stimulus without changing the energy. Fission is expected to have the same character as the giant resonance, and so far experiments show that in fact it does.

Toledo Commences Operation Of 102-cm Coudé Telescope

Just going into use at the University of Toledo, Ohio is a 40-in. (102-cm) Coudé reflecting telescope especially designed for high-dispersion spectroscopy. An unusual hollow-pier support enables it to accommodate the largest spectrograph one can design with available and contemplated gratings. Also unusual are its optics: All of them (primary, secondaries, folding flats, collimators) are made of a new material, CER-VIT, developed by Owens-Illinois just in time for the Toledo telescope.

The photograph and drawing show the telescope and its mounting. Two and a half floors at the top of the tower are available in the hollow pier, and the entire height of the pier can be made available later. Here will be mounted the reflection grating for high-dispersion analysis. John J. Turin, chairman of physics and astronomy, explains that such research can be carried out despite the inconveniences of a large city; surrounding lights are not a great concern, and Turin estimates that 30–50% of the Toledo nights should be suitable for observation.

The new material for optical parts has so small a thermal coefficient of expansion (less than 10^{-7} per degree centigrade at all temperatures) that the telescope is limited only by diffraction and atmospheric distortion. If you use fused silica for a 102-cm mirror, a temperature nonuniformity of 4° across a diameter or 0.1° front to back will warp the mirror beyond acceptable tolerances. With the new CER-VIT such nonuniformities are completely insignificant.

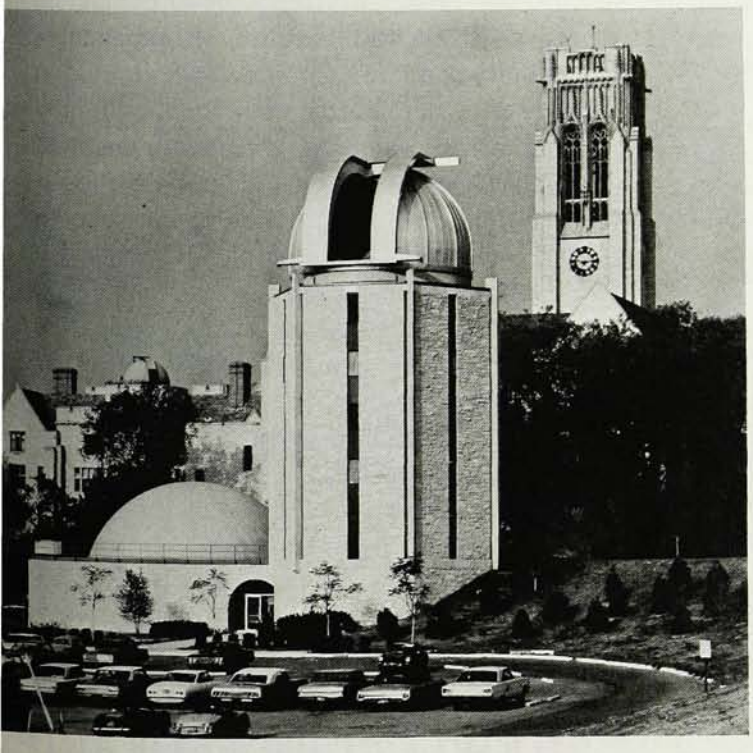
CER-VIT is cast as a glass and then processed to produce a transparent polycrystalline material. Because it is transparent, one can easily inspect it for stresses. Makers of three giant telescopes have recently selected the material for their instruments: the 400-cm AURA (Association of Universities for Research in Astronomy) telescope at Cerro Tololo (PHYSICS TODAY, December, page 59), the 380-cm telescope to be constructed in New South Wales by the Scientific Research Council acting for British and Australian governments and the 360-cm southern France telescope for the French National Center for Scientific Research.

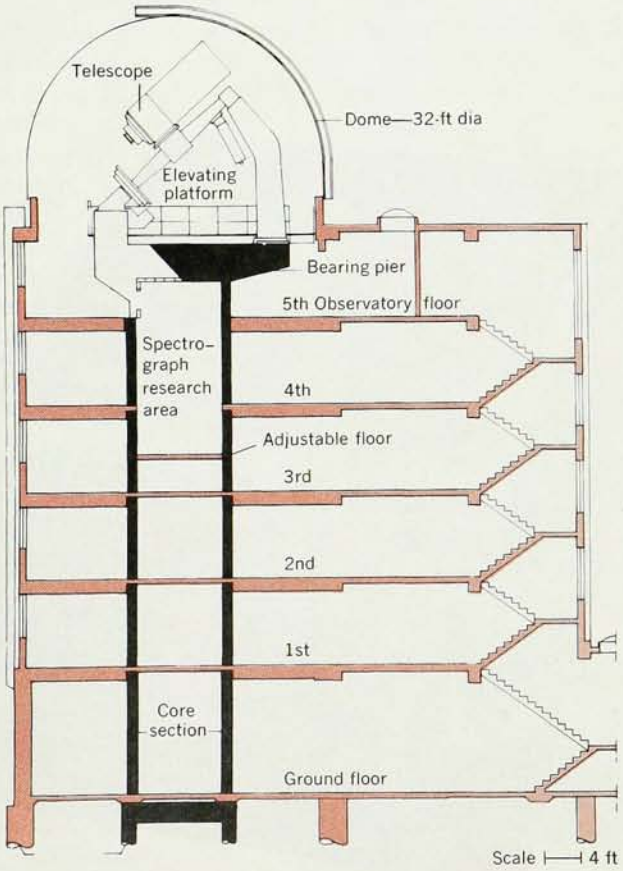
Jodrell Bank Plans Fully Steerable 120-Meter Dish

