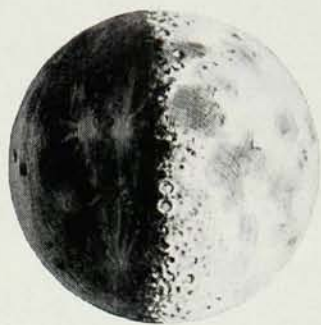


Lunar landing



and exploration

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SEARCH AND DISCOVERY

beams start circulating in Adone, it will be the most energetic electron-positron storage ring in operation. A 700-MeV electron-positron ring started running last year (PHYSICS TODAY, November, page 72) in Novosibirsk, as did a 500-MeV ring (called ACO) at Orsay. Three-GeV electron-positron rings have been proposed by CEA, SLAC and DESY.

Josephson Junction Yields Fundamental Constants

The first low-temperature physics experiment to determine a fundamental constant has yielded new values for e/h (ratio of electron charge to Planck's constant) and α (fine-structure constant). Until now the most reliable determination of α has utilized measurements by Willis Lamb, Sol Triebwasser and Edward Dayhoff on the fine-structure splitting in deuterium; the value is $1/137.0388 \pm 0.0006$. The new experiments (reported in the 20 Feb. issue of *Phys. Rev. Letters*), which use the ac Josephson effect to measure e/h directly, when combined with the measured values of other fundamental constants, yield for α the value $1/137.0359 \pm 0.0004$. This new value may remove the discrepancy between theoretical and experimental values for the hyperfine splitting in hydrogen.

In the experiment microwave radiation strikes a Josephson junction and produces a dc supercurrent whenever applied voltages satisfy the relation $2eV = nh\nu$ (where n takes on integral values). These dc supercurrents show up as regions of zero slope in the current-voltage characteristic. To determine $2e/h$ the solid-state physicists, William Parker and Donald Langenberg of the University of Pennsylvania and Barry Taylor of RCA Laboratories, simply measure the frequency of applied microwave radiation and the absolute voltage at which the current steps occur.

The method uses two types of Josephson junctions, in which two superconductors are weakly coupled; one is a sandwich (PHYSICS TODAY, September 1965, page 97) of two superconducting films separated by a thin insu-

lating oxide layer; the other junction is a point contact (PHYSICS TODAY, November 1966, page 67) in which a superconducting wire with a fine point is pressed onto a flat superconducting plate. All measurements have been done between 1.2 and 1.6°K.

An X-band (8-12.4 GHz) oscillator generated microwaves. Frequency was measured with an electronic counter and microwave frequency converter to 1 part in 10^8 ; since the overall measurement had an rms error of 6 parts per million, frequency errors were negligible.

The difficult quantity to measure is the voltage; typically a millivolt has to be measured to an accuracy of a few parts in a million. To measure voltage the experimenters used a nanovolt potentiometer and six NBS-calibrated standard cells in a constant temperature bath. The potentiometer, a Julie Research Laboratories PVP 1001, is self-calibrating since the operator can measure all factors that contribute to the voltage accuracy and then make any necessary corrections; the instrument was calibrated with an uncertainty of between 3 and 4 ppm.

The experimenters find that $h/e = 4.135\,725 \pm 0.000\,026 \times 10^{-15}$ joule-sec/coulomb.

Compare with theory. When Jesse DuMond and E. Richard Cohen made their last least-squares adjustments of the fundamental constants, in 1963 (PHYSICS TODAY, October 1965, page 26), they calculated α from the measurements of fine structure in deuterium rather than from hyperfine splitting in hydrogen, even though Norman Ramsey, Stuart Crampton and Daniel Kleppner, using a hydrogen maser, measured the splitting to 2 parts in 10^{11} . The problem with hfs splitting is that the theory is uncertain. Although theorists know how to correct for the proton form factors, they do not yet know how large the proton polarizability is. Before the h/e determination of α , there was considerable discrepancy (amounting to about 20-40 ppm) between the predicted hfs splitting, using α determined from deuterium fine structure, and that actually found by Ramsey.

The new value of α , however, is compatible with hfs measurements, provided one uses a model of the pro-

ton in which there is only a very small polarizability correction to the hfs splitting. However theorists Sidney Drell and Jeremiah Sullivan of Stanford have recently pointed out that calculations of this correction based on dispersion theory cannot claim an accuracy of better than 10 ppm.

Accelerator Energies Go Up: 40, 45, 70, . . . , 1000 GeV

The 33-GeV AGS at Brookhaven will soon be surpassed by the 70-GeV Serpukhov accelerator and plans are proceeding for large accelerators in Japan, France and the USSR, according to reports that were given at the National Particle Accelerator Conference, held in Washington early last month.

