Physics

Dietrick E. Thomsen reports from Washington, D.C., at the meeting of the American Physical Society

A passion for accelerators

Ou est la tres sage Heloïs,
Pour qui fut châtré et puis moine Pierre Esbaillart a Saint Denis?
Pour son amour ot cette essoine.
— François Villon, *Ballade des dames du temps jadis*

[Where is that very gifted Heloise, for whom Pierre Abelard of Saint Denis was castrated and then became a monk? He suffered such a trial for the sake of his love.]

Physicists are now busy planning the next generation of accelerators for the study of elementary particles. These machines are planned to endow particles with energies in the tens of trillions of electron-volts to probe ever-finer structures of matter. The most serious studies envision two machines, says Maurice Jacob of the CERN laboratory in Geneva, Switzerland, one in Europe, more or less under CERN's auspices, the other the Superconducting Super Collider in the United States.

Now, however, there is Heloise, or at least her namesake, the Heloisatron. Italian physicist Nino Zichichi, inspired by the famous love affair of Heloise and Abelard, proposes building the accelerator in Apulia, the rugged, romantic "boot heel" of Italy. All such machines would be huge, and Zichichi's Heloisatron would be a circle stretching across Apulia from the Golfo di Taranto to the Adriatic Sea. Its injector, which would supply slightly preaccelerated particles to the main circle, would be called Abelard. Reportedly the Italian government is willing to put up $1 billion for such a machine, provided the rest of the world kicks in a few billion more. Other physicists are referring to Zichichi's proposal as "vague," thus damning it with faint definition. As the refrain of Villon's poem puts it: *Ou sont les neiges d'antan?* [Where are the snows of yesteryear?]

The bottom will not fall out

Ever since cosmologies that feature an inflationary universe were first proposed, there has been an underground current of apprehension among some physicists that the bottom might fall out of the universe, with disastrous consequences for all the objects and structures that we know in nature. In the older theories of the expanding universe, the cosmos expands at a constant rate throughout the ages. To get around some serious problems in that scenario, the inflationary cosmology proposes that there was at least one era when the cosmos expanded much faster than at the current rate (SN: 2/12/83, p. 108). However, while solving some problems, the inflationary scheme raised the specter of catastrophe by its treatment of the vacuum.

The vacuum is physicists' term for the lowest possible energy state, the zero level devoid of matter or energy. Everything that exists occupies energy levels above the vacuum, which is the rock bottom on which physics is based. Or perhaps not quite the rock bottom. Energy scales are relative. A state lower than the vacuum that we observe is conceivable, and the inflationary cosmology implies that such a state could exist for the universe.

If that is so, the universe as we see it is based on a false vacuum, and some appropriate nudge might send it crashing down to the true vacuum with a catastrophic rearrangement of physical structures and processes. Some physicists have feared that something in the laboratory, perhaps some very high-energy collisions of particles, could make a hole in the dike, so to speak, starting a process that would grow until everything in the cosmos was sucked into it and disastrously rearranged.

Now the man generally regarded as the originator of the inflationary idea, Alan H. Guth of Massachusetts Institute of Technology, says it can't happen. Guth, along with co-workers, calculates that if such a region based on a different vacuum got nucleated, it would develop as a universe separate from our own, and would not suck everything in our cosmos into itself. Such a new universe would connect to ours through an umbilicus that would look to us like a black hole.

Furthermore, such a different universe could probably not get started in the first place. It needs not some high-energy collision as a nucleus but an eternal singularity, Guth says. A singularity is a location where space-time becomes infinitely curved, and the laws and equations of physics become infinite or impossible to define. A singularity lurks in the center of every black hole, but these are temporal singularities: They form at some point in time, and they may disappear at some other point in time. The only eternal singularity cosmology knows is the one that started it all, the one at the origin of the Big Bang. Two of those don't seem to be possible.

On the trail of element 110

The heaviest element that exists naturally on earth is uranium, atomic number 92. Since the 1940s, physicists have tried to manufacture heavier and heavier elements in their laboratories. Part of this is curiosity about the structure of such elements; part is the hope of finding things that might last long enough to be useful. All elements heavier than uranium that have been found so far are subject to radioactive decay, but there is a strong hope that somewhere above element 110 there is a range of stable or relatively stable elements.

Confirmed discoveries of transuranic elements now go as far as element 109. Recently physicists from the Dubna laboratory in the Soviet Union reported a possible finding of element 110. However, Dubna does not have the facilities for confirming such a discovery to the satisfaction of physicists generally. The confirmation comes by observing the decay of the supposed element 110 into a lighter element with emission of an alpha particle. Then the lighter element decays to something still lighter, and so on until the chain reaches a stable nucleus. The spectrum of alpha particles emitted during this chain of decay should uniquely identify element 110.

The Gesellschaft für Schwerionenforschung (GSI) in Darmstadt, West Germany, has the facilities for observing such alpha spectra, and, according to Paul Kienle of GSI, the Dubna report prompted GSI experimenters to start attempts to confirm element 110. At the time of the American Physical Society meeting the experiments were still in progress, and Kienle could give no results.

Strange nuclei in Japan

Physics nowadays is very much an international collaboration, and while physicists in one country or continent concentrate on a particular experimental approach, those somewhere else often try a complementary approach. Thus, while physicists in the United States and Europe approach the frontier of nuclear physics by colliding nuclei with other nuclei, the Japanese intend to see what happens when nuclei contain particles of the class called strange particles instead of some of their usual neutrons and protons. These strange particles contain a different kind of quark from those in neutrons and protons, and the purpose is to see how the introduction of this strange quark affects nuclear structure and behavior. For this work the Japanese will build an apparatus that bombards nuclei with K mesons, Toshimitsu Yamazaki of the University of Tokyo says. The new machine will be located in Tsukuba, Japan's "Science City." Bombardment with K mesons will turn neutrons or protons into strange particles.