AIP and IUPAP Meet in Washington

The annual meeting of the corporate associates of the American Institute of Physics (AIP) this year was combined with the 19th general assembly of the International Union of Pure and Applied Physics (IUPAP), the latter a triennial event. Sessions were held at the facilities of the National Academies of Sciences and Engineering, Washington, DC, September 30–October 2. The theme of this year's gathering was "Physics in a Technological World," and speakers from a variety of institutions and physics subdisciplines addressed the state-of-the-art as it applies to both basic research and technological applications.

Prof. D. Allen Bromley (Yale University), outgoing IUPAP president.

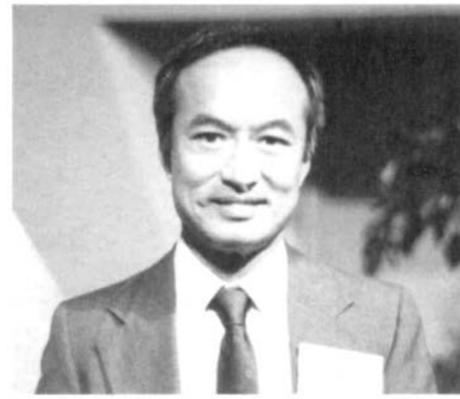
Introductory welcoming remarks were presented by National Academy of Sciences president Frank Press, American Physical Society president Val L. Fitch, and the chairman of the AIP Governing Board, Hans Frauenfelder (professor of physics, chemistry and biophysics, University of Illinois, Urbana). The remainder of the first morning was given over to a lecture by Prof. D. Allan Bromley (Yale University), outgoing president of IUPAP. His talk on "The State of Physics: a Tour d'Horizon" covered a broad spectrum of leading edge developments in physics. Bromley briefly highlighted such topics as increased evidence against the existence of a fixed ether à la Michaelson and Morley, the absence of hidden variables in the quantum theory, and progress toward grand unification of the electro-weak and strong forces. He referred to interesting events which impact on time reversal noninvariance, Higgs Bosons supersymmetry, and string theory, which compete as explanations for the existence of mass in the universe. A common theme through his high energy physics remarks was the need for higher energy accelerators to test these competing hypotheses. He went on to discuss the search for proton decay, the advent of laser techniques in nuclear physics, heavy ion collisions, and the proposed heavy ion accelerator at Brookhaven National Laboratory.

Under the category of atomic physics, Bromley mentioned optical cooling and optical traps for atoms, single electrons in Penning traps, increased accuracy in distance measurements, the advent of a soft x-ray laser, and progress in inertial confinement fusion. Under condensed matter physics, Bromley noted the quantum Hall effect and the new high temperature superconductors. In astronomy, he described the Super Nova 1987A and discussed questions regarding the mass density of the universe. Advances of astronomy using wavelengths of radiation well beyond the visible were emphasized and adaptive optical components were mentioned. Bromley particularly noted evidence of gravitational radiation from binary pulsars and the gravitational lensing effect deduced from the behavior of quasars behind heavy galaxies. In summary, with the recent excitement over superconductors, superstrings and supernovas, Bromley contended that physics had a "super" year, and that this all portends well for the future of the science.

During the afternoon of September 30, the topic was the "roots of high technology." Discussions revolved around the involvement of government, as both a funder of basic research and a customer for basic research, and as the sometimes unintentional influencer of the environment of basic research. Pierre Aigrain discussed the roles of government. H. Casimir described the character of research in an industrial environment. Hans Mark (University of Texas, formerly of NASA) discussed international exploration of space, describing successful international collaborations, particularly those little exposed in the press between the United States and the USSR. Despite the often-heard rationale that international cooperation in science is good for international politics, Mark stated his belief that there is no cause-and-effect relationship between the two. Mark ended by proposing the international cooperative creation of a lunar astronomical observatory, with the first observations scheduled by the year 2000.

After astronaut Joseph P. Allen (now with Space Industries, Inc.) showed compelling pictures of the effects of the gravity-free environment in space, Joseph Demuth (IBM) described the scanning-tunneling microscope and its rapid development to a commercialized characterization tool.

