letters

Synchrotron radiation facilities

Your report on the growth of synchrotron radiation facilities (February, page 21) shows that neither the government nor the science community is willing to make the hard choices I believe to be necessary to create the kind of university–government lab–industry vertically integrated system to maintain a reasonable US position in international *technology*. The DOE Office of Basic Energy Sciences official in your story is reported to have posed the question: "Compared to other needs, is the US overextended in synchrotron radiation?" Which other needs? Other analytical tools, in solid-state science, or solid-state technology, all of materials research, or all of science and engineering? Reductionism wins again; by narrowing the question, scientists can always shut out their concern for society.

On February 8th when this topic was discussed at the NAS by the Solid State Sciences Panel it was evident that the need for synchrotron facilities had never even been compared to the needs of the rest of solid-state sciences, leave alone materials research or technology. Let us see the results.

Members of the NSF staff present at this meeting pointed to the relatively poor position of the US vis-à-vis Europe and Japan in another part of solid-state science—materials processing. My question to George Keyworth on where he would put the priorities between another synchrotron facility versus additional work in materials processing, received the reply that the US is rich enough to do both. I submit that this is a signal error. Of course, there is enough *money* to do both; but not enough *intellect*. While money is provided for a cadre of our best brains to pursue the simple (and partly trivial, on the Weinberg critieria) and technically "sweet" experiments of picosecond x-ray work, and so on, neither the managers nor the scientists will worry about the dirty, complex, inelegant but more nationally significant work on laser processing of semiconductors or precision tape casting. The codification of this effect, which is my modification of Gresham's Law, is that: "*Narrower and simpler science will always drive out more useful, always more complex hence more difficult, science.*" It was proved on the spot by questioners from the floor at the same meeting, who established that in the materials science program of DOE—the largest by far in the nation—its Office of Basic Energy Sciences did not have a single person trained in polymeric materials (and, I would add, very few knowledgeable in ceramic materials).

If Einstein could produce a half dozen patents on refrigeration and concern himself deeply about the propulsion of torpedos, perhaps by a step-function re-programming of funds and personnel, *some* of the outstanding minds of physics could be turned to the more important and difficult problems in materials processing, of much greater short-term significance to society.

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I read with bemused resignation of the question Don Stevens asked the Lynch subcommittee to answer in evaluating synchrotron radiation facilities: "Compared to other needs, is the US overextended in synchrotron radiation?" An analogous question could well be posed by a perverse surgeon who, after amputating a crushed foot, steps back from the operating table to survey the patient, and with scalpel still in hand, asks a colleague, "Compared to feet, do you think this man may be overextended in hands?"

It is indeed a sign of our times when an exceptionally able science administrator—in his considerable wisdom—must pose such questions.

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COMMENT FROM DOE: Paul Sigler's apparent frustration is shared by many of us, from the bench-level scientist on up. There is an extensive amount of new or proposed research that is not funded, and additional ideas come to our attention daily. However, hard choices must be made, we cannot—nor should we—

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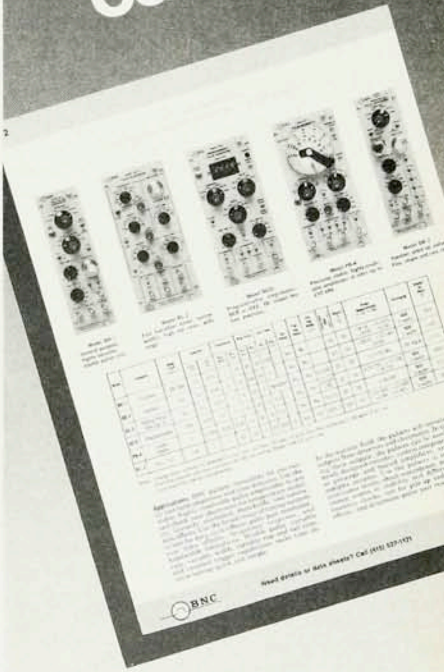

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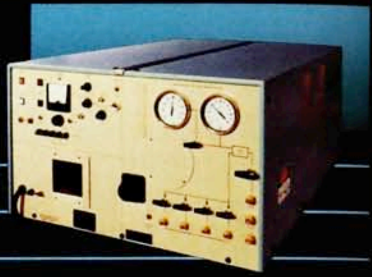

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do everything immediately. I agree with George Keyworth's position that lower-priority research areas must give way to provide the means to give emphasis to more promising areas of research.

