APS notes

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PARTICLES

Gravity, electrons and positrons

Experimenters at Stanford University are attempting to find out whether gravitational forces on electrons and positrons are what theory says they should be. Any oddities that might exist in the relation between gravity and electromagnetism, an important theoretical point, should show up in such determinations.

First results, says Dr. Fred C. Witteborn, show that gravity attracts electrons that are free with the same force that it attracts those bound in metals. Therefore, it would seem, the electromagnetic binding of the metals does not affect the gravitational interaction of the electrons.

The next step is to try to measure the gravitational forces on free positrons. Some physicists have suggested that positrons, being antimatter, should have opposite gravity from matter. If this is true, however, then Einstein's general relativity will have to be revised since he predicted that matter and antimatter would attract each other indifferently.

Determining these forces is a formidable task since the particles are both small and electrically charged. Stray electric forces could mask gravity entirely. The particles are let fall through vertical copper tubes that shield outside electric fields. A superconducting magnet guides them along the center of the path.

Prof. William Fairbank and graduate student John Madey are associated with Dr. Witteborn in the work.

PARTICLES

Conservation of leptons

Particle physicists have seen so many of their conservation laws, which they had believed unbreakable, broken in recent years that they have become edgy about the ones that remained. To see if one of these, conservation of leptons, holds, Drs. R. K. Bardin, P. J. Gollon, J. D. Ullman, and C. S. Wu of Columbia University set up an experiment in an Ohio salt mine.

Leptons are particles that interact mainly by the weak interaction. The class includes certain mesons, muons, electrons, neutrinos, and the antiparticles to each of these. The law says that the number of leptons minus the number of antileptons that goes into an interaction should equal the number of leptons minus the antileptons that come out.

Double beta decay, in which certain nuclei simultaneously emit two electrons and two antineutrinos, can be used to test the law. If the law holds, then, since no particles go into the interaction the number of leptons coming out must equal the number of antileptons. Two antineutrinos—antileptons—must accompany the two electrons—leptons. If the law does not hold, the antineutrinos are unnecessary, and so the experiment looked for double beta decay without antineutrinos.

Double beta decay happens very infrequently—only a few decays per day are expected from many grams of source material. The background of false events caused by external radiation is usually many hundreds of times this rate, and previous experiments of this sort have been bedeviled by this mass of background out of which the true double beta decay had to be sorted.

Therefore the Columbia group set up their experiment 2,000 feet underground in a Morton Salt mine.

Only one suspected event was seen in a time period that should have shown a million, strong evidence, say the investigators, that the law is valid.

COSMIC RAYS

Heavy particles detected

A new cosmic ray detector, consisting of a large flat package of sheets of Lexan plastic, has provided scientists with unexpected information about the chemical composition of cosmic rays (SN: 3/18/67, p. 266).

Scientists at General Electric Research and Development Center, Schenectady, N. Y., where the device was perfected, have found that iron and two neighboring elements in the periodic table, manganese and chromium, are all about equally abundant in low energy cosmic rays.

As a result, astrophysicists will have to take a new look at the complicated sequence of events that occur during the explosion of a supernova, a suspected origin of cosmic rays (SN: 4/6, p. 330).

The detector was developed by Dr. P. Buford Price, David D. Peterson and Dr. Robert L. Fleischer. It is an outgrowth of the discovery by Drs. Price and Fleischer, with Dr. Robert M. Walker of Washington University, St. Louis, that all electrically insulating solids can record heavy charged particle tracks (SN: 4/27/68, p. 404). These tracks, which register in minerals and glass as well as plastics, can be revealed by chemical etching.

PLASMA PHYSICS

Confinement time increased

A substantial reduction in the instabilities of the hot hydrogen gases generated in magnetic bottles to study controlled fusion has been achieved at Lawrence Radiation Laboratory, Livermore, operated by the University of California for the Atomic Energy Commission.

Dr. Frederic H. Coensgen reports that the new work partly bridges the gap between the turbulent behavior normally encountered in plasma containment experiments and the stable conditions required for success in a controlled fusion reactor.

Impurities, such as cold plasma and dirt in the chamber, can cause the instabilities, providing the hope of further reduction of instabilities. A consequence of the reduction has been the maintenance of fusion reactions for a two-thousandths of a second—about three to four times longer than in earlier experiments.

This lifetime is only about one-tenth what it would be if the plasma were completely stable.

