

spaced along an east-west line, and the two others move along a 300-m rail track at the eastern end of the 1.6-km baseline. First observations will be made at 21-cm wavelength, for which the resolution will be 22 sec of arc. The telescope will be used for counts of radio sources, investigation of the structure and spectra of these sources, and work on the distribution of radiation and polarization in nearby spiral arms of our own galaxy.

The Science Research Council has agreed to meet the estimated £2-million (\$4.8-million) cost of the 5-km (3-mile) interferometer at the University of Cambridge. The new telescope will be built at Lord's Bridge, site of the existing 1-mile interferometer, along the roadbed of a now disused railroad that runs along the northern boundary of the Mullard Radio Observatory, a few miles outside Cambridge. Eight 12.8-m-diameter paraboloids will comprise the interferometric array; four of them will be fixed and four movable along the east-west axis of the instrument.

The existing 1-mile interferometer has a resolution of 20 sec of arc. The planned instrument is expected to

see structure as fine as 1-2 sec of arc. It will be used for observations of quasi-stellar objects and radio galaxies; as with the present instrument radio astronomers from any British university will have access to it.

Check of T Invariance in Electromagnetic Interaction

An apparent violation of time-reversal invariance in the electromagnetic interaction was reported at the New York American Physical Society meeting by David Bartlett, K. Goulianos, Carl Friedberg, Ira Hammerman and David Hutchinson of Princeton. The group compared angular distributions for $n+p \rightarrow \gamma+d$ with data from other sources on the inverse reaction $\gamma+d \rightarrow n+p$ to test reciprocity and hence check time-reversal invariance. In the experiment, neutron energies from 160 to 680 MeV were studied. At lower values of energy the angular distributions for both of the reactions matched. But at about 600 MeV, which corresponds to formation of the N^* resonance, the curves did not match. Michael Longo (University of Michigan) and his collaborators in a similar experiment do not see the large effect reported by the Princeton experimenters. Although many particle

physicists are excited about the observations, a typical attitude is, "Interesting if true." —GBL

Polar Cap May Have A Geoelectric Field

During the period of high solar and geomagnetic activity in late May 1967 the Air Force satellite OV1-9 detected energetic proton fluxes coming up the magnetic field lines from the earth at high magnetic latitudes ($\lambda \geq 65$ –70 deg). Ludwig Katz and Paul L. Rothwell of Air Force Cambridge Research Laboratories suggest that, because the flux is highly collimated along magnetic-field lines, there may be a radial polar electric field of about 0.14 volts/meter (*Phys. Rev. Letters* **21**, 1764, 1968). Electric fields had been suggested earlier as a possible explanation for aurora or other polar-cap particle precipitation.

Polarized Targets Used To Study Spin Effects

By hitting targets of aligned Ho^{165} with a polarized neutron beam, experimenters are now able for the first time to study the dependence of total cross section on the relative orientation of neutron spin and nuclear spin.

In recent work at Stanford (*Phys. Rev. Letters* **20**, 502, 1968), the target is a cylinder of polycrystalline holmium metal (1.6-cm diameter, 7.4 cm long), mounted inside a dewar that is provided with thin windows for the passage of a fast-neutron beam; the cylinder is thermally anchored to a bath of pumped He^3 at a temperature of 0.3 K. An external magnetic field of 18 000 oersteds along the axis of the cylinder is provided by a superconducting solenoid. The large hyperfine interaction between the nuclear magnetic moment and the atomic electrons causes a nuclear polarization of 55%. This method of producing systems of oriented nuclei is a common one, but applying it to a target suitable for experiments with fast neutrons is new.

The Stanford group, consisting of Thornton R. Fisher, J. S. McCarthy, R. S. Safrata (now at the Nuclear Research Institute, Rez, Czechoslovakia), E. G. Shelley (now at Lockheed Palo Alto Research Laboratories), finds that over the range 0.3–15 MeV total cross section depends strongly on nuclear orientation. The

IN BRIEF

The Serpukhov alternating gradient synchrotron is now producing 10^{12} protons/pulse at 70 GeV, according to Yuri Ado, who spoke at the March Particle Accelerator Conference in Washington. The space-charge limit on intensity is about 2×10^{12} protons/pulse.