The following morning was led off by Alfred Cho (AT&T Bell Laboratories), who



Alfred Cho, director, Materials Processing Research Laboratory at AT&T Bell Laboratories.

described artificially structured materials, concentrating on those that can be engineered layer by atomic layer using molecular beam epitaxy. Michael Fisher (Cornell University) then described what might be called "flat land phases." He discussed the phase diagrams applicable to the adsorbed surface layers on materials and how they undergo unique phase transformations as a result of their low dimensionality. The fractional quantized Hall effect was next described by Horst Stormer (AT&T Bell Laboratories), and the new 90 K superconductors were described by C.W. (Paul) Chu (University of Houston). The morning session concluded with a summary of superconductor applications by Yu Ossipyan, Director of the Solid State Physic Institute of the USSR's Academy of Sciences. Attendees were then offered the opportunity to tour the Goddard Space Flight Center or the National Bureau of Standards.

The presentations on October 2 centered on frontiers of physics applications. Hans Frauenfelder explained the hierarchy of biological molecules and current thinking on the structure and applications of physics to them. Paul Alauterbur highlighted advances of medical imaging, and Paul Fleury (AT&T Bell Laboratories) considered physics in the information age, which largely is based on optical transmission and devices. Brian Petley (National Physical Laboratory, UK) described the pursuit of the ultimate precise values of the fundamental constants. Completing the program were talks on high temperature plasma physics by Harold Furth (Princeton University), on modern atomic physics by Daniel Kleppner (Massachusetts Institute of Technology), on quarks and gluons in nuclear and particle physics by L. Van Hove (CERN), and on particle physics beyond one teravolt by T. Appelquist (Yale University).

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The program, a *tour de force* in covering the state of physics, was much enhanced by many attendees from outside the United States, their trips associated with the IUPAP assembly. In that context, several comments regarding international cooperation were all the more pertinent. Most speakers throughout the meeting alluded to the need for physicists, and scientists in general to increase their efforts to educate the public about their pursuits.

It's interesting to note that a significant fraction of the developments described at the forefront of physics could also have been described at the forefront of materials research—high temperature superconductivity, artificially structured materials, phase transformations in adsorbed layers on crystalline materials, advanced characterization through scanning tunneling microscopy, and optical and photonic materials to name a few.

AIP plans to publish the proceedings of this meeting, which will be edited by Anthony P. French (Massachusetts Institute of Technology). Inquiries about the proceedings should be addressed to Dr. Rita Lerner, American Institute of Physics, 335 East 45th Street, New York, NY 10017.

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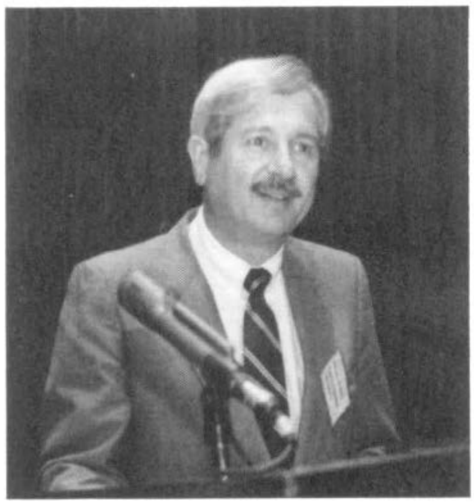
DOE Notes

Fourth Superconductor Information Meeting Held at Argonne National Laboratory

The latest in a series of U.S. Department of Energy information meetings on superconducting materials was held at Argonne National Laboratory, September 21–22, 1987. It was the fourth meeting where researchers from DOE laboratories could exchange information on high temperature superconductor research. As with the previous meeting in May (see MRS BULLETIN, Vol. XII No. 4, 1987, p. 18), this meeting was open to industrial and university scientists as well as DOE researchers. Host on behalf of Argonne and organizer for the sessions was Merwyn Brodsky, who has been closely involved in superconductor research at Argonne. Opening remarks were presented by Argonne director A. Schriesheim and by I. Thomas of DOE.

The first day's sessions covered preparation of and elemental substitution in the new ceramic superconductors. Speakers also considered the current understanding and results of physical property measurements on these new materials. On September 22, ten individual presentations on possible theoretical approaches to the understanding of the high temperature superconductors were offered, followed by a panel discussion on the state of the theory. The meeting was rounded out by speakers concerned with applications-related research.

