# Three big steps toward a unified field theory

## A third positive result confirms existence of neutral weak currents

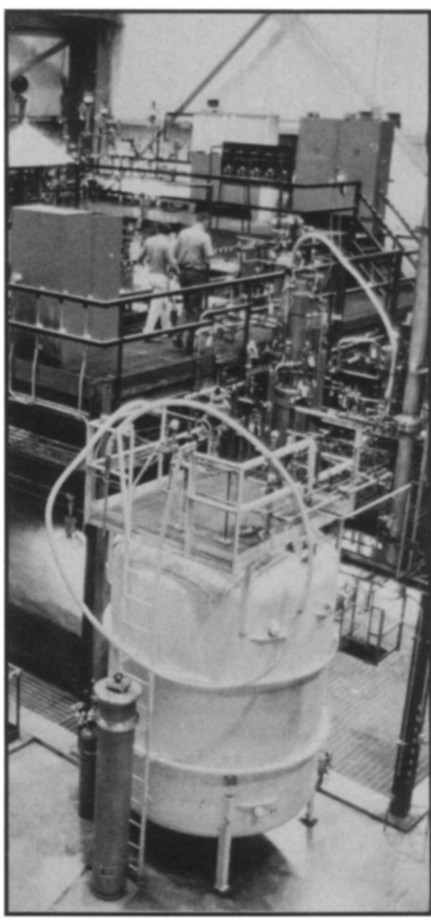
For those who keep score—and many particle physicists are eagerly watching the tally—the count on the question of whether the so-called neutral weak currents exist is now three favorable results. The third, an unqualified yes, comes from an experiment done at Argonne National Laboratory by a group from Argonne, Purdue University and Concordia Teachers College. It was reported at last week's meeting of the American Physical Society in Washington by S. J. Barish of Argonne. "We conclude that neutral currents exist," he says. The two previous results were from the CERN Laboratory in Geneva (SN: 9/15/73, p. 164) and the National Accelerator Laboratory in Batavia, Ill. (SN: 4/20/74, p. 253).

The existence of neutral weak currents would cause a major change in the way theorists think about subatomic particles and the forces that influence their actions. It involves the substitution of a newer theory that attempts to unite at least two different kinds of force in a single explanation for older theories that explained each kind of force separately.

Physicists recognize four kinds of force or "interactions" in nature, gravitational, electromagnetic, strong and weak. Of these, all but gravity operate significantly in the subatomic domain, and each of them governs particular collisions between particles and particular radioactive decays of particles. The "weak" in "neutral weak current" indicates that the phrase has to do with occurrences under the control of the weak interaction. (This is the force responsible mainly for slow radioactive decays). "Current" comes from the mathematics used to describe a collision or decay. Mathematically at least, the intimate details of these happenings bear an analogy to currents moving from place to place similar to electric currents, and the interactions of the particles are treated as interactions of currents. Currents may either carry electric charge or be neutral. If the current is charged it changes the charge (and thus the identity) of particles involved with it. If it is neutral it does not. Under a charged current a particle that goes in a neutrino may come out an electron. Under a neutral current a particle going in a neutrino comes out a neutrino.

One of the things most exciting about the new theories is that they unite two seemingly different kinds of force: weak and electromagnetic. Physicists have long hoped and dreamed of a unified field theory that would show all four of the varieties of force to be different aspects of a single thing. Force is a single philosophical concept; why should nature provide four substantially different kinds of it? Experimental confirmation of theories that unite at least two of the varieties is a significant step toward the final goal.

The experiment done at Argonne is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*Argonne's big 12-ft bubble chamber: A place to look for neutral currents.*

especially significant, says Barish, because of its knowledge of the "final states" of the collisions studied. "We confirm the existence of neutral currents for the first time in the final states," he says. The final states of a collision are what comes out after it occurs. Often an experimenter will know what particles went into a collision and whether or not what he was looking for came out. He may not know what else came out. If he knows everything that comes out, he knows the "final states," and this knowledge gives him extra confidence in the conclusions he draws about what happened during the collision.

The Argonne experiment used a beam of neutrinos made by striking the proton beam from the 12-billion-electron-volt Zero Gradient Synchrotron against a target of beryllium. The neutrinos were then run into the 12-foot bubble chamber, which was filled at times with liquid hydrogen and at times with liquid deuterium.

The collisions that were looked for were of two sorts: Neutrino strikes proton and yields neutrino plus neutron plus positive pi meson; and neutrino strikes proton and yields neutrino plus proton plus neutral pi meson. In both these cases the neutrino maintains its identity. Therefore they are mediated by a neutral weak current.

Such collisions were found in a dozen or so instances out of more than half a million. Neutral weak currents are thus very rare, but that too was anticipated by the new theories. The rarity of the find is a tribute to modern accelerator technology with its copious beams of energetic particles, its huge detection chambers and its computer-assisted data gathering and analysis. The lack of these things in the past and the absence of a theory specifying the existence of neutral weak currents is probably what prevented their discovery before now.

Now that neutral weak currents have been found, experimenters will look with renewed vigor for other predictions of the new theories, especially certain new kinds of particles. Theorists are already at work trying to meld the strong interaction into the theory. □