physical sciences

PULSARS

Distances and patterns

Most astronomers believe that the pulsars are associated with our own galaxy, but exactly where the pulsars are is a matter of controversy.

The distance estimates are based on the dispertion of the radio signals, the time lag between the arrival of the high and low frequency parts of the same pulse. The dispersion should be proportional to the distance and the density of the interstellar electrons that cause it.

Dr. B. Y. Mills of the Cornell-Sydney University Radio Astronomy Center in Sydney, Australia, suggests, in the Nov. 1 NATURE, that physicists start with the assumption that the pulsars are submerged in a uniform sea of electrons with a density of 0.06 particle per cubic centimeter. He justifies this figure by arguments from other evidence and contends that the distances so determined should be accurate to a factor of two or three for individual pulsars.

If these distances are accepted, he says, they tend to associate the pulsars with the spiral arms of the galaxy.

SOLID STATE

Sound waves affect nuclei

A sound wave in an electrically conducting solid crystal can deliver energy to the atomic nuclei in the crystal. The sound wave forces a mechanical motion of the charged particles in the crystal.

In the presence of an external magnetic field these motions are deflected to form a current across the crystal, and the current produces an electromagnetic wave in the crystal.

Work of the last few years shows that in crystals of tantalum and niobium the electric portion of this wave interacts with the electric properties of the atomic nuclei in such a way as to cause their spins to absorb energy and thereby change direction.

Now Drs. Jean Buttet and E. H. Gregory of the California Institute of Technology and P. K. Baily of the University of California at Los Angeles report in the Nov. 3 PHYSICAL REVIEW LETTERS that the magnetic portion of the wave will interact with the magnetic properties of the nuclei of a crystal of aluminum so as to produce a similar effect on the nuclear spin.

QUASISTELLARS

Determining masses

Studies of the redshifts of the light emitted by quasistellar objects, bodies that appear to be quasars but do not always emit radio waves as quasars do, has convinced Dr. John N. Bahcall of the California Institute of Technology and others that certain of them are associated with clusters of galaxies. Galaxies in these clusters move in complicated orbits within the cluster.

In the October ASTROPHYSICAL LETTERS Dr. Bahcall and Dr. E. E. Salpeter of Cornell University argue that these motions can be used to determine at least a maximum mass for the quasistellar object in a cluster. Provided that the quasistellar's mass is much larger than that of any individual galaxy, the method will work, they say, even if the quasistellar is not big enough to cause observable deflections in the motion of individual galaxies. As an example, they state that the mass of the quasistellar B264 can be no more than 500,000 billion times that of the sun. Previous estimates of quasistellar masses go as high as a billion billion times that of the sun.

PULSARS

Magnetic laser emission

Most theorists now regard a pulsar as a neutron star surrounded by a plasma of ions and electrons trapped in a magnetic field. The whole ensemble is supposed to rotate rapidly to produce the pulsed effect in the signal while the radiations themselves are produced by the plasma particles.

The details of how the particles produce the radiation are in dispute. A number of theorists suppose that the pulsar signals are synchrotron radiation, a kind of radiation characteristic of charged particles moving in circles in a magnetic field. But Drs. Hong-Yee Chiu, Vittorio Canuto and Laura Fassio-Canuto have argued instead for a laser-like action in which the radiation is produced by electrons moving from one quantized energy state to another as they do in an atom (SN: 3/1, p. 207).

Drs. Franco Occhionero of the Institute for Space Studies in New York City and Marek Demianski of Syracuse University have done a theoretical study of the fields around a pulsar in which they include effects of general relativity that they say others have neglected.

They contend in the Nov. 10 PHYSICAL REVIEW LETTERS that a pulsar will have an electric field so shaped that matter cannot move across the magnetic field and produce synchrotron radiation. Instead, they say, particles will be accelerated parallel to the magnetic field, collisions will raise electrons to high quantized energy states, and they will then produce radiation by dropping back to lower energy states.

PARTICLES

Matter-antimatter symmetry

Particle physicists have based their theories on the assumption that nature is symmetric with regard to matter and antimatter. They believe that for every particle there is an antiparticle, that a given particle and its antiparticle are exact mirror images of each other, and that subatomic processes produce or destroy equal numbers of particles and antiparticles.

One experimental check involves the magnetic moment of the positron: that is, the positron's response to magnetic forces. For the positron and its antiparticle, the electron, to be exact mirror images of one another, their magnetic moments should be equal.

Drs. John Gilleland and Arthur Rich of the University of Michigan report in the Nov. 10 PHYSICAL REVIEW LETTERS that they have measured the positron's magnetic moment five times as accurately as anyone has done before. The positron magnetic moment equals the electron magnetic moment to an accuracy of one part per million, and this, they say, rules out any violation of matter-antimatter symmetry in this case.