Argonne has successfully operated the world's largest superconducting magnet, which will provide an 18-kG field for the 3.7-meter bubble chamber nearing completion. The magnet consists of a 110-ton stack of circular coils inside a 1600-ton steel yoke.

An experiment on OGO-5 has detected low-frequency fluctuating electric fields generated in the earth's bow shock. R. W. Fredricks, Charles F. Kennel, Frederick L. Scarf, G. M. Crook and I. M. Green (*Phys. Rev. Letters* **21**, 1761, 1968) of TRW Systems Group found that the turbulence is strongly correlated with time variation in the magnetic field.

A new candidate for the standard

wavelength is the 3.39-micron rotation-vibration line of methane. R. L. Barger and J. J. Hall of the Joint Institute for Laboratory Astrophysics locked two lasers independently to the transition with a reproducibility of ± 1 part in 10^{11} (*Phys. Rev. Letters* **22**, 4, 1969). This reproducibility is two orders of magnitude better than the present length standard, the 605.6-nanometer line of Kr^{86} .

The compressibility of nuclear matter in S^{32} is about 200 MeV, according to calculations (*Phys. Rev. Letters* **21**, 1479, 1968) by Werner Scheid, Rainer Ligensa and Walter Greiner (University of Virginia and the University of Frankfurt). They used O^{16} – O^{16} scattering data from Yale. The new 2.7-m (107-inch) reflector at the McDonald Observatory, University of Texas, is currently the world's third largest optical telescope. To be used largely for planetary astronomy, the instrument was paid for by NASA.

result was expected because Ho^{165} is a deformed nucleus. They also find that dependence of total cross section on relative orientation of neutron spin and nuclear spin is less than 0.2%, about the limit they can observe. Although holmium nuclei are

particularly susceptible to orientation, the Stanford researchers expect that by lowering the temperature they can produce other targets of oriented nuclei suitable for fast-neutron experiments.

Earlier work on aligned Ho^{165}

was done by Harvey Marshak and Allan Richardson of the National Bureau of Standards, collaborating with R. Wagner, Philip D. Miller and Taro Tamura of Oak Ridge National Laboratory (*Phys. Rev.* **139**, B29, 1965 and *Phys. Rev.* **150**, 996, 1966).

A Visit to Arecibo Finds a Telescope Seeking Improvement

The cable car looks not on white slopes and prancing skiers but on the tropical green and brown of Puerto Rican forests. At the top terminus you can look straight down a distance equal to the height of the Washington monument. You look into the center of the world's largest dish—18 acres of wire mesh on a carefully positioned spherical network of supporting cables. You walk around on a 500-ton assembly that supports two carriage houses, a workshop, cables, waveguides and motors to turn and slide its various parts. Below extend the horns, snouts and Yagi antennas that can transmit and receive radio frequencies between 20 and 600 megahertz. A few miles south of the northern coast of Puerto Rico, this is the radar and radio telescope of the Arecibo Ionospheric Observatory. It was dedicated in 1963 (*PHYSICS TODAY*, January 1964, page 66).

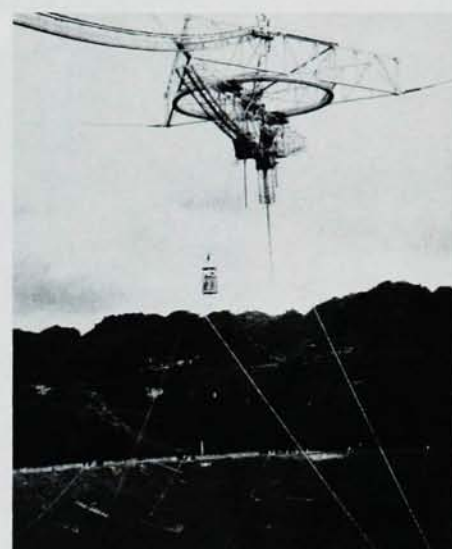
We talked there recently with Gordon Pettengill, who is on leave from MIT to be AIO director for the next few years. He spoke with some pride of the present installation and its important discoveries. He described the program and the way the installation is scheduled and operated, and he told about history and sponsorship. Particularly on his mind, however, is a projected improvement of the reflector and radar that would make

