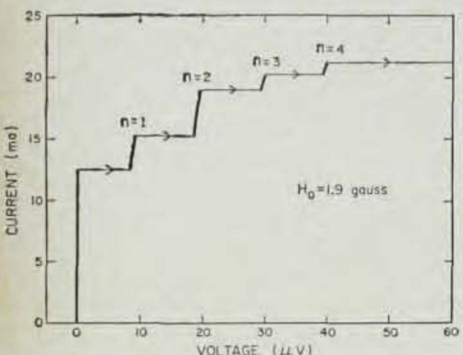


Fig. 2. A characteristic curve for the tin-tin oxide-tin junction used to detect Josephson radiation. Each step corresponds to a frequency separation of about 4600 Mc/sec.

thickness of the flux sheet through the junction, and **n** is a unit vector normal to the junction. The current density is given by a constant times $\sin \varphi$ (**r**, t), and one is interested in what φ will be for a fixed dc bias voltage V_0 and a constant field H_0 in the plane of the junction and aimed in the y direction. Since $\partial\varphi/\partial t = 2eV/\hbar$, the equation obtained is $\varphi = \omega t - kz$, where $\omega = 2eV_0/\hbar$ and $k = 2edH_0/\hbar c$. The first term shows that the current density varies with time; the second term shows that it varies with position. A third term also has to be considered; it is caused by the induced ac voltage. This introduces a dc component in the current density and gives the I-V characteristic of the junction.

The spatially modulated Josephson current now excites TM (transverse magnetic) waves which propagate in the insulating barrier in the z direction with a phase velocity $\bar{c}$. A Josephson junction of length L will have characteristic frequencies, ν_n, given by $n\bar{c}/2L$, where n has integral values. The excitation of these modes shows up as steps in the I-V characteristic at bias voltages equal to $h\nu_n/2e$. Figure 2 is one of the characteristic curves obtained by the Penn group.

The group found that the magnitude of the signal received depended on the distance between the junction and the short, and became maximum when this distance was half the guide wavelength. Operating in the $n=2$ mode, a frequency of 9200 Mc was detected, with a spectral purity better than one part in 10^4. The highest power reported in the published letter was 10^{-12} W. Subsequently, the group has achieved 10^{-11} W.

Now that detectable power has been found, experimenters are trying to get usable power out. The problem is that the effective impedance of the Penn junction, for example, was only about 10^{-5} of the waveguide's impedance. Attempts to improve impedance matching include: (1) shaping the oxide layer like a horn, spreading out from 10 Å to 0.1 mm, (2) hanging an antenna on the junction, and (3) putting the junction in a high Q cavity.

Many solid staters are forecasting a useful future for Josephson junctions. They could serve as a generator or detector of microwave or infrared radiation, as an extremely sensitive dc detector (since frequency can now be measured to one part in 10^{12} and is proportional to applied voltage), and as a sensitive detector of magnetic fields. The effect can be used for a precise determination of h/e, and also of h/m (m being the electronic mass). Macroscopic quanta have already been used as a uniquely sensitive ammeter—the current was measured by simply counting the number of flux quanta.

AGS modification

The Atomic Energy Commission has requested funds to modify the Brookhaven Alternating Gradient Synchrotron. The alterations are expected to take five years and will raise the AGS intensity to about 10^{13} protons per pulse. Until the Soviet Union's 70-BeV machine at Serpukhov is finished in 1967 or 1968, the AGS will continue to produce higher-energy particles than any other machine on earth. The proposed 200-BeV proton accelerator will not be in operation in the United States until 1975 at the earliest.

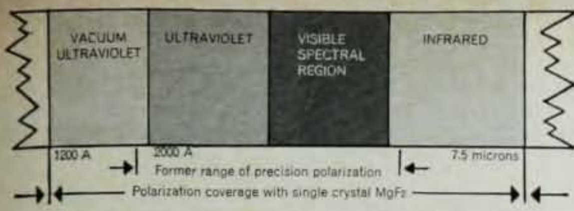
When the AGS was originally proposed, its designers promised 10^{10} protons per pulse, although they actually hoped for 10^{11} protons per pulse. With experience and improvements, the AGS now yields 1.5×10^{12} protons per pulse, but further intensification is limited by space-charge effects to 2×10^{12} protons per pulse. (If there are too many protons in a region, they start to interact with each other.) Since the space-charge limit is roughly proportional to the injection energy, this energy will be increased. Brookhaven's original plans for modification called for a thousand-foot linac to produce 500-MeV protons. (At present, protons are injected from a 50-MeV linac.) In order to keep costs down, only a 200-MeV linac will be built at this time. However, there is a provision for an addition, to be built sometime later, that will provide 300 MeV more energy.

