RESEARCH FACILITIES AND PROGRAMS

Superconducting linac

Successful operation of a 4-in superconducting linear accelerator section has been announced by H. Alan Schwettman, professor of physics at Stanford University. Schwettman and two colleagues, Perry B. Wilson and William M. Fairbank, did the work with the assistance of graduate students L. Michael Axford, John M. Pierce, and John P. Turneaure.

The object is a cylindrical copper cavity, 4 in long and $3\frac{1}{2}$ in in diameter, filled with disks about 1 in apart. A 1-in hole through the disk centers channels an electron beam. Inside surfaces are coated with lead, which becomes superconducting at very low temperatures.

Superconductivity is maintained by keeping the cavity in a liquid-helium bath at 1.8°K. Liquid nitrogen surrounds the helium, and the whole is contained in an insulating vessel. The remaining components (at normal room temperature) are similar to nonsuperconducting linacs. Power comes from klystrons, and injection is by an electron gun.

The machine has already accelerated electrons at a rate of 4 MeV/ft or about the maximum obtained in present linacs. Theoretically, it should be able to go to 10 MeV/ft, but up to now it has been limited by electrical breakdown caused by microscopic whiskers on the lead surfaces. Elimination of the whiskers and other technological improvements should raise the energy increment per foot.

A Q ratio (energy stored to energy lost) of five billion has been achieved with the superconducting prototype. This is 100 times better than previous achievement and 100 000 times the Q of copper at room temperature. With 99 percent of the power going into acceleration and no resistance in the cavity, there would be little heating in a full-sized superconducting linac. Therefore, pulsing of the power input would be unnecessary, and electrons could be accelerated in steady streams instead of in short bursts. The duty cycle would be 1000 times longer than present linacs. The resolution would be better than with present machines.

The Stanford group hope to develop a machine capable of research. It would take five years, they figure.

Three Stanford professors display the superconducting linac section they have built. Left to right: Perry Wilson, Alan Schwettman, and William Fairbank.

Electron linac at Oak Ridge

Money has been appropriated for construction of a 140-MeV electron linear accelerator at Oak Ridge National Laboratory. The new facility will cost $4.8 million; design work has begun and a contract for architect engineering services has been let to Charles T. Main, Inc., of Boston.

The main purpose of the new machine is to produce short-duration, high-intensity (15-A) electron bursts, which will be used to produce intense neutron bursts for time-of-flight spectroscopy. An area for experiments in electron scattering and photonuclear reactions will also be provided.

The linac is a joint project of the Oak Ridge Physics and Neutron Physics Divisions. J. A. Harvey of Physics and F. C. Maienschein of Neutron Physics will be codirectors.

The rotation of Mercury

The planet Mercury does not have a rotation period equal to its orbital period. The aesthetically satisfying belief that the planet was gravitationally locked in so that it always turned the same face to the sun has been received doctrine for more than 80 years and is enshrined in almanacs and reference books. It is not so according to work done during the past year. Both radar and optical observations now appear to agree on a rotational period somewhere around 58 days or about two thirds of the orbital period (88 days). This kind of ratio, which means that Mercury turns opposite faces to the sun at successive perihelion passages, is unique so far in the solar system. Lately a theory has been put forward to explain the stability of the ratio 1 : 2/3.

The tale begins with radar observations carried out at Arecibo during the last inferior conjunction of Mercury in April 1965. G. H. Pettengill and R. B. Dyce observed the limb-to-limb Doppler shift of signals reflected from the planet on April 6, 10, 12, and 25. They concluded (*Nature*,

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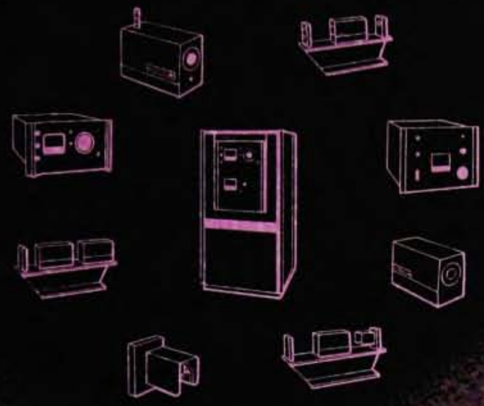