In addition to the technical discussions, a short session was held to announce the DOE Superconductor Initiative, which involves the creation of centers at the national laboratories to focus on specific aspects of research in the new materials. Ames National Laboratory will be the focal point for information on basic research, Argonne National Laboratory will emphasize such applications as transmission and accelerator components, and Lawrence Berkeley Laboratory will concentrate on applications such as sensors and electronic components. In addition, DOE has created a computerized data base at the Office of Science and Technology Information in Oak Ridge, Tennessee (not associated with Oak Ridge National Laboratory), and has designated Los Alamos National Laboratory the lead laboratory for examining industrial partnerships and joint venture possibilities.



Merwyn Brodsky (Argonne National Laboratory).

For detailed information on any aspect of DOE laboratory research, contact the laboratories directly or the appropriate researchers by obtaining referrals from the Division of Materials Sciences, Office of Basic Energy Sciences, DOE.

Some of the topics discussed during the information meeting are as follows:

1. Observations of T_c as a function of oxygen stoichiometry in the 90 K superconductor $YBa_2Cu_3O_{7-x}$ show a plateau in T_c vs. stoichiometry at approximately 50 K and approximately $O_{6.6}$. This may imply a change in mechanism from CuO chains to CuO planes for superconductivity. (Johnston/Ames)

2. As T_c decreases with decreasing oxygen, the lattice in the yttrium material expands in the C direction, with the copper-oxygen distances in the planes increasing faster than the corresponding distances in the chains. The plateau observed in T_c as a function of oxygen content corresponds to the region of oxygen stoichiometry where a transition from orthorhombic to tetragonal crystal structure occurs. (Veal/Argonne)

3. Using Doppler broadening spectroscopy on positron annihilation radiation, a significant shift in broadening was observed at T_c. Also, the trapping rate for positrons in the yttrium material was seen to increase drastically during the transformation from the orthorhombic to the tetragonal structure. (Veal/Argonne)

4. The positron lifetime as well as the so called "S" parameter in positron annihilation experiments were seen to change significantly at T_c. (Moodenbaugh/Brookhaven)

5. Introducing hydrogen into the yttrium-based material increases T_c by 2 K. (Moodenbaugh/Brookhaven)

6. Under transmission electron microscope examination, evidence of degradation in the yttrium-based material was seen as an amorphous periphery on grains which are otherwise perfect toward their interiors. These amorphous regions are found associated with a particular type of crystalline defect (copper-oxygen layer doubling) which may be related to the formation of the damaged or amorphous layers. The extra copper-oxygen chain inserted along the B axis between barium layers is believed to be a defect associated with low temperature decomposition. It is possible that the long-time low-temperature (500°C) anneals of these materials can actually have deleterious effects. (Stacey/Berkeley)

7. Better properties for the yttrium-type materials can be achieved if, instead of yttrium, the mid-rare earths such as Eu, Gd, Dy, Ho, and Er are used because processing can be achieved at temperatures 30–50°C higher. (Quinn/Los Alamos)

8. Thin films of superconducting yttrium-based phases as well as Gd, Ho, and Dy substituted phases have been successfully prepared by laser ablation of compound targets followed by annealing of substrates in oxygen. This work was originally demonstrated by scientists at Bell Communications Research (Sales/Oak Ridge).

9. Oriented powders have been produced by applying high magnetic fields which take advantage of the magnetic and anisotropy of these materials at normal temperatures. (Sales/Oak Ridge and McCallum/Ames)

10. Measurements of the coefficient of thermal expansion of yttrium-based material which is oxygen deficient ($O_{6.12}$) shows

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a significant increase in thermal expansivity as a function of temperature at approximately 450°C for hot pressed material. Measurements of Young's modulus on as-hot-pressed materials (nonsuperconducting tetragonal phase), when compared to the same material after annealing in oxygen to form the superconducting phase, show a drastic decrease in modulus for the superconducting orthorhombic structure. This is presumably attributable to twin boundary motion. (Loehmann/Sandia)

11. Methods of explosive consolidation and explosive bonding have succeeded in forming superconducting compacts encapsulated in copper metal in the shape of rods and rings. (Eror/Oregon Graduate Center)