While the linac is being built, the power supply (now 35 000 kV-amperes) will be doubled. This modification will make it possible to pulse the AGS every second at full energy, instead of once every two and a half seconds. Even more rapid cycling is possible at lower energies. According to John Blewett, director of BNL's Advanced Accelerator Development Division, the combination of increased injection energy and more frequent pulsing should give at least 10^{13} protons per second. At 30 BeV and the new pulse rate the proton current will have a time average of 1.6 microamperes. It will also be possible to pulse more slowly to allow a longer-lasting beam for counter and spark-chamber experiments.

The number of straight sections used for rf acceleration will be reduced from twelve to eight, in order to provide more space for experimental targets, beam-extraction equipment, and so forth. Further, the electronic components of the accelerating system will be moved outside the ring so they can be serviced during operation.

The modified AGS is expected to produce 400 R/hour in target areas. Even now, radiation damage to equipment has become a problem. It was recently necessary to replace the particular AGS magnet which had been getting the largest dose. The insulation of the copper coils had changed from a healthy grayish brown, to a bright green, and finally a bilious yellow. At this color, in the last stages of radiation sickness, it became conducting.

In order to prevent similarly induced ailments in physicists and other essential equipment, the more intense AGS will require about ten extra feet



Single crystal magnesium fluoride expands optical capabilities

Optovac is now supplying production quantities of excellent optical quality single crystal magnesium fluoride (MgF_2) which has very high transmission (without antireflection coatings) from 1200 Angstroms in the vacuum ultraviolet to 7.5 microns in the infrared. This new availability of MgF_2 opens up the following optical capabilities:

1. Precision polarization in the vacuum ultraviolet and in the infrared where suitable birefringent materials have not previously been available.

2. A choice of lens and window material for the vacuum ultraviolet and the infrared featuring very high transmittance, low index, low reflectance losses and high nu value; all in combination with high shock resistance, a hardness similar to fused quartz and high general physical and chemical durability. Severe duty applications requiring superior optical qualities are thus a field for this newly available material.

Specifications and prices on request.

A free catalog on OPTOVAC'S line of optical crystals, and laser and research crystals available on request.

OPTOVAC, INC.

NORTH BROOKFIELD, MASS. 01535 Tel: (617) 867-3767

THE UNIVERSITY OF MELBOURNE

Applications are invited for two Senior Lectureships or Lectureships in the School of Physics

DUTIES: To carry out teaching and research in theoretical, nuclear or solid state physics, or in electron and X-ray diffraction.

SALARY: Senior Lectureship £A3,250—£A3,800
Lectureship £A2,400—£A3,150

Initial salary will be determined according to qualifications and experience.

Further information, including details of F.S.S.U. type superannuation, travel and removal expenses, housing assistance and conditions of appointment, is available from the **Registrar, University of Melbourne, Parkville, N.2., Victoria, Australia,** and applications should reach him by the **30th September, 1965.**

F. H. JOHNSTON,
Registrar.

to measure thickness and evaluate surface of thin films

HILGER & WATTS

MULTIPLE BEAM INTERFEROMETER

The N-130 Thin Film Interferometer provides a precise technique to determine thickness of films—from 10A to 15,000A thick. The characteristics of substrates or micro-etched surfaces also may be examined.

The instrument incorporates a microscope and universally adjusting stage for fast locating of sample position. Independent universal tilt adjustment of comparison mirror easily establishes desired fringe order. There is no pressure required on sample; there is neither distortion nor wear. Measurement is convenient and rapid, following the principle of fringes of equal chromatic order. Each reading can easily be confirmed by repeating determination in adjacent order.

Actual performance demonstrates repetition to 4% at measured thickness of 120A, and substantially greater accuracy on thicker films.

The N-130 is of special value when several measurements must be taken on samples containing electrical circuits, particularly when several circuit components are in close proximity.

For complete specifications ask for Publication SP-95
Visit us at Applied Spectroscopy and Vacuum Society Meetings

ENGIS INSTRUMENTATION

ENGIS EQUIPMENT COMPANY

SCIENTIFIC INSTRUMENTS DIVISION

8035 AUSTIN AVE. MORTON GROVE, ILL. 60053 of earth shielding to be piled over the main AGS tunnel. To support the increased load, a bridge over the AGS may be necessary. Remote handling equipment (on a more advanced level than used for reactor work) will be designed to replace radioactive malfunctioning equipment and to allow remote positioning and servicing of machine components and experimental equipment. The roof will be raised over the AGS Target Building to allow room for remote-handling gear and increased overhead shielding.

Additional experimental areas will be built to use the variety of particle beams that will be drawn from the more intense circuit beam.