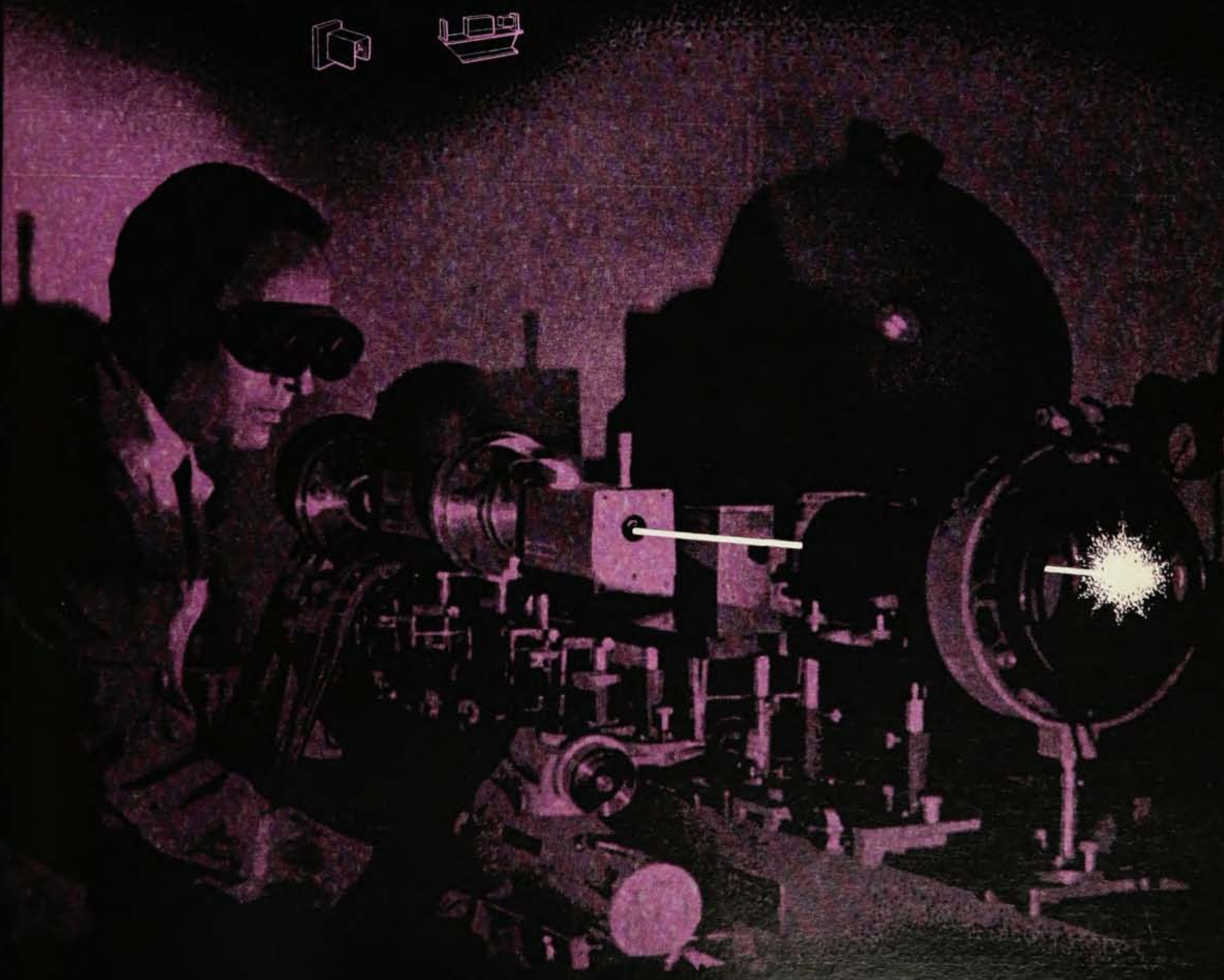

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AT KORAD MADE THE FIRST LASER

June 19, 1965, page 1240) that the data were most compatible with a direct rotation of 59 ± 5 days.

On the same page *Nature* printed a companion piece by S. J. Peale and T. Gold, suggesting that tidal effects on a fairly nonrigid Mercury in an eccentric orbit might yield a final spin period less than the orbital one. Tidal torque depends on the inverse sixth power of the distance from the sun, and the planet in an eccentric orbit would settle down to a spin angular velocity greater than the mean orbital angular velocity but less than the orbital angular velocity at perihelion.