SOLAR ASTRONOMY

Inner magnetic structure

The magnetic features of the sun have previously been described as a patchwork pattern without an overall field structure. For nearly a century, scientists have known that the solar surface layers rotate more rapidly near the

equator than they do at latitudes near the solar poles.
Now data obtained from satellites and maps of magnetic features on the sun's surface suggest that an underlying solar magnetic field structure may not follow this differential rotation pattern obained from the surface. This inner sphere structure is suspected of rotating at a uniform rate at all solar latitudes by Dr. John M. Wilcox of the University of California's Space Sciences Laboratory in Berkeley, and Dr. Robert Howard of Mt. Wilson Observatory.

They suggest that the internal pattern may also influence the pattern of the magnetic field that sweeps outward from the sun into space.

LOW TEMPERATURES

Superconductivity found in beryllium

Superconductivity has now been found in an element, beryllium, where theory predicted it should not be. Beryllium, the theory said, has too few electrons participating in its electrical conductivity to become superconducting.

But experiments by Dr. R. L. Falge Jr. of the National Bureau of Standards have shown that beryllium in its pure crystalline form becomes superconducting at a temperature 0.026 degrees above absolute zero. (Absolute zero is minus 273.16 degrees C.) Dr. Falge had decided to test beryllium because it forms many superconducting compounds, and he suspected the pure element might also have the property in spite of theory.

The discovery of superconductivity in beryllium triggered a search for it in other elements of the same group (IIA) on the periodic table.

Dr. Falge with Dr. N. M. Wolcott of the National Bureau of Standards and Drs. R. A. Hein, J. E. Cox and J. W. Gibson of the Naval Research Laboratory examined magnesium, calcium, strontium and barium, but found no superconductivity at temperatures down to 0.017 degrees above absolute zero.

Nevertheless, they say, the discovery in beryllium proves that superconductivity is more common than has been supposed.

COMETARY ASTRONOMY

Physics of two kinds of tails

The nucleus of a comet is thought to be about five miles in radius and composed of frozen gases and dust that boils off as the comet nears the sun. The gas and dust is blown into a tail pointing away from the sun. These tails can occasionally achieve lengths of 90 million miles.

Dr. John C. Brandt of the National Aeronautics and Space Administration's Goddard Space Flight Center in Greenbelt, Md., has studied the effects of the solar wind and light radiation on the two kinds of comet tails, one composed mostly of carbon monoxide molecules with one electron removed, the other composed of dust. The two types can exist separately or together.

Dr. Brandt reports that carbon monoxide tails are strongly influenced by the solar wind, which blows the tail in the direction of the wind as seen by a hypothetical observer on the comet, thus pointing generally away from the sun but lagging behind in a curve because of the comet's orbital motion.

Dust tails do not show the influence of the solar wind, but appear to be formed by the gentler pressure of the sun's light. Dr. Brandt finds that the form of these dust tails will also agree with observations if the rate at which dust is liberated from the nucleus is allowed to change with time so that it reaches a maximum value as the comet approaches the sun.

COSMIC RAYS

No special sources found

Cosmic rays bombard earth from all directions, but if there were discrete, intense sources, the flux from the direction of these might be more intense than that recorded in other directions. Many attempts to find such anisotropy have been made without success.

A recent attempt by Drs. Hugh S. Tornabene and Stephen K. Young of Woodstock College, Woodstock, Md., to find high energy gamma rays—above 1,000 billion electron volts—from a number of likely sources was also unsuccessful. The Crab Nebula, a selection of quasars, radio stars and X-ray stars were examined by studying showers of particles generated as the gamma rays came into the atmosphere, but no enhancement in the gamma ray flux from their directions was found.

PARTICLES

Detecting the fast ones

As particle accelerators become more energetic, they produce particles nearer and nearer the speed of light. These fast particles are beginning to tax the reaction times of the detecting equipment.

Dr. Luke Yuan of Brookhaven National Laboratory gathered a small group to study the matter and now reports suggestions regarding three possible techniques.

One possibility is the so-called transition radiation, electromagnetic radiation emitted when a charged particle crosses the boundary between two substances with different dielectric properties. But when they compared the ratio of radiation emitted forward to that emitted backward, they found it differed widely from what theory predicted, and this difference will have to be settled if the method is to be useful.

A second method would use secondary electrons emitted when high energy electron beams strike a target. The problem in the past has been that most materials emit too few secondaries to be easily counted, but new materials with better secondary emission are being developed.

Finally the group considered time-of-flight methods in which particles of different mass are separated by the time they take to fly a given distance from the point of generation. Present timing methods can distinguish differences of five hundred-millionths of a second. New electronic and laser timing techniques should cut this to a thousand-billionths of a second.