The world's largest fully steerable radio-astronomy paraboloid, the 250-ft (76-meter) Jodrell Bank radio telescope, will soon have a bigger, fully steerable companion if developing plans mature. Sir Bernard Lovell, professor of astronomy at the University of Manchester and director of Jodrell Bank, recently told PHYSICS TODAY that a final-design contract has been negotiated with Husband and Co. for a 120-meter paraboloid. Husband and Co. are the engineering designers of all the existing telescopes at Jodrell Bank.

For some years British astronomers have been making plans for a tele-

TOLEDO TELESCOPE has all CER-VIT optics; so images are limited only by diffraction and atmospheric distortion. Hollow pier will hold equipment for high-dispersion spectroscopy.





scope that would be bigger than the 76-meter Mark I, which has been in operation for ten years. After a number of feasibility studies and consideration of various engineering concepts, Husband and Co. made a study based on requirements for an instrument that would have theoretical efficiency down to a wavelength as short as 21 cm. The telescope would have half the beam width (four times the power gain) at a given wavelength that the Mark I has. It would also cover three times the frequency range of the Mark I. It would be used both alone and in association with Mark I for a continuation of the radar and radio-astronomical studies of the universe that have been a major part of the Jodrell Bank observational program during the past ten years.

Actual plans to build the instrument will have to wait on completion of the design, which will enable precise estimation of costs. Then, if they are favorably impressed, the UK Science Research Council might finance construction for the University of Manchester. Lovell had originally hoped that a decision to proceed would be made in about a year, but he feels now that the financial crisis in the United Kingdom has made postponement almost certain.

A Visit to Argonne Laboratory—I: High-Energy Physics Research

Although the reputation of Argonne National Laboratory was founded on its reactor-development program, the laboratory is now perhaps equally famous for work in high-energy physics with the Zero Gradient Synchrotron (ZGS), nuclear, solid-state and atomic physics.

The ZGS, now at full intensity, has three bubble chambers to feed, and the laboratory is now building the world's largest chamber (3.7-meter diameter), which uses a superconducting magnet whose outer diameter is 5.5 meters. We recently visited the laboratory, which is about 40 kilometers west of Chicago, to see what kind of physics was being done there.

Zero Gradient Synchrotron. Our first visit was to Robert Sachs, associate laboratory director for high-energy physics, who is in charge of three divisions: high-energy physics (under T. H. Fields), high-energy facilities (R. J. Jones) and accelerator (Ronald Martin). Although Sachs, who is APS regional secretary for the central United States, was busy arranging for the January Chicago meeting, he was eager to show us the high-energy activity at Argonne.

The ZGS is 12.5-GeV weak-focusing synchrotron, designed before the alternating-gradient synchrotrons at Brookhaven and CERN had been completed. Although the ZGS was designed for what appeared at the time to be a rather high intensity of 10^{12} protons per pulse, it turned out that the attainment of this intensity was more difficult than expected. The reason was that it is the first accelerator to have its intensity limited by a coherent vertical instability; the aperture of the vacuum chamber was small compared to the focusing power of the accelerator. After some study of the phenomenon, the instability was damped by applying electric fields to the beam out of phase with the instability; the design intensity of 10^{12} protons/pulse was attained a year and a half ago. Sachs said that by last August the machine averaged 2.2×10^{12} protons/pulse with a peak intensity of 2.8×10^{12} protons/pulse. The machine can be pulsed every 2 sec, but usually the pulse interval is 2.5–2.7 sec.

Sachs noted that the ZGS is very flexible. It can be preprogramed to produce different spill characteristics in successive pulses. Alternatively it can produce during the same cycle a "long spill" from an internal target that is struck by a full-energy beam and a long-spill extracted proton beam with a selected lower energy. Taking advantage of this feature, a University of Michigan–Argonne group was able to do proton–proton scattering experiments at different energies while other experiments were being done at higher energy.

Sachs remarked that the ZGS is the first machine initially designed to operate with a multiple-focus long-spill external proton beam. (The Weston 200-GeV accelerator is expected to have one also.) A second external proton beam will be extracted to feed the 3.7-meter bubble chamber.

Bubble chambers. Even without the 3.7-meter chamber, which the lab expects to have ready for testing in mid-1969, Argonne has an impressive array of bubble chambers. The 30-inch (76-cm) Argonne–MURA (Midwestern Universities Research Association) chamber is rapid cycling (300 millisec); one can take three pictures per pulse; so one gets more pictures for the same amount of power. Since

ROBERT G. SACHS

THOMAS H. FIELDS