A new puzzle in physics: The 'cosmion'

The latest cherished principle of subatomic physics to be threatened by experiment is the charge independence of the strong interaction. Observations that violate it are reported in the Dec. 30 PHYSICAL REVIEW LETTERS as a result of work done partly at Brookhaven National Laboratory in Upton, N.Y., and partly at the Nuclear Research Center Demokritos near Athens.

The strong interaction is the force that holds atomic nuclei together. It acts equally upon the electrically charged proton and the neutral neutron. This independence of charge was crucial in convincing physicists that in the binding of the nucleus they were dealing with a new kind of force and not a manifestation of electromagnetism as early thoughts on the subject had tended to suppose. Now the charge independence doesn't look as complete as it once did thanks to the present work. The work was done by T. E. Kalogeropoulos of Syracuse University and the Demokritos center and nine colleagues from the two institutions.

In the experiments, hydrogen and deuterium nuclei were bombarded with antiprotons to see what happened as the antiprotons met the protons in the nuclei and annihilated each other. Out of such annihilations certain debris is expected, including pi mesons and photons. The basic experimental finding is that there are too many photons, surprisingly too many, almost a whole extra photon per annihilation. The interpretation of this seemingly simple fact leads down a number of important paths in subatomic physics.

Photons are the particles that embody electromagnetic forces; they carry them from place to place, so to speak. The appearance of an extra one in these annihilations means that in some way the electromagnetic interaction is mixing into the nucleon-antinucleon annihilation reaction, quite contrary to the usual expectation. For that meddling to happen something has to slow up the annihilation process. The annihilation was expected to occur under the governance of the strong interaction solely and to proceed "instantly." As physicists define "instantly," this would be the time it takes light to cross a deuterium nucleus. Kalogeropoulos and his group figure that it takes 100 times as long as that. Something is slowing up the annihilation reaction and allowing electromagnetism to get into the act. "It is, of course, a great mystery at the present time why the strong forces, presumably responsible for [the annihilation] do not 'act' with expected typical . . . strong-interaction widths," remarks one of their papers.

The slowing of the annihilation process indicates the existence of a new quasi-atom or metastable bound state of matter and antimatter analogous to the long-studied positronium. Positronium is a state in which an electron and a positron (its antiparticle) become bound together on the way to annihilation and go through a series of atomlike energy transitions before they finally overlap and annihilate. Now such a state appears to occur between particles in the nucleus (nucleons) and their antiparticles, the first evidence for such a thing between particles subject to the strong interaction. One interpretation of the extra photon is as radiation given off during a change from one energy level to another in this quasi-atom. Kalogeropoulos and his group suggest calling the quasi-atom a "cosmion" from the Greek word for jewel, beautiful and cosmos. The cosmion's existence had been suggested by some recent theoretical work, especially that of the Soviet physicist I. S. Shapiro.

Further interpretation of the discovery leads to a suggestion of a microstructure in nucleons similar to that of the atom itself. As the atom consists of a nucleus surrounded by something else, so the nucleon would consist of a core surrounded by something else. Kalogeropoulos says it is as if this core were what you had to get at to make the annihilation happen, and it takes a fleeting bit of extra time to do it.

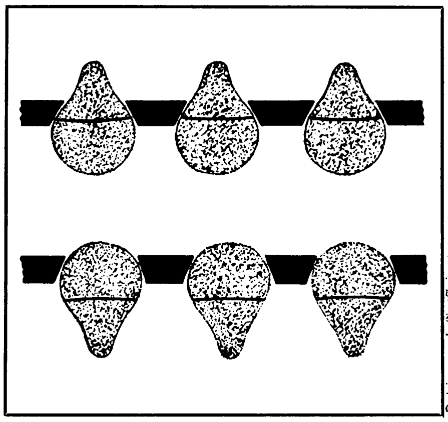
The unexpected time that the annihilation takes suggests a connection with another recently discovered unexpectedly long time interval, the lifetime of the psi or J particles (SN: 11/30/74, p. 340). These are newly discovered extremely massive particles that have lifetimes against radioactive decay that are unbelievably long for particles of that mass subject to the strong interaction. A possibility is that the same aspect of particle structure is responsible for both effects. Kalogeropoulos says theorists are working on ways to link the two discoveries.

Finally the observation of the gamma-ray spectrum from nucleon-antinucleon annihilation offers a way of searching for antimatter in the astronomical cosmos. Many cosmologists would like to find as much antimatter as their is matter. If this gamma spectrum can be observed coming from many locations in the sky, it would indicate that a lot of annihilations are going on, and then cosmologists could conclude that there was a lot of antimatter in the cosmos. □

Egg cells and the electric connection

Egg cells are pretty amazing when you think about it. One tiny cell blossoms into an embryo and eventually into an adult with billions of cells that have differentiated into many tissue types. In most egg cells, a pattern has already been etched before fertilization that will determine which end of the cell will become an animal's head or a plant's shoot and which end will become an animal's tail or a plant's root. How these initial patterns are laid down in the egg is not known, but some Purdue University biologists have completed an interesting experiment that gives them a better idea.

Kenneth R. Robinson and Lionel F. Jaffe report their work in the Jan. 10 SCIENCE. They employed three basic assumptions in the design of their experiment. First, they knew that the eggs of some common brown algae (*Fucus* and *Pelvetia*) are not polarized (do not have a pattern laid down) until after fertilization. This enables the



Brown algae eggs: Rounded ends become leaves, pointed ends develop into roots.