interesting to check the new compounds along the same lines.

Last spring, at the Second Rochester Conference on Superconductivity in d- and f-Band Metals, McCallum, Johnston, Shelton and Maple discussed specific-heat measurements on $Gd_{1.2}Mo_6Se_8$. They found in the plot of specific heat as a function of temperature that the specific heat showed a jump at 5.5 K associated with the superconducting transition. But of much greater interest was the pronounced lambda-type anomaly that occurred at about 3.5 K, followed by an upturn at lower temperatures. At the time, the group said it was tempting to ascribe the lambda anomaly to long-range magnetic ordering in the superconducting state.

In further studies on the $Gd_{1.2}Mo_6Se_8$ and other rare-earth systems, the group continued to see anomalies in the specific heat at temperatures below the superconducting transition. The group now believes that some of these materials are indeed undergoing a magnetic transition. The temperature at which this occurs is obtained by extrapolating down from Curie–Weiss measurements made above the superconducting range. Thus, the La Jolla group appears to be seeing the coexistence of magnetism and superconductivity, Matthias explained. The experimenters believe they are observing antiferromagnetism, but cannot be sure until a neutron experiment is done.

At Bell Labs Matthias, Ernest Corenzwit, Joanna Vandenberg and Hartmut Barz discovered a new ternary system, XRh_4B_4, in which X is a rare earth and decided to see whether or not each compound was superconducting. Going through the periodic table, they found[2] that lanthanum and praseodymium do not form the compound, neodymium forms it with a superconducting transition temperature greater than 6 K, promethium is too radioactive, samarium forms it with a superconducting transition temperature at 2 K, and europium does not form it. But gadolinium, terbium, dysprosium and holmium all were ferromagnetic with dysprosium having a Curie point of 12 K and holmium with a Curie point of 4 K. "But wonder of wonders," Matthias explained, "as you went from holmium to erbium, erbium was superconducting at 8.6 K and thulium was superconducting at 9.5 K, temperatures far above anything previously observed for erbium and thulium." The magnetic moment of pure holmium is about 10.4 Bohr magnetons and for pure erbium it is 9.6. "In the past," he went on, "a magnetic moment of 10 was always the kiss of death for superconductivity. It became obvious that either ferromagnetism or superconductivity must be the ground state."

William Fertig at La Jolla studied the XRh_4B_4 system in which the rare earth was gadolinium, terbium, dysprosium or holmium. Down to 60 mK, the materials showed no superconductivity. "As a consequence," Matthias told us, "it seemed to me that ferromagnetism was the ground state. I expected erbium to become magnetic eventually, in spite of its superconductivity."

In the new experiments at La Jolla, Matthias, Maple, Johnston, Fertig, McCallum and Lance DeLong studied the behavior of $ErRh_4B_4$. They started with the crystal at 60 mK, where it acts as a normal conductor, whose resistivity was measurable. As they went higher in temperature, at 0.9 K, in an interval of 25 mK, the material becomes superconducting. It stays that way until it reaches the transition temperature of 8.5 K, where it becomes normal again. The transition at 0.9 K appears to be ferrimagnetic at least, but at this writing the La Jolla experimenters were not sure. Similarly to the ternary rare-earth molybdenum selenides, a striking lambda-type anomaly for the specific heat was observed to accompany the transition at 0.9 K.

The explanation for the disappearance of superconductivity has become an attractive mystery to Matthias. However, he feels that "this result will help our understanding of superconductivity and may eventually lead to higher transition temperatures." —GBL

References

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2.4-meter telescope could orbit in 1983

If Congress and the President are willing, NASA plans to orbit the Space Telescope some time in the fourth quarter of 1983. The Space Telescope is a complete astronomical facility with a 2.4-meter aperture optical telescope, signal detectors and a number of instruments. NASA is asking for $36 million in fiscal year 1978. The total program cost is expected to be $435 million. In anticipation of approval, NASA recently released an Announcement of Opportunity for proposing instruments. (Copies of this announcement can be obtained from the Project Scientist, C. Robert O'Dell, DS-30, Marshall Space Flight Center, Ala. 35810.)

The 2.4-meter instrument is an f/24 Cassegrain telescope with Ritchey-Chrêtien optics. Mirrors will be made from hollow-construction low-expansion fused silica. The device is 46 feet long and will weigh 17 000 pounds. It is to be equipped with remote detectors to convert photons to electronic signals; these might be detectors such as television, a solid-state array, or one of several electronic detectors now under development. Several detectors could operate in parallel. Data will be transmitted to Earth, and the telescope will be controlled from the Goddard Space Flight Center in Greenbelt, Maryland.

