Trümper, Nature, in press (1985); W. Priedhorsky, J. Middleditch, IAU telegram 4060 (1985); L. Stella, IAU telegram 4102 (1985); W. H. G. Lewin, J. van der Klis, J. E. Trümper, IAU telegram 4101 (1985).
3. M. A. Alpar, J. Shaham, Nature **316**, 239 (1985).
4. F. K. Lamb, N. Shibazaki, M. A. Alpar, J. Shaham, Nature, in press (1985).
5. W. H. G. Lewin, J. van Paradijs, Astron. Astrophys. **149**, L27 (1985).

NRC panel assesses magnetic materials research

"The present separation in much of the magnetics community between fundamental and applied activities is detrimental to the development of new [magnetic] materials and applications.... This split manifests itself in departmental boundaries within universities as well as in professional conferences. Magnetic technology has now reached a level of sophistication where this gap [between physicists and engineers] must be closed...." This is one of several key conclusions drawn by the National Research Council's Committee on Magnetic Materials and cited in the report of their deliberations recently published[1] by the National Academy Press.

The committee, headed by Robert White of Control Data, was convened last year by the Materials Advisory Board of NRC at the request of the Defense Department. It was charged with assessing this country's current progress in magnetic materials research and development, identifying key problems that might limit the use of new magnetic materials, and recommending research and development areas likely to yield "the highest scientific and technological dividends within the next decade."

The study was initiated in response to a number of concerns: our increasing reliance on foreign sources for magnetic materials and devices; the declining interest in magnetic materials at US universities; Japan's commanding lead in new technological developments; and military and industrial concern that we may be "losing [our] dominance in a technology that plays a crucial role in the economy [and]... may provide a military advantage to the discoverer of new applications."

Despite the critical importance of magnetic materials, the report concludes, "the US is rapidly losing its competitive position." The committee attributes this slippage to the growing tendency of manufacturers to rely on foreign sources for magnetic components. In contrast to significant research investment abroad—Japan in particular—domestic manufacturers are finding it "difficult to economically justify significant expenditures on new technology."

Recommendations. Reminding us that "a large base of fundamental, exploratory research regularly produces unexpected, often useful results," the committee recommends that "an effort be made to regenerate a strong university-based program in magnetism and magnetic materials." With regard to condensed-matter physics, they cite: transition-metal magnetism, f-electron magnetic phenomena, and disordered magnetic systems. They also stress the need for better institutional mechanisms for coupling fundamental physics research to technolgy. "The advisory bodies... employed by NSF and other government agencies to evaluate [research] programs in magnetism [should] have some representation from applied centers [such as] those recently established at the University of California, San Diego and Carnegie–Mellon University, as well as from industry."

The report identifies three "growth areas" of particular technological promise:

▶ Permanent magnets. In the past decade the quality of permanent magnet materials has improved spectacularly with the introduction of cobalt–rare-earth compounds. However, the report points out, "the supply situation for cobalt is precarious." It was recently discovered that boron, iron and light rare earths form ternary compounds that exhibit magnetic properties superior to the cobalt–rare-earth compounds. The research issue, we are told, is to understand the origin of these good magnetic properties, and how they can be further improved.

▶ Soft magnetic materials "offer enormous opportunity for improvement," particularly through the introduction of amorphous materials. Such materials might, for example, replace those currently used in magnetic recording heads. The recording density of present-day heads is limited by their low saturation magnetizations. Research in this area must address such questions as stability and controllability of domains.

▶ Magnetic recording, the committee concludes, offers "enormous opportunity for innovative research." Increased storage density is crucial if we are to benefit fully from the increasing component densities on semiconductor chips. Better understanding of the magnetic and nonmagnetic properties of particulate and thin-film media will allow tapes and disks "to be designed rather than developed empirically, as is done today."

Fundamental questions. In connection with its recommendation that "the relationships between scientific research in magnetism and magnetics technology be strengthened," the report cites several examples of "fundamental problems whose solutions would advance magnetic technologies":

▶ Surfaces. By what mechanism does a surfactant increase the coercivity of a magnetic particle? Why are the magnetic properties of amorphous films more surface sensitive than their crystalline counterparts?

▶ Fundamental limits. How could one increase magneto-optic or magnetoresistive coefficients by an order of magnitude? Could one design a useful ferromagnetic insulator in which the sublattices are all ferromagnetically coupled?

▶ Statistical physics. What governs the spread in the nucleation fields for an ensemble of magnetic particles?

▶ Amorphous materials. What governs their formation? What is the origin of their anisotropy and magnetorestriction?

▶ Micromagnetics. Much remains to be learned about the dynamics of magnetic domain wall singularities such as Bloch lines. "We believe that the United States has overreacted in its disenchantment with magnetic bubbles by abandoning all fundamental research in this area."

To "bring the two cultures together," funding agencies should look more favorably on proposals involving the collaboration of physicists, engineers and materials scientists, the committee recommends. Such interdisciplinary activity should also be supported by interdepartmental courses at universities, travel grants and tutorial sessions at national conferences.

The report's final recommendation urges the formation of a national resource center for the assimilation of magnetic materials information. Pointing out that more and more information is making its first appearance in the Japanese literature, the committee strongly endorses the recent decision of the IEEE Magnetics Society to publish translations from the Japanese journals, and it urges more effort in this direction.

—Bertram Schwarzschild

Reference

1. *Magnetic Materials*, Publication NMAB-426, National Academy, Washington, D.C. (1985). □