them about 30 decibels better at highest frequencies and at least 200 times as sensitive as the two other leading contenders, Haystack at the MIT Lincoln Laboratory and the Jet Propulsion Laboratory instrument at Goldstone, Calif. Pettengill, who was associate director at an earlier stage of observatory history, is the fourth director. His predecessors have been William E. Gordon (1960–65), John Findlay (1965–66) and Frank Drake (1966–68). Rolf B. Dyce has been associate director since 1965.

Hoped-for improvement would essentially raise the accuracy of the 1000-foot-diameter (300-meter) reflector to a level matching the positioning accuracy of the feed support. Arecibo would become as good at 5-cm wavelength as it is now at 50. An estimated \$3.5 million would improve by a factor of 10 the shape of the reflector which, in places, now departs from the true sphere by a little more than an inch. A new 10-cm transmitter, new feeds, a larger computer and similar equipment to take full advantage of the improved reflector might cost another \$2.5 million. Pettengill estimates the present value of AIO at \$12–15 million. Annual budget is currently \$1.8 million. The new sensitivity would enable radar observation of the four largest moons of Jupiter as well as extending the range of possible pulsar measurements.

To make the present installation, engineers cut away parts of a natural hollow in the mountains until they had a 300-meter circle and a roughly spherical bowl inside it. On the circle are anchors that hold 3.2-cm-diameter north-south oriented cables separated by 30 meters. Each north-south cable is tied down to a series of anchors along its length so that it hangs in a nearly perfect circle instead of a catenary.

Crossing the north-south cables are smaller east-west cables at 1-meter intervals, and on the resulting criss-cross are 1.5×6 -meter panels of wire mesh that has about a 1-cm gauge. Wrinkles in the mesh contribute to



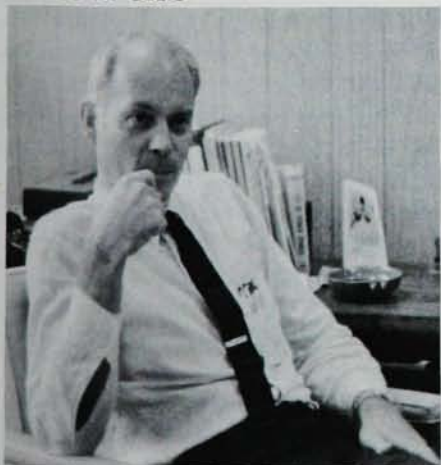
LARGE SIZE of installation is shown by passengers in cable car.

the departure from a true sphere; these are somewhat improved by a crimping tool that will pull in some of the parts of the mesh where unusual departures from the perfect surface exist. The basic north-south supporting cables already have a spherical shape within tolerances suitable for operation at 5-cm wavelength.

Three cement towers on hills outside the 300-meter ring support cables, which, in turn, support the feed assembly over the center of the antenna. A fixed triangular structure hanging from the cables supports a circular track on its lower surface; from this hangs a 120-meter horizontal arm, and rf feeds project downward from two carriage houses that move along the bottom of the arm. Among the feeds long line feeds are designed to correct for the difference between a parabolic reflector and the actual spherical one. Portions of a signal that arrive too soon from parts of the sphere that are nearer than the equivalent parabola are received on the line feed below its base and appropriately delayed to be in phase with later arriving portions that are intercepted closer to the base.

Movement of the various feeds permits experimenters to sweep over a

PHOTOS BY ELLIS



GORDON PETTENGILL, on leave from MIT, is present director at Arecibo.