Zeta Particle: Physicists' New Mystery

Particle physicists are busy trying to round out what they call their "standard model," to find all the key phenomena predicted by the series that have so far so well explained the relations among the already known sub-atomic particles and the changes and interactions they undergo. In doing so they keep finding surprises. A group that set out in the hope of finding the Higgs particle, an object whose existence is fundamental to the existence of everything else, has found something that doesn't fit in: an odd, very heavy particle they call zeta.

Bogdan Niczyporuk of the Stanford Linear Accelerator Center (SLAC) in Menlo Park, Calif., and the Krakow Institute of Nuclear Physics in Poland, representing the 79 physicists of the Crystal Ball Collaboration, reported the discovery last week at the Topical Conference on Particle Physics held at Stanford University. "It's at least very interesting, and it may be a great discovery," says Fred Gilman of SLAC.

The zeta has tantalizing resemblance to the Higgs. However, certain of its important properties disagree with what the standard model expects for the Higgs. Its discoverers prefer to emphasize the disagreement, and make no claims. For now, it is zeta, an unexpected particle with a mass of about 8.3 billion electron-volts (8.3 GeV) or 8 times that of the proton, that nobody knows quite what to do with. It appears among the decay products of the upsilon particles, a family that includes the heaviest particles now known. However, the ratio of its production to those of other things in these decay processes is wrong for the Higgs particle. There are ways of fudging this prediction, but the discoverers of the zeta reject them. The data analysis also "is consistent with" decay of the zeta into a tau particle and an anti-tau particle, which would identify a Higgs, but the existence of that decay mode has not been directly proven.

The zeta was found by the Crystal Ball detector, an arrangement of scintillation counters made of sodium crystals, each backed by a photomultiplier tube and arranged in a sphere around a point where highly energetic electrons and positrons collide and annihilate each other. Out of these annihilations come the particles involved in this investigation.

The 79 physicists in the collaboration represent institutions in the United States, West Germany, the Netherlands, Italy, Poland and South Africa. The detector was originally built at SLAC and worked at that laboratory's SPEAR electron-positron collider. About two years ago the Crystal Ball was moved to the Deutsches Elektronen-Synchrotron laboratory (DESY) at Hamburg. The DORIS collider there can give electrons and positrons of slightly higher energies than SPEAR and so provide the 10 GeV total that the experimentors thought they would need to find the Higgs.

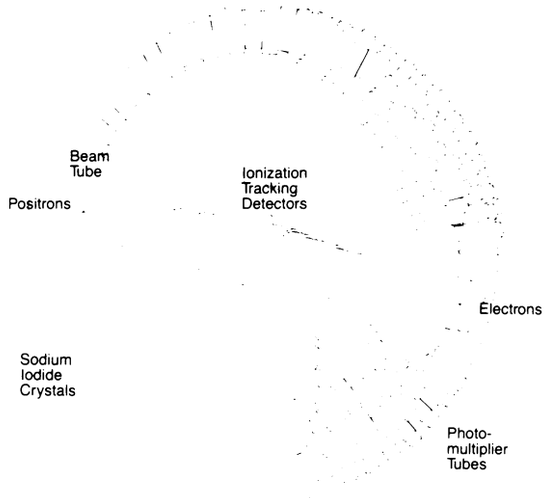
For the moment the zeta is itself a puzzle for the physicists. If it were the Higgs, it would be a central piece in the jigsaw puzzle of particle physics, because, in a way, the Higgs makes everything else possible. In their search for a theory that would give a unified description for all of particle physics, theorists kept coming up against the frustration that they could not give particles mass. With a few exceptions subatomic particles manifestly have mass. If they did not, larger material structures would be impossible.Theory has to describe how they get it, but the theories that were tried kept giving the particles zero or infinite masses, both not allowable.

The theoretical mechanism that finally worked, providing the particles with finite masses, bears the name of Peter Higgs of the University of Edinburgh. In giving the other particles workable masses it requires the existence of this kind of fairy godmother particle, the Higgs. Existence of the Higgs thus guarantees mass to the others and particularly to the W and Z particles.

The recently discovered Ws and Z (SN: 2/5/83, p. 84) play a central mediatory role in the interaction of the other particles. Their existence is a prediction of the unified theory that now exists, the so-called Glashow-Weinberg-Salam theory (which is a particle standard model), and their discovery is regarded as perhaps *the* confirmation of Higgs. They have certain amounts of mass, and they need their mass to do their job. Theoretically, the Higgs guarantees that they have it, so their existence as predicted implies the existence of the Higgs. Finding it would be the final icing on this theoretical cake.

Right now, the zeta is rather a mystery ingredient. Theorists may be tempted to re-tailor the standard model to make the zeta into the Higgs. Or they may take other approaches. For now, says Gilman, in the few days they have had to consider the matter, no promising starts seem to have been made.

Another commentator, Burton Richter, who will soon assume the directorship of SLAC, points out that the zeta is not alone. There is a similar anomalous object produced by the psi particles, a family similar and related to the upsilons. One may be an accident, he says, two ought to mean something. "I wish it was the autumn of 1986, and we had the [Stanford Linear Collider] online," he says. The zeta and other anomalous results that have popped up recently (SN: 5/5/84, p. 276), he avers, increase the need for the next generation of electron-positron colliders, the Stanford Linear Collider and the European Lep apparatus. With total energies up to 150 GeV, they may be able to sort these out. —*D. E. Thomsen*



The Crystal Ball detector, a 1.5-meter-diameter arrangement of sodium crystals, picked up evidence of the anomalous zeta. The SLAC-built detector was mounted around an electron-positron collision point, with the electrons and positrons provided by the powerful DORIS particle-storage ring in West Germany.

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A 'nothing-Burford'

Former Environmental Protection Agency Chief Anne M. Burford last week bowed out of her presidental appointment to the National Advisory Council on Oceans and the Atmosphere (NACOA), which had whipped up a furor among environmentalists (SN: 7/14/84, p. 25).

Her resignation came just hours before she was to be sworn in as the new NACOA chief, and days after the House voted overwhelmingly to ask President Reagan to rescind his selection of Burford, who resigned from the EPA 17 months ago amidst clouds of controversy (SN: 2/26/83, p. 132). Before bowing out of NACOA, which will soon study ocean floor development, Burford termed the council "a joke" and a "nothing-burger," prompting further fire from environmentalists who predicted that Burford would become a campaign issue. □