Prospecting in the Desert of Physics

Some theoretical physicists have suggested that particle physics has reached the edge of a desert: From just above the current maximum energy of particle experiments for a very long range, there would be no interesting new phenomena to be found. If such a belief turned out to be true, it would render new, higher energy equipment of dubious value. However, two experiments done at the CERN laboratory in Geneva and reported at last week's meeting in Washington, D.C., of the American Physical Society have found new, exotic and, for the moment, inexplicable phenomena just at the upper edge of currently available energies. Such a short step into the desert and new things appear, says Carlo Rubbia of Harvard University and CERN. "The desert is blooming already."

What blooms in the desert is a double mystery. The two CERN experiments, called UA1 and UA2, see two different kinds of exotica. So far neither can find the other's sort of exotica in spite of diligent efforts. Both, however, are attached to the same accelerating device, the Super proton antiproton Synchrotron (Sp$\bar{p}$S). The Sp$\bar{p}$S accelerates protons and antiprotons and collides them with each other. The collisions take place in the centers of detectors that constitute the UA1 and UA2 experiments, which are operated by dozens of physicists from all over Europe (and in UA1's case, the United States, too). In each collision 540 billion electron-volts (540 GeV) are available to create new phenomena.

As Rubbia describes it, UA1 has seen six and possibly seven instances in which large amounts of energy disappear off to the side, and there is no present explanation for what happens. Proton and antiproton collide and annihilate each other. In some cases a jet of hadrons (protons and related particles) comes off to the side, in other cases photons. By applicable conservation laws, the same amount of energy as carried by the jets or the photons must come off in the opposite direction, but the detectors find nothing. The "missing energy" can amount to 50, 70 or 80 GeV, Rubbia says. Some undetectable thing is taking it away, and for the moment nobody knows quite what.

UA2's findings, as described by Jean-Marc Gaillard of CERN, also involve events with large amounts of energy coming off to the side, but in these four events, the energy is carried on one side by a jet of particles and on the other by an electron and a neutrino (or at least by a neutral particle that looks like a neutrino). The dynamics of these events, however, render them impossible to interpret in terms of known physical processes. In a paper submitted to PHYSICS LETTERS B the UA2 group concludes: "While the present study ... suggests the existence of a new phenomenon, more data need to be collected in order to place the result on firmer ground."

Commenting on the CERN findings, a prominent Philadelphia experimenter who was not involved, Alfred K. Mann of the University of Pennsylvania, says, "These events suggest something important in the mass region 150 to 200 GeV [that is, the lower end of the desert range]. None of us had a good reason to believe something should be there." Speaking of a new sense of optimism, he says the results "tell us something we hadn't anticipated."

These two experiments are part of a continuing effort to test the "standard model" of particle physics. The standard model includes two components, the Glashow-Weinberg-Salam (GWS) theory, which is a unification of the theories of electromagnetism and of the weak subatomic interaction, and quantum chromodynamics (QCD), which is the theory of how quarks behave. GWS theory concerns the behavior of electrons, muons and neutrinos and how most radioactive decays occur. QCD concerns quarks, how they stick together to build up protons, neutrons and related particles and how those things behave. Grand Unified Theories (GUTs) attempt to link GWS and QCD into a single framework. A further step yet is to link GUTs with the phenomena of gravitation by way of supersymmetry theories (SUSYs). Neither GUTs nor SUSYs are considered part of the standard model. Their characteristics are still too controversial and they do not make good quantitative predictions as GWS and QCD do.

The two CERN experiments are taken as confirmation of the standard model. The exotica they have found are regarded as going beyond it. Further confirmation of the standard model is found in two experiments also reported at the meeting that sought phenomena suspected to exist by some physicists that would have required amendments to the standard model. One experiment was done at the TRIUMF accelerator in Vancouver, B.C., and searched for right-handed W particles. The W's, previously discovered by UA1 and UA2 (SN: 2/5/83, p. 84) are pivotal particles in the GWS theory. So far only left-handed W's have been seen. Right-handed W's would require change in the standard model, but the experiment did not find any. Similarly, work reported by Eugene W. Beier of the University of Pennsylvania studied the collisions of neutrinos with electrons and protons to see whether amendments to the dynamics described in the GWS theory are necessary. No need was found.

As to what the CERN exotica may be, Rubbia and Gaillard mention several possibilities. They may be new processes involving the already discovered W and Z particles, the particles central to the dynamics of the GWS theory, but they would be processes unforeseen in that theory. They could involve particles predicted by the SUSY theories, so-called photinos or zuinos. They could involve the long sought Higgs particles, which are important to understanding how such particles as Ws and Zs have the properties they do. But if they are, says Rubbia, they are not the kind of Higgs particles envisioned in the standard model.

All agree that more investigation is needed, and so it is into the desert with pick and shovel — literally — new equipment is being built. The immediate next step is a new run at CERN starting in September with slightly higher energy, 640 GeV total. Just now, too, the Tevatron at the Fermi National Accelerator Laboratory in Batavia, Ill., has begun to accelerate protons to 800 GeV. At the moment it strikes them against stationary targets, not the best sort of experiment for this kind of investigation. In a couple of years, however, it should also be able to accelerate antiprotons to 800 GeV. Then collisions with 1,600 GeV total available energy will be possible. Rubbia foresees the Tevatron collider as the arena to which the search will then shift. — *D.E. Thomsen*

Gene-spliced blood factor

A substance necessary for the normal clotting of blood, and which is missing in most hemophiliacs, has been produced in a laboratory with genetic engineering techniques. Genentech Inc. of South San Francisco, Calif., says the substance, called Factor VIII, is the largest and most complex protein so far created artificially. It contains more than 2,300 amino acids. Genentech scientists moved the Factor VIII gene from human blood into animal cells growing in a laboratory culture. The animal cells then produced and secreted the complex protein.

Several companies are competing to produce the clotting factor with recombinant DNA techniques. Factor VIII, for treating hemophiliacs, is currently extracted directly from human blood, but it is expensive and the blood product can carry agents causing hepatitis B and Acquired Immune Deficiency Syndrome (AIDS). Just five months ago Genetics Institute, Inc., of Boston, reported the identification and cloning of a piece of the Factor VIII gene (SN: 12/10/83, p. 372). Genentech says it expects clinical trials in less than two years. □