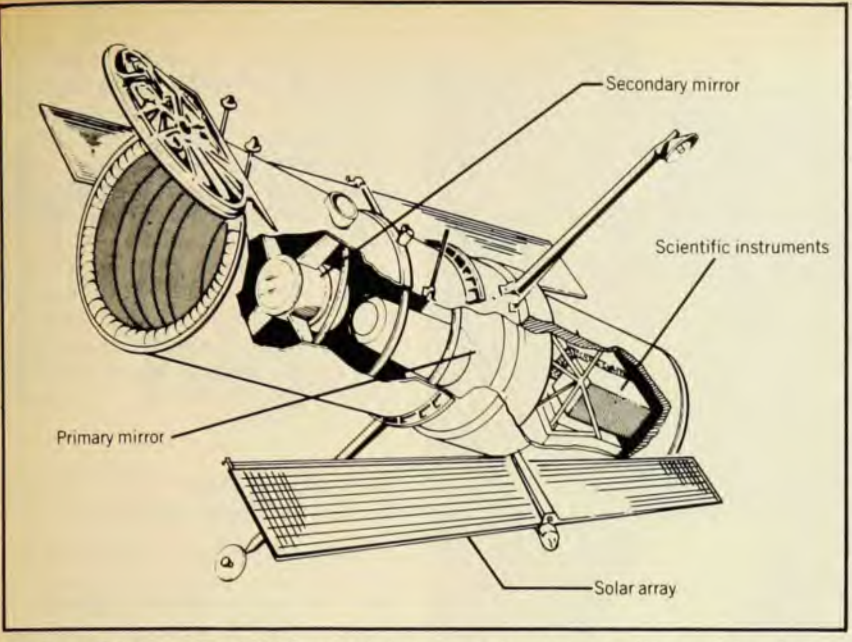
The Space Telescope is to be launched by the Space Shuttle into an orbit 300 nautical miles above Earth with an inclination of 28.8 deg. The shuttle would then return to Earth; every two or three years the shuttle would visit the telescope to make repairs and change or add instruments. At roughly five-year intervals, the shuttle could bring the telescope back to Earth for major repairs as needed, and then the device could be orbited once again. The total design life in orbit is at least 15 years.

The telescope facility has room for five scientific instruments, although five will not necessarily be flown in the initial launch. Two instruments that are definite are a wide-field camera (which is capable of seeing 28th magnitude objects and whose field of view would be several arc minutes) and a faint-object spectrograph (which can be used in both the extreme uv and the visible). A third instrument that has been seriously considered is an infrared photometer, which would make the overall spectral range be 1 mm–1150 Å.

NASA is in the final stages of negotiating an agreement with the European Space Agency for participation in the Space Telescope program. Last October the European agency voted to spend approximately $88 million for participation in the project. The agency would provide a faint-object camera, the solar-power array, and its share of operating the facility while in space.

Many space scientists are advocating that a special institute be established for the Space Telescope. The institute would be responsible for selecting users, scheduling observations, data analysis and so on.

Observations. O'Dell told us that the Space Telescope will be most useful for three kinds of observations. One is the study of active galaxies such as quasars. The instrument would have an image capability ten times better than if it were Earthbound. If the imaging is done down to about Lyman alpha(1150 Å), one can look at nearby quasars in the ultraviolet to study their evolution because this same radiation is what is observed as optical light in the highly red-shifted quasars. John Bahcall (Institute for Advanced Study), a frequent spokesman for the Space Telescope, notes that many absorption lines are seen in the spectra of large red-shift quasars, corresponding to several different red shifts. One school of thought attributes this phenomenon to very high-velocity clouds shot out of the quasar. Bahcall, on the other hand, feels that many of the red-shifts are caused by material along the line of sight, for example, from a number of large galactic



The Space Telescope is an f/24 Cassegrain instrument whose mirrors will be made from hollow-construction low-expansion fused silica. The device is 46 feet long and weighs 17 000 pounds.

halos. This controversy could be settled by looking at the nearby quasar, 3C273, whose radiation is accordingly not red-shifted as much as more distant quasars (if one believes quasars are at cosmological distances), so that it is observable in the ultraviolet. If Bahcall's point of view is correct, those absorption lines should not be present. If the lines are present, Bahcall loses the argument.

A second kind of observation, made possible because the Space Telescope can see much fainter sources than a telescope on Earth can, is to find the distances of galaxies very far away. Thus one can study the cosmological evolution of the universe.

