Unconventional physics: 'Quite crazy' after all these years

Physicists have a set of theories by which they try to explain the basic structure of matter and the interrelations of subatomic phenomena. This "conventional physics" explains most things very well, but anomalies keep popping up. The three latest things that conventional physics can't (yet) explain are the particles called U^+, U° and U^-; the production of electrons and positrons in collisions of heavy atomic nuclei; and the fifth force. All of these were discussed last week at the Twenty-Third International Conference on High-Energy Physics held at the University of California at Berkeley.

Conventional physics recognizes four kinds of forces that hold the world together and animate its motions: gravity, electromagnetism and the weak and strong subatomic interactions. For 30 years there have been repeated hints of the existence of a fifth force, the most recent being that of Ephraim Fishbach of the University of Washington at Seattle (SN:1/18/86,p.38).

Fishbach's fifth force is a kind of negative gravity, a component of gravity that is repulsive for ordinary matter and that depends on the nature of the substances involved, as ordinary gravity does not. Different chemical elements or compounds repel each other differently even if they have the same mass. This negative force is 100 times weaker than ordinary gravity.

Fishbach's suggestion derives from a reanalysis of a famous experiment done in Budapest about 60 years ago by Roland von Eötvös. Eötvös measured the gravitational forces among a large variety of different substances; and Fishbach's reanalysis shows, he says, variations from substance to substance that this fifth force would cause. Critics, pointing to seeming inconsistencies in the Eötvös data, jumped all over this assertion.

Fishbach now claims that further analysis removes the objection. Reanalysis, he says, shows that the inconsistencies had to do mostly with fortuitous coincidences between different substances in the number of neutrons and protons present in an atom or molecule. The fifth force depends on that number.

Also, it had not been quite clear where Eötvös had done the experiment. Now, from the testimony of people who were in Budapest then – particularly Jeno Barnothy, who now lives in Evanston, Ill. – it is clear that the work took place in a basement. Taking into account the effects of the depth and walls of the basement – as well as those of the brass vials that Eötvös used – also removes many of the criticisms, Fishbach says.

There is also evidence from particle physics, found in the behavior of K mesons. Fishbach points out that this evidence links the fifth force to electromagnetism and the weak interaction, while his Eötvös work links it to gravity. Thus, he says, it may be the key to a unification of those forces and so an important step on the way to one of the most important goals in physics, a unified theory of all the forces.

In pursuit of the second mystery, an international group of physicists at the Gesellschaft für Schwerionenforschung in Darmstadt, West Germany, has found a mechanism that produces electrons and positrons in collisions of heavy atomic nuclei that conventional physics cannot explain (SN:5/10/86,p.295).

The experiment, dubbed EPOS, originally sought to create positrons out of the vacuum by the strong electric forces that are generated when two heavy nuclei come together to form a kind of hypernucleus with 500 or more neutrons and protons. Positrons from the intended source did not appear, but pairs of positrons and electrons from some unexpected source did appear.

More recent running of the experiment adds new puzzles, according to Larry Krauss of Yale University. If the experimenters lower the energy at which the two nuclei collide, a second peak of positron emission appears when the energy gets below a certain threshold. Nobody knows the source of this.

What has been learned about the emission mechanism itself only deepens the mystery. Krauss says the source can't be anything in, or in the presence of, the heavy nucleus. Nuclear physics or associated atomic processes don't explain it. Although somehow related to the existence of ultraheavy nucleus, whatever it is could be happening as far as 100 fermis away, a very long distance from the atom's point of view. Particle physics serves equally badly in the hunt for understanding. "There is no theoretical explanation," says Krauss.

Finally, analysis of data from an experiment at the CERN laboratory in Geneva, Switzerland, run for 20 days in 1980, shows evidence for the existence of an inexplicable new particle, or rather trio of new particles. According to Hans W. Siebert of the University of Heidelberg, West Germany, these are fairly heavy particles, being about three times as heavy as the proton with masses of about 3.1 billion electron-volts.

These particles, which the discoverers have named U^+, U° and U^-, decay into a combination of a lambda hyperon, an antiproton and pions. Depending on which kind of force animates the decay, the U^+, for example, could be a combination of a strange quark, an up quark and two anti-down quarks, or a combination of two D mesons. Either is "quite crazy" by conventional theory, Siebert says.

The beam in which the original data were taken no longer exists at CERN, but the University of Heidelberg is trying to get CERN to put up a new one. Meanwhile, an experiment done at Serpukhov in the Soviet Union has confirmed the U° and U^-.

They called the new particles U, Siebert says, because before this discovery, they had been working on a particle called a T meson, and U comes after T. However, the CERN COURIER has chosen to interpret U as "unconventional," which, Siebert says, is better than the German interpretation, *Unsinn,* which means "nonsense."

From time to time, anomalous things have appeared (and disappeared) in physics. Their cumulative effect may someday reveal a serious inadequacy in conventional physics, as similar occurrances did in the 1890s and early 1900s. George Santayana said that those who do not study history are doomed to repeat it. However, in physics, if not in history, nothing ever repeats exactly.

– D. E. Thomsen

Monitoring Soviet tests

For the first time, American scientists have begun monitoring seismic waves near a nuclear weapons test site in the Soviet Union, the New York-based Natural Resources Defense Council reported last week. U.S. seismologists are already setting up two monitoring sites and are looking for a third site, each about 200 kilometers from the nuclear test area near Semipalatinsk in Kazakhstan. Surface seismometers – and, if the U.S. government approves their "export" to the USSR, sensitive deephole detectors – will help detect nuclear explosions and possibly bring the superpowers closer to a comprehensive ban on nuclear testing.

But, says seismologist Thomas Bache, who has conducted related research for Science Applications International in San Diego, the experiment is "a bit of a red herring. It doesn't address the . . . issues we're most concerned with." Central among those issues, he says, is the geological makeup of the ground under the test site itself, information crucial to identifying explosions and the size of the devices creating them (SN:10/26/85,p.268; 11/2/85, p.282).

If the monitors remain in place for several years and if the data they collect are untainted and of high quality, Bache adds, the information could prove useful to seismologists. "It's scientifically not a bad experiment," he says, "but it's limited." *– T. Kleist*