perfect. Naturally the total range of variables over which the correctness of this model can be tested is limited both by the energy of the available beams and by the data rates which can be recorded.

Another, more dramatic demonstration of the existence of point-like particles can be made by comparing elastic and inelastic scattering. This is shown in fig. 11. It is seen that the probability of elastic scattering on the proton as a whole falls off much more rapidly with increasing momentum transfer than does the probability of inelastic scattering which involves presumably only single point-like objects. You will recall that this is precisely what Rutherford observed in regard to the nucleus within the atom. By this analogy we see at least a strong indication that the proton and neutron do indeed have point-like constituents, which were first dubbed 'partons' by Richard Feynman. These are now recognized to be identical to the point-like 'quarks' whose existence had been postulated through a completely different line of reasoning; this was to explain the great number of different particle states that had been discovered by the high energy physicist, the systematic relations among their masses, and the rules that govern their conversions into one another.

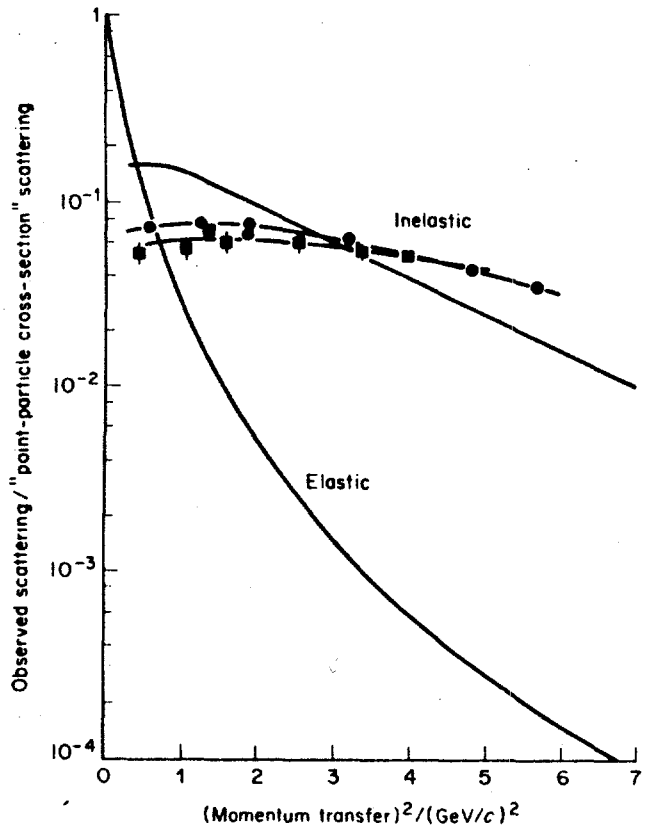

Fig. 11. Comparison of inelastic and elastic electron–proton scattering. This graph shows the ratio of the observed scattering to the point particle cross-section for elastic and inelastic events plotted as a function of the square of the momentum transfer. Note that inelastic scattering falls off much more slowly with momentum transfer than does elastic scattering. This indicates that inelastic scattering appears to take place on point-like objects within the proton.