12. No improvement in T_c has been observed by substitution of flourine for oxygen. (several speakers)

13. It is possible that "La_2CuO_{4-y}," studied as the classic starting material for the 40 K superconductor, does in fact show lanthanum vacancies even in single-crystal form. This affects interpretation of observations of both antiferromagnetism and superconductivity in these lanthanum materials. (Morgan/Rockwell International and other speakers)

14. J_c for the yttrium-type material deduced from magnetic measurements shows a high value (1.4×10^6 A/cm^2) at 5 K in as-grown single crystals, whereas a reduced flux-pinning tendency is apparent at higher temperature. Neutron irradiation causes increased pinning at 77 K and only reduces T_c by 2.6 K per 10^{18} neutrons/cm^2 dose. (Crabtree/Argonne)

15. Normal state resistance of the yttrium material as a function of pressure shows a drastic decrease up to 150 kbar. (Phillips/Berkeley)

16. The effect on T_c of isotopic substitution of O^{18} for O^{16} in the yttrium-based materials is now quoted as small but possibly non-zero. (Phillips/Berkeley)

17. The functional dependence of the resistivity on temperature in single crystals of La_2CuO_4 varies drastically between conduction along the C axis and conduction in the basal planes. (Fisk/Los Alamos)

18. Preparation of La_2CuO_4 in high pressure oxygen has produced up to 50% superconducting material in this compound. (Schirber/Sandia)

19. Two-dimensional angular correlation of positron annihilation radiation gives momentum distributions for the electrons in single crystals of the La_2CuO_4 material which show sufficient structure within the Brillouin zone to expect significant comparisons of this experimental data with existing band structure calculations. (Kaufmann/Lawrence Livermore)

20. X-ray diffraction characterization of the superconducting materials is insufficiently sensitive to reveal aspects of the materials which are important for performance. Metallography, even optical metallography, is more incisive in revealing small amounts of second phases. (McCallum/Ames and Cappone/Argonne)

Theoretical discussions covered such topics as one electron band theory calculations, applications of Hubbard models, electronic structure near and within twin boundaries, magnetic polarons, strong vs. weak coupling theory, Eliasberg theory, excitonic-enhancement models, bond-assymetry mechanisms, and coexistance of antiferromagnetism and S-wave electron pairs in the superconducting state. The only way to characterize the theoretical discussions is that they were lively and tended to confirm that the present understanding of the material still allows a wide variety of theoretical approaches.

University Research Instrumentation Awards Announced

Twenty-one universities will receive 24 awards totalling $4.8 million to purchase state-of-the-art scientific instruments for energy-related research. The awards are being made under the Department of Energy's University Research Instrumentation Program.

The DOE received 188 applications from schools throughout the United States in response to its program solicitation. The funds will be used to help meet the needs of universities carrying out DOE-sponsored research in combustion, geochemistry and geophysics, health and environmental effects, and materials science. The universities selected for awards in geosciences and materials sciences, the names of the principal investigators, and the types of instruments are listed below:

Geosciences

- University of California-Riverside (Riverside, CA 92521), Dr. Wilfred A. Elders, stable isotope ratio mass spectrometer.
- University of New Mexico (Albuquerque, NM 87131), Dr. John W. Geissman, superconducting rock magnetometer.
- University of Oklahoma (Norman, OK 73019), Dr. R. Paul Philp, pyrolysis system.
- Stanford University (Stanford, CA 94305), Dr. Franklin M. Orr, triple stage quadrupole mass spectrometer system.

Material Sciences

- Colorado State University (Ft. Collins, CO 80523), Dr. William Fairbank Jr., sputter-initiated resonance ionization spectrometer (SIRIS).
- Lehigh University (Bethlehem, PA 18015), Dr. Kamil Klier, high resolution electron spectrometer system (ESCA).
- University of Virginia (Charlottsville, VA 22901), Dr. Gary J. Shiflet, medium high voltage analytical electron microscope.
- University of Washington (Seattle, WA 98195), Dr. Albert S. Kobayashi, high temperature impact testing system.
- University of Wisconsin (Madison, WI 53706), Dr. David C. Larbalestier, scanning auger microprobe and secondary ion mass spectrometer.

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