... Colliding Beams

the other kinds of force in nature, but it has a particular importance in the present state of physical theory. In the theorists' grand attempt to develop a unified field theory, a scheme that will collect all the varieties of force in nature into a single explanatory framework, it happens that the weak interaction is one of the most convenient for mathematical physicists to start with. An experimental entry into the domain peculiar to the weak interaction could thus test the current unifying efforts and give some indication whether the mathematical architecture on which they are based is likely to hold up when the strong interaction and gravity are added to the present efforts, which bring together the weak interaction and electromagnetism.

It is this domain that Richter proposes that the third generation electron-positron colliding-beam facility enter. The energy criteria can be determined by a simple question: What is the threshold at which the intermediate vector boson, the particle that embodies the forces of the weak interaction, can be produced? (In modern physical theory, forces are represented by particles: A force between two bodies is equivalent to the exchange of a stream of intermediate particles between them. Each kind of force has its own particular intermediaries.)

Richter determines the lower threshold on the basis of producing a single, electrically neutral intermediate vector boson — they are also called W or Z particles. That is about 100 GeV. Furthermore, if the machine gets above this level, "the weak interaction will dominate no matter what theory is true." The upper threshold is determined by the unified field theories, which add to the electrically neutral W^0 a pair of charged intermediate vector bosons, Z^+ and Z^-. The charged ones must be produced in pairs, so the higher threshold is 200 GeV.

Richter reviews a number of options for reaching this energy range and finally concludes that the sort of machine he calls a "big 50" would be best. This would be built to produce first a beam of 50-GeV electrons and one of 50-GeV positrons (thus 100 GeV in all) and be expandable in energy to 100 GeV per beam. The energy expansion would be done by substituting superconducting elements for ones employing ordinary conductors as they become available. It would not be wise to wait until superconducting equipmment is available and build the 100-GeV beams right off, Richter says. Little money would be saved, and time would be lost.

Will such a thing ever be built in the world? Richter believes that it will be — in Europe. "How are we [American physicists] going to get involved?" he asks. "As visitors." Historically there has been much more interest in storage rings and colliding beams in Europe and somewhat more support from European governments than in the United States.

If one such machine is built in Europe, does the world need two? Richter answers yes, because the competition is healthy scientifically and psychologically. But if one is built in the United States, it should not come along five years after the European effort. Every machine needs a period of excitement when it represents the newest physical effort in the world. Five years later it has already been upstaged. □

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