When modifications are completed, the AGS will be ready to do a wide variety of experiments. A large increase in intensity, generally, can be useful in the following ways:

1. Some experiments which would simply have taken too long to do, are now feasible.

2. Some experiments need improvement in statistics to clarify their interpretation.

3. With a greater intensity, more experiments can be done simultaneously or in quick succession. It has been argued that information should be acquired rapidly to maintain peak enthusiasm in high-energy physics.

Last year, in support of BNL's proposal, a committee of physicists produced a list of specific experiments which would require greater AGS intensity. The samples below were selected from the list.

In the field of weak interactions, it was proposed to look for the elusive intermediate boson and try to solve the mystery of the muon. The modified AGS will give a much stronger neutrino flux. One can produce a high-energy neutrino beam by allowing a focused beam of, say, 12-BeV pions to decay. Then one sends the neutrinos over a 75-meter flight path. This can be sent into the BNL 80″ hydrogen bubble chamber and one can look for the intermediate boson. The reaction would be

$$\nu + p \rightarrow W^{+} + \mu^{-} + p.$$

If one assumes that the boson mass is 1650 MeV, the neutrino threshold energy would be 3 BeV. It is expected that 24 events per day could be observed. Still better statistics (by a factor of twenty) could be obtained if a proposed 14′ hydrogen chamber is built at BNL.

Direct production of the intermediate boson, without intermediate production of neutrinos, might also be observed, by the reaction:

$$\pi^{\pm} + p \rightarrow W^{\pm} + p$$
$$W^{+} \rightarrow \begin{cases} \mu^{+} + \nu \\ e^{+} + \nu. \end{cases}$$

The experiment has not been done with present AGS intensity because of rate and background difficulties.

The increased intensity might be used to solve the muon puzzle—why the heavy electron exists at all. There have been suggestions that the muon, even though it has spin 1/2, may not satisfy Fermi-Dirac statistics. No direct information about the statistics of the muon or muon-neutrino has been found yet, but this could be obtained from a reaction in which one muon is incident and three muons emerge. A muon beam can be produced from the modified AGS. The direction and spins of the muons produced in the target can then be measured and compared with theoretical predictions.

Proposals for strong-interaction studies include scattering, neutral-particle detection, and lepton pair production. Clean, separated beams of kaons, pions, and antiprotons can be produced at high energies. These beams can strike protons and the resulting elastic and inelastic scattering up to 25 BeV/*c* can be measured with high precision, using a counter hodoscope system with on-line computer (see S. J. Lindenbaum, *Physics Today*, April 1965, p. 19). These high-energy, precision data would be extremely valuable in checking the asymptotic behavior predicted by various current theories, and would provide sufficient information for a possible better theory.

At high-interaction energies ($\geqq$ 5 BeV), many different particles are created, including one or more neutral particles (such as π^0, K_2^0, n, γ). Although the counter or spark chamber is convenient for simple interactions (such as two-body reactions), and the hydrogen bubble chamber is usually preferable for complex interactions, the latter is still not good enough to allow reconstruction of all the processes. A new technique developed at the CERN proton synchrotron could also be used at the AGS. The CERN group used a pencil beam of negative pions at 6 and 16 BeV/*c*. The beam entered a heavy-liquid bubble chamber which contained a hydrogen target. This allowed detection of all the particles, including the neutrals, usually undetectable in hydrogen bubble chambers. At the modified AGS the same technique would be used with $K^{\pm}$ and $\bar{p}$ pencil beams, which need at least fifty times as much intensity as the π^- pencil beam. With the new detector, one could study the reaction $K^- + p \rightarrow \Lambda^0 +$ neutrals. With a hydrogen chamber as detector, all one knows is the total mass of the neutral particles, but their identity is unknown. They probably include η^0, ω^0, or, γ from Σ^0 or π^0. Using the new detector and a high-energy K^- beam would probably disclose the neutral decay of the ω^0 into π^0 and γ, and show strange-particle exchanges (K and K*).

In another CERN experiment proposed for repetition, antiprotons from the CERN PS struck a CH_2 target, annihilated the protons, and produced pairs of leptons. After several weeks of running time, experimenters found only ten events at an antiproton momentum of 2.5 BeV/*c*. (Both the target and momentum had been chosen to give the maximum event rate.) With the modified AGS, a meaningful experiment could be done with better precision and over a wide momentum range.

Meanwhile, experiments will continue at the present AGS facility. Only two major shutdowns are planned—one sometime in the second year of construction (probably to install shielding), and another at the very end. The entire down time is expected to be eight months.

The surface of Venus

Recently published observations [Astrophys. J. 142, 23 (1965)] of 10.6-cm radiation from the planet Venus have yielded information about the temperature and dielectric constant of the surface of the planet. The work