SOME ASPECTS OF STRONG-INTERACTION THEORY THAT CAN BE STUDIED AT HIGH ENERGIES

S. C. Frautschi
California Institute of Technology

In present theories, interactions are produced by the exchange of particles. Consistent application of this idea, however, has long been thwarted by the divergence problem occurring in relativistic theory at small distances. One way to avoid divergences at small distances is to assume that the particles have spread-out composite structures lacking a point core, as in atomic and nuclear physics, and a promising means of incorporating this assumption into the theory is provided by Regge poles. A systematic description of scattering in terms of particle exchanges then becomes possible. The mathematics of Regge-pole theory takes on a simplified form inviting experimental checks, in the region of "asymptotically-high" energies.

One consequence which appears to be independent of detailed considerations is that the energy dependence of a cross section at fixed momentum transfer depends on the isotopic spin and other quantum numbers that can be exchanged in the process. The different quantum-number exchanges lead to cross sections falling off with differing powers of energy, a gross distinction which sets in quite rapidly with increasing energy.

More subtle is the detailed variation with energy and momentum transfer for a given quantum-number exchange. There arises here an unresolved theoretical question as to whether the "complete set" of exchanges involves just Regge poles, or associated "moving cuts" as well. At stake are

(i) the location of "asymptotic behavior", corrections to which vanish as a power of energy for poles, but only as a logarithm of energy for cuts,

(ii) the qualitative behavior of peaks at small momentum transfers -- these shrink indefinitely with increasing energy if only Regge poles are exchanged, but would tend to stabilize if cuts are also present.

The present experimental and theoretical situation suggests that energies higher than 30 Bev will be needed to test this kind of theory fully. To take a particular example, it now appears certain that the present energy range is too low to check conclusively the Pomeranchuk predictions equating particle and antiparticle cross sections in the asymptotic limit.

Theories based on particle exchange also lead to interesting statements concerning production of large numbers of secondary particles, and groups of secondaries such as "fireballs". Our knowledge of such matters would certainly be improved by a higher energy accelerator. It appears, however, that the more fundamental questions are approached more directly through reactions involving only a few particles than in multiple production.