Positrons, electrons from supernuclei

Naturally occurring atomic nuclei get as large as about atomic mass 250. By striking nuclei against each other, however, physicists can sometimes make them amalgamate for a fleeting moment into something like a supernucleus, with atomic weight around 500. One thing such a supernucleus has is an extremely strong electric field. And physicists were hoping that in this way they could make a field strong enough to produce positrons out of the vacuum – or, as some of them put it, to produce positrons by ionizing space-time itself.

Experiments at the Gesellschaft für Schwerionenforschung (GSI) in Darmstadt, West Germany, are in fact finding positrons that come out of such heavy-nucleus collisions. However, these positrons seem to come not from the vacuum but from some other source, perhaps a new kind of subatomic particle. Such a particle, if it is real, would be something unexpected by current theories of subatomic particles.

At last week's meeting of the American Physical Society in Washington, D.C., Jack Greenberg of Yale University described the course of the experiments, which began about a decade ago and now include three international groups known as EPOS, ORANGE and TORI. Theorists had predicted that if a nucleus could be made with atomic number (that is, electric charge) greater than 173, it would produce an electric field strong enough to bring the energy of its innermost shell of electrons to the energy of the "Dirac sea."

Decades ago, as part of his prediction of the existence of antimatter, the late P. A. M. Dirac postulated that the vacuum, which physicists regard as the zero energy level devoid of all matter or energy, actually contains a sea of virtual electron-positron pairs, which can be pulled into actual existence by the proper forces. As an electric force of a certain strength can ionize an atom, pulling positive and negative charges apart, so this procedure, in the words of D. Allan Bromley of Yale, "ionizes space-time itself," producing a positive and a negative charge.

The electric field of the supernucleus should do this, if there is a vacancy among the electrons of the innermost shell into which the new electron can fall. The positron would then come out to be detected. The first experiments, which collided uranium against thorium to produce a supernucleus with charge number 188, brought forth positrons that seemed to be the right kind. Checking the result, the experimenters then tried thorium on thorium. Theory predicts that the energy of the positrons should increase as the 20th power of the nuclear charge, so with this combination they expected a fivefold increase in positron energy. Positrons came out with the same energy as before. Every combination they tried produced positrons with about the same energy.

By now suspecting they were seeing positrons from some unexpected source, the experimenters tried thorium against tantulum to produce a supernucleus with charge 163, well below the theoretical threshold for producing positrons from the vacuum. Again they found positrons, and again the positrons had more or less the same energy.

Then they decided to look for something else produced with the positrons, if anything. The positrons have a very sharply defined energy, and that means they have to come from a process that produces a positron and only one other particle. The two obvious candidates for the other object are a neutrino and an electron. Electrons are easier to detect, so the experimenters started with them. Most recently, Greenberg reports, they have started to find electrons of the proper energy.

The experimenters now suppose that some new subatomic particle, electrically neutral with a mass three to four times that of the electron, is produced in these nucleus-nucleus collisions, and it then decays to an electron-positron pair. So far its existence is only a supposition needing much more experimental work for confirmation, but if it is confirmed, Greenberg says, "it would upset the usual wisdom" about subatomic particles.

– D. E. Thomsen

New dates for 'early' tools

Four bone artifacts thought to provide evidence for human occupation of North America approximately 30,000 years ago are, at most, only about 3,000 years old, report archaeologist D. Earl Nelson of Simon Fraser University in British Columbia and his colleagues in the May 9 SCIENCE.

The four bone tools, all of which have counterparts in more recent times, were found in 1966 along a riverbank in the Yukon Territory. But at the time, say the researchers, the carbon used for radiocarbon dating was extracted only from the inorganic material that makes up about three-quarters of bone mass; scientists have since shown that this part of the bone tends to collect extraneous carbon from several sources, including the groundwater near rivers. Nelson and his co-workers examined carbon from the protein-rich organic portion of the bones, which is less susceptible to external carbon contamination.

The difference in age estimates between the two types of carbon samples from the same bone is, to say the least, significant. For example, a "flesher" used to remove flesh from animal skins was first given a radiocarbon age of 27,000 years old. That age has now been revised to about 1,350 years old.

The times and circumstances surrounding human colonization of the New World prior to 11,500 years ago are controversial, note the researchers, but the Canadian bones cannot be used in the debate. □

More shakers felt in Mexico

For several moments last week, residents in Mexico City and four Mexican states thought the nightmare had returned. Seven months after a magnitude 8.1 earthquake demolished parts of Mexico City, killing about 9,500 people (SN: 9/28/85, p. 196), another large quake shook Mexico. But this time, the most trouble the earthquake and its two aftershocks caused were a few blackouts and some panic.

According to the National Earthquake Information Center in Boulder, Colo., the April 30 quake registered magnitude 7 and its epicenter was located in the Pacific about 250 miles southwest of Mexico City – in the same area as the Sept. 19 shaker. However, the New York Times reports that the National Autonomous University of Mexico has said the quake measured magnitude 6.5 and was centered 380 miles southwest of Mexico City. A smaller quake reportedly occurred in the same region on May 4.

Since the September quake, seismologists have been most concerned that an area to the southeast, closer to Acapulco, might experience a large earthquake in the next five to 10 years. Had last week's quake occurred in that region, it might have signaled increased stress in that area. But so far, says Hiroo Kanamori at Caltech in Pasadena, based on its location and size as reported by the Earthquake Information Center, the earthquake does not appear to be unusual or a cause for worry; it is not uncommon for a magnitude 7 quake to occur in the same area several months after a much larger event.

Still, it will be a few months before seismologists will have studied all the details of the two recent quakes to learn their full significance. As the 100 satellite-telemetered stations of a planned Global Seismographic Network are erected around the world over the next five to 10 years, adds Kanamori, seismologists will be able to study and interpret such seismic events much faster than they do now.

– S. Weisburd