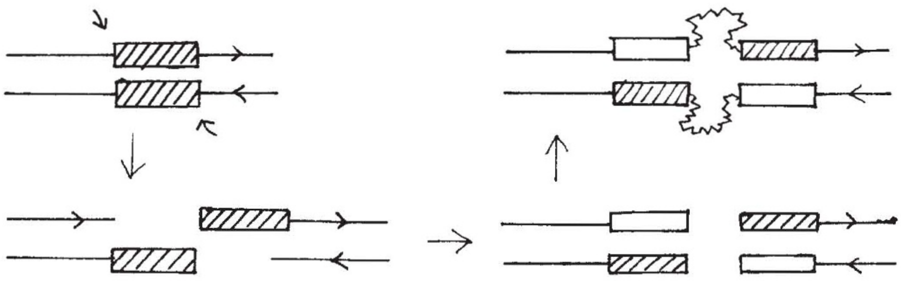

Fig. 2

interestingly other direct duplications result from transpositional events. When bacteriophage Mu is used to mediate transposition of a bacterial gene X, to a new replicon, X is finally found to be bounded by directly repeated Mu genomes. Similarly, experiments in Falkow's laboratory in Seattle and ours in Brighton, have shown that transposition of one class of mutant transposon from replicon A to replicon B, results in the acquisition by B of two directly repeated copies of the transposon sandwiching replicon A.

Sequence analysis of IS*1* (N. Grindley; Ohtsubo & Ohtsubo *Proc. natn. Acad. Sci. U.S.A.* **75,** 615; 1978) and part of Tn*3* (Cohen, Chou & Casadaban) shows a number of interesting features. IS*1* has at its ends an inverted repeat of 30 bases while that of Tn*3* is somewhat larger. Neither set of repeats is perfect and those of IS*1* contain a number of promoter-like sequences as well as a sequence homologous to that of the phage lambda attachment site. The promoter sequences are particularly interesting because of Ikeda and Kobayashi's report (*Proc. natn. Acad. Sci.* **74,** 3932; 1977) of RNA polymerase involvement in *rec*A independent recombination in lambda. Analysis of the RNA specified by the ends of transposable elements could give some idea of the possible role of these sequences in transposition. Although transposable elements are not normally autonomous replicons (except those like Mu that also carry viral genes) and are only found integrated within other replicons, the Stanford workers have shown that if genes for autonomous replication are inserted into a transposon, then autonomously replicating transposons that are still capable of transposition can be isolated, albeit at a fairly low frequency. Whether this suggests that transposons normally have an autonomous (but non-replicating) existence remains an intriguing question. □

Hunting the W

from Peter Landshoff

It seems that there are in nature four different types of force between particles: the strong interaction that holds protons and neutrons together inside a nucleus, the electromagnetic interaction, the weak interaction responsible for nuclear beta decay, and the very much feebler gravitational interaction. Of these, the electromagnetic force is the best understood: it is described to extremely high accuracy by quantum electrodynamics. This theory quantises Maxwell's classical electromagnetic field, so that the field is given a particle-like character. The particles, photons, transmit the electromagnetic force between charged particles.

It has been believed for many years that there are also particles that transmit the weak force. These particles are known as W particles. It is now hoped that their existence will soon be established. It has not yet been possible to produce them in laboratory experiments because, if they exist, they are very massive and so a very high energy accelerator is needed.

The mass m of a particle that transmits a force is related to the range R of the force by $R \approx \hbar/mc$. Thus, the photon has zero mass and consequently the electromagnetic force has infinite range, while the pion (discovered over 30 years ago) has mass 0.14 GeV/c^2 and gives the strong interaction a range of 10^{-15} m. (For comparison, the mass of the proton is 0.94 GeV/c^2.) Neutrino scattering experiments have shown that the weak interaction has very short range, such that the mass of the W particles is at least 20 GeV/c^2.

Salam and Weinberg have formulated an elegant quantum field theory which incorporates both the electromagnetic and the weak interactions. Their model is a first step in the unification of all four fundamental forces into a single relativistic quantum theory, which has long been an ambition of theoretical physicists. Predictions of the model agree well with experiment but the existence of W particles is crucial for its validity. In order that the Salam-Weinberg model be internally self-consistent, the mass of the W particles must be greater than 37.5 GeV/c^2, but a value close to twice this makes the model agree best with the details of the neutrino scattering data.

There are various plans, on both sides of the Atlantic, to construct accelerators of energy high enough to produce particles of such large mass. The Super Proton Synchrotron (SPS) in the European laboratory at CERN is particularly well suited to be adapted to provide the necessary energy. At present, the SPS accelerates protons to energy 400 GeV. They are extracted from the machine and are made to scatter on fixed targets. It is planned to inject into the SPS simultaneously both protons and antiprotons; these will circulate in the accelerator ring in opposite directions and will be made to collide head-on. Each particle in the head-on collisions will have energy 270 GeV; according to special relativity the available energy in each collision then is equal to that of a 150,000 GeV proton colliding with a fixed target.

At such high energy many interesting things are expected to occur as a result of the proton–antiproton interaction, among them the production of W particles. If the SPS collider performs as well as is hoped, there will be at least 10,000 interactions per second, and each interaction is expected to produce about 25 particles, mostly pions. There are indications from cosmic ray studies that in some interaction events the multiplicity will be considerably higher than this. In order to cope with the full complexity of the events, a sophisticated particle detector will be needed. A collaboration of more than 50 physicists, from Aachen, Annecy, Birmingham, California, CERN, Collège de France, Queen Mary College, Rutherford Laboratory and Saclay is proposing to build a huge detector, weighing 1,500 tons. As the SPS is underground the detector will have to be assembled 25 m below ground level.

It is estimated that one proton–antiproton interaction in every 10 million will produce a W particle. It may not be straightforward to recognise these events but, nevertheless, the race to find the W is on, and Europe hopes to win it. □

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