Two last-minute papers by Soviet physicists, who appeared unexpectedly at the meeting, caused a stir. E. Myae reported that the Serpukhov alternating-gradient synchrotron may have a 70-GeV proton beam by the end of the year. And A. Vasilev of the Radio Technical Institute in Moscow said that the institute has completed a 1-GeV model for a 1000-GeV alternating-gradient proton synchrotron.

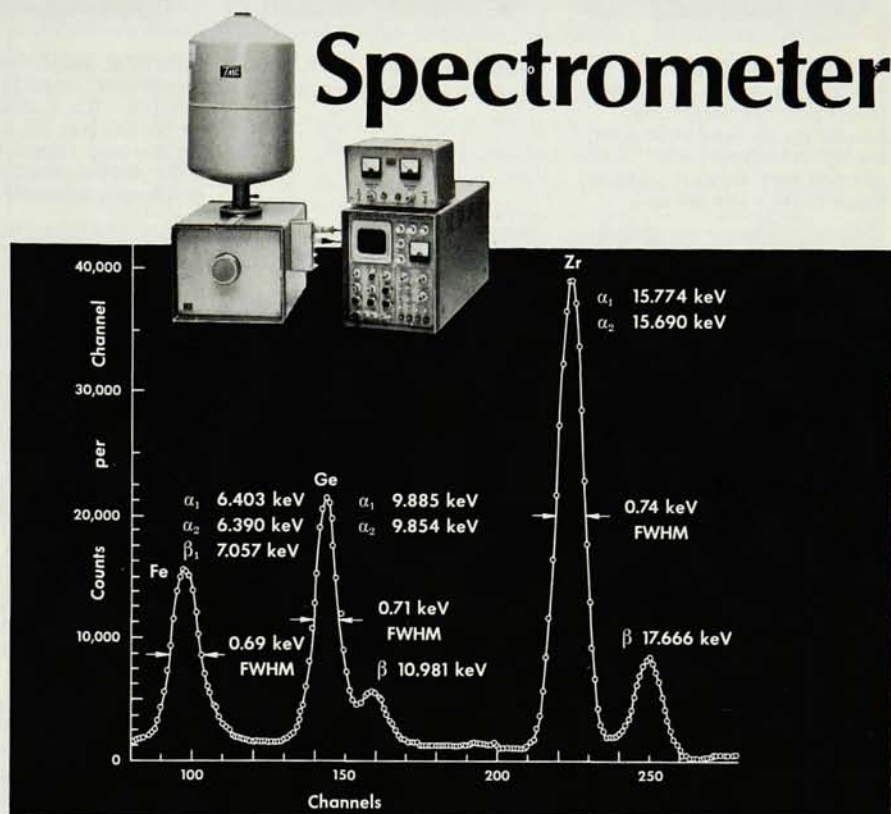
In an effort to reduce the beam aperture, and thereby drastically reduce cost, the Soviet group will soon start testing a system for rapid control of beam position. Pickup electrodes measure beam location; when correction is needed the accelerator applies magnetic deflecting fields and magnetic gradients. The 1-GeV model has an aperture only 1.6 by 2.1 cm, although the 1000-GeV machine would require a larger aperture.

The Japanese government has approved construction of a 40-GeV alternating-gradient synchrotron and at Saclay plans are being laid for a 45-GeV machine.

. . . also of Interest: TRIGA and a Q Machine

A General Atomic TRIGA Mark 2 reactor, which can produce 250 000 thermal kW peak power for a few milliseconds, is now running at the University of Pavia, Italy. . . A Q Machine to produce quiescent plasma is being built at the University of California at Irvine, says Nathan Rynn. □

Energy resolution of less than 1 keV guaranteed with new TMC Photon Spectrometer



Graph of K X-rays of iron, germanium and zirconium, obtained with TMC Photon Spectroscopy System. TMC Lithium Drift Detector: W-80-2A. Detector bias: 200 Vdc. Temperature: 78°K. Time: 100 minutes.

Resolution values of substantially less than 1 keV, FWHM, are being routinely obtained with TMC's new Model 331/332 Photon Spectroscopy System. These values exceed those available anywhere else and are better by a factor of two or more than those normally obtained from a conventional detector-preamplifier system.

What's the secret behind these resolution capabilities? Part of the answer lies in TMC's broad-range experience in all aspects of nuclear spectroscopy, from ultra low-noise semiconductor detectors and preamplifiers to multi-

channel analyzers. That experience is reflected in the unique self-contained design of the 331/332 System, which is supplied complete with detector, FET preamplifier, cryostat, vacuum chamber, ion pump and all necessary power supplies. Since it's designed, built and tested as a single system, TMC can — and does — guarantee its performance on an overall system basis.

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