The radar measurements stimulated a reëxamination of optical records, which had been the authority for the old belief in synchronous rotation. The results of two such investigations have been published. W. E. McGovern, S. H. Gross, and S. I. Rasool studied the records of optical observations made at various times over the past 40 years. In the October 23 *Nature* (page 375), they wrote that they had found the optical records compatible with the shorter rotation period and furthermore increased the accuracy of the figure to 58.4 ± 0.4.

Meanwhile Giuseppe Colombo and Irwin I. Shapiro were also reëxamining visual data. They came up with a figure of 58.65 days, but they did not think their conclusion as strong as that of McGovern and his colleagues. Colombo and Shapiro, however, went a step further and sought to set up a dynamical model of the sun-Mercury interaction to explain the situation. The results appear in Smithsonian Astrophysical Observatory Special Report 188 (October 13).

Assuming that Mercury is a rigid body with a density assymetry that provides a kind of gravitational dipole for solar torques to work on, they proceeded to derive an equation that predicts resonances between the rotational angular velocity and the orbital period. These resonances correspond to integral and half integral values of the ratio of the rotational angular velocity to the mean orbital angular velocity. The resonances represent dynamically stable conditions, and there is a particularly strong one when the critical ratio equals 3/2, corresponding to the rotational period of 58.65 days or two thirds of the orbital period.

Among questions for future study Colombo and Shapiro set forth the determination of a plausible history that would bring the planet to its present state, starting out either with Mercury orbiting the sun with a rotational period of about ten hours or with Mercury orbiting around Venus in retrograde fashion and later being captured by the sun. They raise but do not answer the question: If Mercury's rotation is stable now with the critical ratio equal to 3/2, why were earlier states, for example when the critical ratio was equal to 2, not stable?

North Carolina Van de Graaff

The Atomic Energy Commission has begun negotiations with Duke University and the Consolidated University of North Carolina to pay for purchase of a 30-MeV tandem Van de Graaff for protons.

The machine, which will have a 15-MeV cyclotron injector, is to be located on the Duke campus at Durham, N.C., and will become part of a regional nuclear laboratory. AEC will provide \$2.5 million toward the cost. Duke University, with support from the North Carolina Board of Science and Technology and possibly other agencies, will provide the building.

Henry W. Newson of the Duke physics department will direct the program. Research in nuclear structure with emphasis on relatively unexplored excited states is planned.

The moon in color

Color glows on the moon have been observed and photographed by a group of amateur astronomers working under contract for the National Aeronautics and Space Administration. The color was seen in the crater Aristarchus during a 4-hr period before dawn on Nov. 15. A 16-in telescope located at Port Tobacco, Md., was used.

Although such occurrences have been reported several times since the Russian astronomer N. Kozyrev first recorded red glows on spectrograms, this is the first time the phenomena were successfully photographed. The glows could not be seen by eye, even through the telescope. They appeared on the photographic plates and could be seen as a blink when a special two-color rotating filter was inserted into the optics. The filter is built on the principle that colored light passing first through a filter of the same color and then through one of a different color will cause the eye to sense a blink as the filters change. The group of amateurs, who come from Annapolis, had watched for 16 months and observed the glows several times before they were able to photograph them. The telescope belongs to an observatory built and operated by Lyle Johnson, a physicist and amateur astronomer.

Two different explanations have been put forth to explain the colored glows. One opinion maintains that they are evidence of lunar gas fields, from which some of the gas occasionally escapes through fissures. The other theory is that the spots are csused by fluorescence of the lunar surface under bombardment by solar radiation.

Solar-spectra satellite

According to reports at the beginning of December, the latest US solar-explorer satellite was "working perfectly." The craft was launched from Wallops Island on Nov. 28 and is moving in an orbit inclined at 60° to the equator with an apogee of 548.7 miles and a perigee of 440.9 miles. It takes 100.8 min to go once around.

The satellite is a joint project of the Naval Research Laboratory and the National Aeronautics and Space Administration. Its mission is to measure the sun's energetic x-ray emission, to measure the history of x-ray emission intensity and the spectral quality of solar-flare emissions, to correlate these measurements with those of terrestrial radio and optical observatories, and to provide real-time solar monitoring information to participants in the IQSY program.

To accomplish its purpose, the craft carries Geiger counters for detection of x rays between 0.5 and 8 A, ion