

SEARCH AND DISCOVERY

predictions is limited to a few percent by uncertainty in the contribution of Compton processes and lack of precise measurement of inelastic form factors of the target nucleus.

Meanwhile Pipkin is repeating his electron-positron pair-production experiment at the CEA and hopes to have his data analyzed by the end of the summer. He also plans to do a similar experiment with the 18-20 GeV beam at the Stanford Linear Accelerator later this year. And at Cornell, Talman has repeated his experiment at slightly higher momentum transfers. —GBL

Tunneling Electrons Cause Molecular Vibrations

In the 28 Nov. *Phys. Rev. Letters* Robert Jaklevic and John Lambe of the Ford Scientific Laboratory report changes in the conductance of tunnel diodes caused by the excitation of molecular vibrations in impurities at the diode junction. This effect may be useful as a probe of the detailed surface structure of junction interfaces. Possibly it also will be useful in tunnel-diode technology.

Jaklevic and Lambe observed that the conductance of a clean junction of aluminum, oxide and lead rises anomalously at bias voltages corresponding to the energies of O-H vibrational modes. Although the surface was clean, there could have been water in the oxide or adsorbed on the interface that would give rise to the anomalies.

When the surfaces were contaminated by exposure to air, propionic acid or acetic acid, anomalies occurred at bias voltages corresponding to the characteristic organic C-H vibrational modes as well. Other metal-oxide-metal junctions exhibit similar behavior.

Confirmation that the anomalies are caused by such molecular vibrations comes from work subsequent to their Letter. Jaklevic and Lambe contaminated the surfaces with deuterated compounds and found that the anomalies then occurred at bias voltages shifted by an amount appropriate for the vibrational modes of deuterated molecules.

Structure in the conductance was

also observed at bias voltages below 100 mV where excitation of the oxide molecules is expected. Thus, although no definite identification of the structure was possible, it may be that the junction itself can be involved in the effect as well as impurities.

Other anomalies also have been observed in the conductance of tunnel diodes. Adrian Wyatt found that many metal-oxide-metal junctions have about 10% greater conductance at zero bias than at 5 mV. Ralph Logan and John Rowell observed these peaks and also peaks in the zero bias conductance of p-n junctions.

Explanations of such anomalies depend upon detailed properties of the junction surface. For example, Joel Appelbaum showed that the zero-bias anomaly could arise from second-order scattering by localized states near the barrier. As Philip Anderson has suggested, such states could be impurities or interstitial metal atoms in the oxide.

Clearly a sensitive probe of surface properties and impurities would be valuable for investigating such detailed surface structure. It would also be useful for studying other surface phenomena such as surface conductivity, adsorption and catalysis. If the tunneling scattering process can be related to the more general problem of surface scattering, electron excitation of molecular vibrations in tunnel diodes may serve as a microscopic probe of surface phenomena.

Fantastically Low Energy Accelerator Reaches 100 peV

Reversing the trend in accelerator construction, William Fairbank and his collaborators (Fred Witteborn and Larry Knight) at Stanford University have built a Fantastically Low Energy Accelerator, also known as FLEA. The device is being used to compare gravitational attraction of the electron and positron and to measure their anomalous magnetic moments. Ground state electrons or positrons travel up a cylindrical tube, guided by a magnetic field, and their time of arrival is measured. Fairbank, speaking at the annual Belfer Graduate School conference on 16 Nov., said that in a 2-cm-diameter tube they have obtained

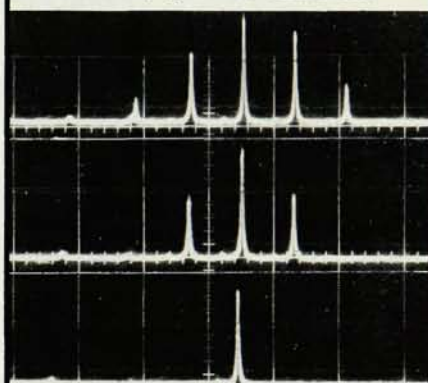
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energies as low as 10^{-10} eV, much smaller than was thought possible.

In a talk at the December APS meeting, Witteborn described a new, enlarged apparatus with a free-fall region 5 cm in diameter and 300 cm long. Preliminary results indicate that freely falling electrons experience the same gravitational force as electrons bound in a metal (in agreement with a recent theoretical paper by Leonard Schiff and M. V. Barnhill of Stanford). By passing a current through the walls of the drift tube a known uniform force smaller than gravity could be applied on the otherwise freely falling electrons. Comparison of the time-of-flight distributions taken with various applied forces demonstrated that the slowly moving particles were electrons and that no other net forces larger than $\pm 0.2 mg$ existed within the drift tube (where m is the electron's inertial mass and g is 980 cm/sec^2).

To solve the more difficult problem of obtaining low-energy positrons, a source is being developed by John Madey, a graduate student. Positrons emitted from a radioactive source will be slowed down by multiple collisions with gas atoms. Witteborn notes that their experiment will be the first direct determination of the gravitational properties of antimatter.

Bevatron Shut Down 3 Months: Metal Fatigue in Alternator

Metal fatigue has cracked the dovetail on the rotor of a Bevatron alternator. Repairs will shut down the Berkeley 6-GeV proton synchrotron for at least three months. During routine maintenance in December, Bevatron technician W. B. Thompson found some indications that one of the poles had cracked; further inspection showed that the other Bevatron alternator also had cracked poles. Westinghouse is fabricating new parts for the alternator, which is expected to be running again around March.

The alternators, each rated at 46 MW, energize the large Bevatron magnet; they are pulsed about 10 times per minute. Similar alternators are used at Brookhaven, CERN, Argonne

and NIMROD in the United Kingdom.

Last year metal fatigue on a NIMROD alternator caused a crack while the accelerator was running; the moving rotor grabbed the stationary stator and tore it to pieces. The damage took almost a year to repair. When *PHYSICS TODAY* spoke to Harold Vogel (who is in charge of the Bevatron power supply), he noted that the NIMROD fatigue failure occurred after only about 7 million alternator pulses, whereas the Berkeley machine, running since 1954, has been pulsed about 37 million times. The Brookhaven AGS, running since 1959, has already been pulsed 57 million times, because it pulses more frequently.

Brookhaven accelerator people, concerned over the possibility of metal fatigue in their own alternators, are studying the Bevatron failure. They have inspected the AGS alternator in detail and found no signs of fatigue cracks there.

Radiation-Damaged Hose Causes Fire at AGS

A fire at the Brookhaven AGS on 9 Dec., which destroyed the coils on one magnet and downed the accelerator for six days, is a symptom of the radiation damage that is becoming a serious problem at the facility. Because the accelerator is operated at 15 times its original design intensity, water hoses burst, magnet insulation turns a sickly greenish yellow and some of the AGS staff is being exposed to almost the allowable radiation limit. So we were told by Kenneth Green, chairman of Brookhaven's accelerator department. Green feels that the AGS in its present configuration cannot continue running at its average intensity, 1.5×10^{12} protons/pulse, for more than another year or so. However, he expects that the AGS conversion project (*PHYSICS TODAY*, September 1964, page 98) will soon relieve some of the radiation problems involving men and equipment.

Burst water hoses have occurred with increasing frequency at the AGS since the neoprene rubber hoses used to cool magnet coils last only two or three months in the intense radiation. To protect equipment from water damage, operating personnel had spread polyethylene sheets. On 9 Dec. a