who claim that the present limits are not safe. Rather, it is for the "experts" to prove the safety of the limits they have imposed on us. We do not need to be reminded that a panel of experts decided that Galileo's books should be burned, and that the same panel came close to burning Galileo himself. In more recent times, "expert" panels have been reducing allowable radiation dosages with rather alarming regularity, and I doubt that we have seen the last of that.

But the saddest fact of all is that this needless argument has to go on. Jordan and those who think like him try to make us believe there are only two alternatives: reactor power or eventual depletion of oil and coal under a smog blanket. There is a third choice: Reactors can and will be made clean. The nuclear industry is now fighting a losing battle, and either voluntarily or through legislative action they will clean their reactors. I am looking forward to the day that we can live at peace with the clean atom.

Leon Kaufman
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The author comments: I do, of course, deny that I attempt "to justify industry's apathy and short-sighted self-interest." I have tried to show that there are some very real benefits from nuclear energy; I based my estimates of the risks due to low-level radiation on the publications of the International Commission on Radiation Protection, a body of eminent scientists who make it their business to evaluate all of the data on radiation effects. Their figures for the maximum permissible dose to occupational workers is 5 rem/yr; to individuals not engaged in work with

radiation 0.5 rem/yr; and to the population at large 170 mrem/yr. These figures are based on a linear extrapolation from exposures to mice and other mammals at doses of 100 rem or higher and at high dose rates. I certainly would not attempt to convince Kaufman that these are safe limits, or even that the analogy with Galileo is not very accurate. Indeed with the *assumption of linearity between dose and effect* there is no such thing as a "safe" dose; only that the risk becomes vanishingly small as the dose approaches zero.

The average genetic dose to the overall population of the US is some 90 to 150 mrem due to natural radiations plus an additional 55 mrem/yr due to diagnostic medical x rays. It has been argued that the x-ray dose could readily be decreased to 25 mrem/yr. In either case most of us feel that the medical dose entails a benefit well worth the risk.

The Public Health Service has recently conducted an extensive survey of the radioactivity released by the Dresden nuclear-power station. They considered all pathways by which nearby residents could receive radiation and concluded that a person living near the boundary for an entire year might receive a dose of 5 to 7 mrem. The Dresden reactor is one of the oldest operating reactors; newer designs provide for considerably reduced release of radioactive liquids and gases. The estimated dose at the boundary of a modern nuclear power station is less than 1 mrem/yr. That should indeed end the argument as to whether reactors "can and will be made clean."

Walter H. Jordan
Oak Ridge National Laboratory

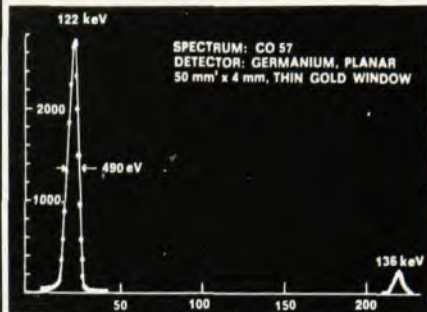
Solid-state biology

I should like to present a more optimistic view of the present status of "solid-state biology" than that offered by Robert Pearlstein in his recent letter (January, page 15).

A combined theoretical and experimental foundation for solid-state biology has already been laid, and has been summarized in several reviews.^{1,2,3} Because most of the literature of the subject has appeared in the biological journals, it is not widely known among physicists, a deficiency which this letter is intended to help correct.

Theoretical studies have shown that the kinetics of several important large-molecular-weight or particulate enzymes (especially cytochrome oxidase) are most easily explained from the hypothesis that electron conduction through the solid enzyme particle is the rate-limiting process.^{2,3,4} Experimental studies of semiconduction in

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Quantum Mechanics—Non-Relativistic Theory

by L. D. Landau and E. M. Lifshitz, *U.S.S.R. Academy of Sciences*. Translated from the Russian by J. B. Sykes and J. S. Bell.

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dried enzymes and other proteins give results consistent with the behavior of the functioning enzyme.^{4,5} An indication for a polaron conduction mechanism in the enzyme cytochrome oxidase has been obtained.⁴

Photochemical reactions in various biological systems (nerve, eye, photosynthesis) follow the Roginsky-Zeldovich equation, which has long been known to describe charge-transport processes across inorganic semiconductor surfaces. A solid-state theoretical derivation of this equation applicable to reactions at both biological solid surfaces and inorganic surfaces has been developed.^{2,3}

The concepts and theory of solid-state theory have also been applied to ionic processes in the living cell, because of evidence for crystallinity of cell water, and for complexing of conductive sodium and potassium ions by cell macromolecules.^{6,7} Theoretically, therefore, one may treat ions dissolved in structured cell water like conduction-band electrons, and complexed ions like valence-band electrons in a semiconductor.³

The field of solid-state biology is wide open to the solid-state physicist, but it is extremely difficult because of purification problems and because of the essential role of water in living systems. Purification and analysis of state of purity of high-molecular-weight enzymes, such as cytochrome oxidase, is extremely difficult; one may reach a point beyond which purification destroys enzymatic activity and therefore destroys relevance of physical measurements to biological reality. To achieve biological relevance, semi-conductive measurements on biological solids, such as proteins, should be made in a wet system. Unfortunately, protonic conduction in the water around the particles then interferes with measurements of electronic conduction within the particles. These experimental problems of solid-state biology are significantly more difficult than those already being faced by the organic solid-state physicists, as well summarized in a recent book.⁸

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Switch to microfiche?

I would like to add my support to the suggestion of Enrique Grünbaum and Claudio Gonzalez (October, page 13). I have recently bought a microfiche reader for my own use to avoid being swamped in a sea of reports within my specialty (reactor physics). Contemplating the volume of my bookcase space taken up by archival journals (I belong to several scientific societies), I would cheerfully prefer to have the future issues delivered in microfiche only. Aside from storage advantages, I have discovered that microfiche reading permits more convenient scanning, which is what, I am sure, most readers do with most articles. Of course, it is nice to have some articles to read and study in page form, but there are many, many of us with access to microfiche page-copying machines. All I would ask is approval to duplicate one copy without copyright worries.

As to price and availability of microfiche readers: My machine is a small, cheap French one which is quite adequate (about \$50). It, and fancier European machines in the price range you mention, have been on the market for some years. The International Atomic Energy Agency has a system for information handling (International Nuclear Information System, INIS) which includes furnishing microfiche copies of reports, and this system is gaining acceptance in both advanced and developing countries; so there must be an acceptable number of user's machines in existence.

In brief, I don't think that study of the idea would take very long before a conclusion is reached that providing a microfiche alternative to journal subscribers is a good idea.

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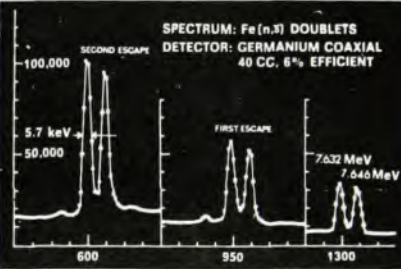
Doctor of Arts degree

The present focus on PhD employment difficulties promises to obscure both the need for certain types of advanced-degree people and what is being done to provide the best postbaccalaureate education to satisfy those needs. I refer to the continuing demand for well continued on page 61

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