physical sciences

Gathered from the annual meeting of the American Physical Society in New York

ASTROPHYSICS

A black hole in the galaxy

According to theorists of gravitation a black hole is a star or similar object that has been so condensed by its own gravity that its gravitational field is too strong for any matter or even light to escape from it (SN: 12/26/70, p. 480). It is thus totally cut off from the rest of the universe.

Dr. A. G. W. Cameron of Yeshiva University in New York City believes there is such a black hole or collapsar, as he calls it, in our own galaxy. He says it is the dark companion of the star Epsilon Aurigae.

Epsilon Aurigae is what is called an eclipsing binary. Two stars, one bright and one dark, are bound together by gravity and revolve around each other so that part of the bright star's light is periodically cut off by the dark one. Dr. Cameron says that Epsilon Aurigae differs from other eclipsing binaries in that its eclipses are caused, not by a single solid disk, but by a swarm of small dark particles. "You can see the difference in the light curve," the graph of brightness over time, he says.

He suggests that the swarm of particles is bound to and orbiting around a central unseen object, the black hole. There is no way to prove this positively. All that astrophysicists can do, a kind of negative proof, is to rule out all other possible explanations, until the black hole is the only one left.

SOLID STATE

Positrons and A centers

Solid crystals often deviate from perfect theoretical regularity: Atoms are dislocated from the positions they ought to hold.

Defects in crystals can be located by bombardment with positrons. When a positron meets an electron, they annihilate each other and form gamma rays. In a solid this happens in billionths of a second, but the positrons last a little longer if they encounter a vacancy caused by a dislocation.

In particular, Drs. Werner Brandt and Hsi Fong Waung of New York University report, doping potassium chloride with calcium produces what they call positive-ion vacancies. This is an opening where a positive charge should be, and a positron may be trapped there for a short time. They call such a formation an A center and regard it as the opposite of the much-studied F center, where an electron is trapped in a similar vacancy.

PARTICLES

CPT survives a test

One of the bases of modern particle physics is the principle of symmetry between matter and antimatter that goes by the initials CPT. It says that there is no way to distinguish a particle going forward in time from its antiparticle going backward in time.

The total symmetry principle is a combination of three subsidiary symmetry principles: that nature does not favor one kind of electric charge over the other (C); that nature does not favor lefthandness over righthandness (P, for parity); and that nature does not favor going forward in time over going backward in time (T).

In recent years experiments have shown that each of the subprinciples is sometimes slightly violated, and this has raised concern whether the overall CPT symmetry is also violated or whether the subsidiary violations cancel each other out.

A test done with K mesons at Brookhaven National Laboratory by Drs. David J. Sager, Robert M. Morse and Uriel Nauenberg of the University of Colorado shows that, at least in this case, CPT survives. The neutral K meson decays radioactively in two different modes, one that takes a long time, the other a short time. CPT predicts that equal numbers of neutral K's should take each mode. In 14,000 decays the Colorado group found that the number taking the short mode was almost exactly half the total: 0.505 ± 0.0005.

PLASMA PHYSICS

Stellarators vs. tokamaks

Stellarators and tokamaks are two varieties of toroidal or doughnut-shaped chambers in which physicists are trying to achieve controlled thermonuclear fusion. Recently the tokamaks have produced plasmas nearer to fusion conditions than any other devices have been able to do (SN: 11/8/69, p. 424).

At Princeton University, where researchers have studied stellarators for years, they now have a tokamak. They are trying to see whether the differences between the two designs account for the difference in performance.

According to Dr. Don Grove, "Some things we thought responsible are not." Tokamaks have a copper shield around the doughnut, and it had been thought that this helped the magnetic field confine the plasma. Removing it made no difference. Stellarators have bumpier magnetic fields than tokamaks, but when a tokamak field was made bumpier than a stellarator's, again performance was not affected. Ruling out these factors, says Dr. Grove, raises the hope that ultimately either tokamaks or stellarators may become fusion reactors.

PARTICLES

And still no quarks

For 10 years physicists have been searching for the quark, a hypothetical subparticle out of which all the known physical particles are supposed to be built. In 1969 an Australian physicist, Dr. Charles McCusker, reported that he had found five possible quark tracks in cloud-chamber pictures.

No one has ever published evidence in confirmation of that claim. Drs. Arnold F. Clark, Donald E. Smith, H. F. Finn and N. E. Hansen of the Lawrence Radiation Laboratory at Livermore, Calif., and Wilson M. Powell of LRL at Berkeley report that they have examined 100,000 particle tracks in cloud-chamber photographs and found no possible quarks.