A third kind of observation is synoptic study of planets, in particular, the study of the outer planets such as Uranus and Neptune, which will not be observed by planetary orbiters for decades. The Space Telescope's resolution will be comparable to the early fly-bys of the inner planets.

The scientists involved in planning the Space Telescope expect that it will be used for the most exciting problems of the day, many of which cannot be identified today. In testimony before the House Subcommittee on Space Sciences and Applications in mid-February, Bahcall explained that studies over the last eight years suggest the Space Telescope would allow a better understanding of planetary atmospheres and meteorology, the search for other planetary systems, studies of clouds where stars like our Sun are now being formed, a search for massive black holes and compact white dwarfs inside globular clusters, a measurement of the size of the universe, and the investigation of the nuclei of active galaxies.

The Space Telescope has appeared in the NASA budget in four successive years. For the first two years, it was called the Large Space Telescope, and the design called for a 3.0-meter aperture. O'Dell feels that because the Space Telescope was the first NASA science program to be submitted as a budget item while still in the preliminary design stage, it ran into trouble with Congress. After pressure from Congress and the Office of Management and Budget, NASA redesigned the telescope in Fall, 1974, reducing the aperture to 2.4 meters. In the old scheme, the systems for pointing and communication (support-systems module) had to be placed in the rear because the telescope itself was so wide. This configuration produced a large moment of inertia. With the smaller aperture, the support-system module could be placed in an annular ring around the center of gravity, thus reducing the moment of inertia. So one could have a simpler, more reliable pointing system. The new design has an apparent reduction in cost of about 20% and a greatly increased predictibility of cost. O'Dell is optimistic that the Space Telescope will finally be approved in this go-round. —GBL

Electron cooling

continued from page 17

held in Moscow in 1974. A subsequent report was given at the National Accelerator Conference in Washington the following year.

In recent experiments, protons at 1.5 MeV are injected from a Van de Graaff accelerator into the ring, where they are accelerated to about 65 MeV in a good vacuum. The 100-microamp beam has a lifetime of about eight hours. The ring has four quadrants and long straight sections. After the protons are accelerated, a 35-keV, 1-ampere electron beam is run parallel to the proton beam in one straight section. Only 0.01% of the electrons are lost in the cooling process; the rest are collected at a kinetic energy of 1 keV.

The Novosibirsk group has found that the relative difference in speed between the proton and electron beams must be less than 2×10^{-3} for cooling to occur. When there is cooling, the lifetime of the proton beam in NAP-M is increased from 900 to 5000 seconds. The proton-beam amplitude is reduced from 1 cm initially to 0.5 mm after cooling. The fractional momentum width after cooling is 5×10^{-5}. Thus, the beam is extremely tight. Betatron oscillations are extremely small. (Fields essentially do not penetrate the beam beyond the Debye length. It is so cold that one cannot observe ordinary Schottky noise.)

Based on a naive theory, cooling time was expected to be about one-half second. In fact, the group finds it occurs in 50–60 millisec. It is this rapid cooling rate that has caused much of the enthusiasm at other labs. Two other puzzling features are a skewed electron velocity and the effect of the magnetic field on collisions.

Potentialities. The excitement about the Novosibirsk results is that if electron cooling gives sufficient antiproton densities, it should be possible to build low-cost, high-energy proton-antiproton colliding-beam devices at CERN or Fermilab. The Novosibirsk group is proposing a p-$\bar{p}$ colliding-beam device with 2 TeV in each beam be built at Serpukhov. At the Soviet National Accelerator Conference last year, a detailed analysis was presented by Ya. Derbenev and Skrinsky.

David Cline (University of Wisconsin), Peter McIntyre and Carlo Rubbia (Harvard University) and Frederick Mills (Fermilab) have proposed and are working with Fermilab staff under Russ Huson to implement the following scheme: Protons produced in the main ring at 100 GeV could strike a target, producing 5–6-GeV antiprotons. These would be transported to the booster synchrotron, injected and decelerated to 200 MeV. (This energy is apparently most suitable for electron cooling.) Then the 200-MeV antiprotons could be transferred to a 200-MeV cooling ring, which would, according to calculation, cool the antiprotons in 60 millisec. These antiprotons would then be collected for several hours until 10^{11} antiprotons were obtained, then injected into the booster, accelerated to 8 GeV and injected into the main ring. Then both the proton beam and the antiproton beam would be accelerated to full energy and allowed to collide with each other in a long straight section.

With a high-energy proton–antiproton