physical sciences

PARTICLES

Objections to cosmic ray quarks

In September Dr. Brian McCusker of the University of Sydney reported that he believed he had found quarks, particles fundamental to the current theories of subatomic particles, among cosmic rays he had been studying (SN: 9/13, p. 198).

For a decade physicists had been looking for quarks without success in any place that seemed even remotely plausible. Dr. McCusker's report was greeted with much excitement but also a good deal of skepticism.

Now that skepticism is being fueled by specific objections. One, in the Dec. 8 PHYSICAL REVIEW LETTERS, comes from Drs. R.K. Adair of Yale University and Henry Kasha of Brookhaven National Laboratory.

Drs. Adair and Kasha have also been looking for quarks in cosmic rays and have not seen any. They have been looking at a lower energy, 100,000 billion electron volts (GeV) rather than Dr. McCusker's 3 million GeV, so they calculated the possible ways quarks could be made in cosmic rays to see if they should have seen some in their energy range.

From the flux of quarks that Dr. McCusker reports, Drs. Adair and Kasha calculate that they should have seen 1,000 quarks where they saw none. They suggest that the cloud chamber tracks Dr. McCusker takes for quarks were made by high-energy electrons or mu mesons.

PULSARS

Source of radiated energy

Only two pulsars have so far shown sudden increases in their pulse rate (SN: 4/19, p. 377) instead of the uniform gradual decreases that observers have come to expect. Others, however, continue to behave as expected: 13 surveyed by Dr. G.C. Hunt of the University of Manchester in England continue to show the steady decrease that theorists attribute to a slowing of their rotation.

This rotational slowdown has been held to be the source of the energy carried off by the pulsars' radio and light emissions. Dr. Hunt calculates it for the example of CP 0808 and concludes that if all the radiated energy comes from rotation, the efficiency of conversion from rotation to radiation is 0.15 percent. Dr. Hunt considers this too high and suggests that the radiation has an additional energy source, possibly a progressive collapse of the pulsar under its own gravitation.

COSMIC RAYS

Destruction of high-energy nuclei

Atomic nuclei of various elements form a significant part of the cosmic rays at low energies. At very high energies, a hundred million billion to a billion billion electron volts, the abundance of atomic nuclei falls off so drastically that some observers believe the cosmic ray flux in this range contains only protons.

Since the mechanisms that could produce cosmic rays should produce atomic nuclei in the high-energy range as easily as in the lower ranges, astrophysicists have sought some mechanism that would destroy the high-energy nuclei after they are made.

A popular suggestion has been collisions between the nuclei and the photons or light particles that are given off by stars and other objects and pervade interstellar space. But calculation shows that the photons in interstellar space could not disintegrate nuclei in the energy range under consideration. If they worked at all it would be for much higher energy ranges where there may be no cosmic rays at all.

Drs. James B. Pollack of Cornell University and B.S.P. Shen of the University of Pennsylvania suggest in the Dec. 8 PHYSICAL REVIEW LETTERS that the high-energy nuclei may be destroyed at the source. Their calculations show, they say, that the photons immediately surrounding pulsars, quasars and supernovas, the objects most usually regarded as possible cosmic-ray sources, could destroy the nuclei.

RADIO ASTRONOMY

Interstellar plasma blobs

Stars twinkle because differences in the density of the air from place to place distort their light rays, alternately widening and constricting them. Pulsars also twinkle, or scintillate, but in their case it is variations in the density of the interstellar plasma of charged particles that does the distorting.

Study of the scintillations of the pulsars CP 0834, CP 1133, AP 1237 and CP 1919 leads Dr. Kenneth R. Lang of the Cornell-Sydney University Radio Astronomy Center at Arecibo, Puerto Rico, to estimate the size and speed of the plasma blobs. He writes in SCIENCE for Dec. 12 that if the scintillations are caused by blobs of plasma moving across the line of sight at 20 kilometers per second, the speed of the earth's motion with respect to the stars, then the blobs are something like 10,000 kilometers across and located about 250 light years from earth.

NUCLEAR PHYSICS

Charge distribution in lead

One way of gaining some information about the structure of an atomic nucleus is to bombard it with electrons. The way they are scattered tells the electric charge distribution, which represents the concentration of protons within the nucleus.

Drs. J.R. Heisenberg, Robert Hofstadter, J.S. McCarthy and Ingo Sick of Stanford University, B.C. Clark and Robert Herman of the General Motors Research Laboratory and D.G. Ravenhall of the University of Illinois report in the Dec. 15 PHYSICAL REVIEW LETTERS a charge distribution for lead that they say is not accounted for by present theory.

The charge density is a maximum, they say, about halfway from the center to the edge. At the center the charge density is about seven percent lower than it is at the halfway point, instead of being greater as current theoretical models predict. The charge density falls off rapidly from the halfway point to the edge so that most of the charge of the nucleus is concentrated in the inner half of its volume.