The condensed-matter community should take heart in the fact that it is being provided new and expensive research facilities to attack selected areas of research. The community has disagreements over which one comes next and still worse, refuses to face the question which of the existing stable should be shut down. Because of the void that the community constitutionally is incapable of healing, decisions are made by government, a political arena.

My remarks were made to the NAS/NRC Solid State Sciences Committee (not the Lynch subcommittee) in an effort once again to motivate a closing of the ranks to elicit recommendations of priorities of the condensed-matter community as input to the governmental decision-making process.

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Nuclear-waste disposal

I wish to call attention to one point concerning the nuclear-waste-disposal debate that is frequently overlooked in such dialogs (December, page 36). The point of concern is the effect of radiation damage on the integrity of the geological disposal site, particularly for salt-dome or bed disposal. One effect that was obvious from the Lyons, Kansas, test of 1972 was that the physical properties of the salt had changed. The salt next to the cannisters developed a deep blue-black color under irradiation and became very brittle. The coloration changes were due to the formation of colloidal sodium particles in the salt.

Subsequent research at Harwell,[1] Brookhaven[2,3] and elsewhere characterized the growth of colloidal sodium particles in natural rock salt and synthetic NaCl. The growth of sodium metal from the natural rock salt follows a Ct^n dependence where C is a constant, t is the irradiation time (constant dose rate assumed) and n is expected from theory[4] to be in the range 1–2. Recent experiments[3] on samples from various localities measured $n = 1.85 \pm 0.18$. The growth of the colloid is temperature dependent and reaches a maximum in the vicinity of 150 °C. The data, when extrapolated to a dose reasonable for a repository [10^{10} rad(NaCl)], indicate that the salt will contain 0.01 to 10 mole percent sodium metal, and perhaps be completely dissociated by 10^{11} rad. Impurities, brine, and strain in the salt are some of the factors that govern the actual rate of colloid production.[3]

While the implications of these findings are not known at present, they raise considerable questions about the suitability of a rock-salt formation as a permanent waste-disposal site due to the instability of the formation in a high-dose radiation environment.

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The debate on radioactive-waste disposal seemed incomplete because it failed to mention the nuclear-waste implications of underground nuclear weapons tests—both as a source of data and as a prototype method for disposal.

Hundreds of underground nuclear explosions have been set off by the US and the Soviet Union over the last twenty years, and France has recently moved its South Pacific tests underground. The amount of radioactivity released per explosion is smaller than the radioactive waste from a nuclear power plant, but it is not negligible. The one kilogram of fission products produced by a "nominal" twenty-kiloton test equals the amount created in 10 hours of running time of a 2.3 Gigawatt (thermal) nuclear power plant. The residue of each test contains approximately 1–10 kilograms of uranium and/or plutonium. These wastes are intimately mixed with the rock which is vaporized by the heat of the explosion. The mixture cools and solidifies in place.

By drilling back into the residue from old nuclear tests, one can recover radioactive core samples that provide experimental data concerning the stability of the solidified formation. Different rocks can be compared, because nuclear tests have been done in Alaska, Colorado, New Mexico and Mississippi, as well as at the Nevada test site.

If a stable geologic formation can be found and approved, nuclear explosives may be the least expensive method of dispersing the wastes into the rock. If each 20-kiloton nuclear explosive were surrounded by spent fuel rods containing 10 or more kilograms of fission

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