The essential point to note about this result is that in the triplet scattering there are LS and tensor-like terms which can couple states of different angular momentum.

Yang raised the question of whether it is true that every conservation law is related to a gauge transformation. This has already been discussed in a published paper in connection with isotopic spin conservation. The essential point is that the conservation law is related to invariance under certain transformations, which implies that there is some indeterminacy in the phase. What has to be asked is whether this indeterminateness of phase should have a local character. This idea can also be applied to the conservation of heavy particles. If you asked what group of transformations generates the conservation of heavy particles the simplest one is the transformation
\[ \psi_p \rightarrow e^{i\alpha} \psi_p, \quad \psi_n \rightarrow e^{i\alpha} \psi_n \]
where the phase is the same for both neutrons and protons. If the phase depends on space time it is easy to show and in order to preserve invariance, one needs to introduce a vector field with zero charge and zero mass. In this case there is no complication such as the non-linear terms which arose in the case of isotopic spin. The consequence of this vector field is a heavy particle number associated with any system and a repulsive force between any two objects. If the number of nucleons in the two objects are \( A_1 \) and \( A_2 \) this force plus the gravitational force will then be
\[ \frac{G}{r^2} \frac{A_1 A_2}{M_1 M_2} \]
Since \( M \) and \( A \) are not strictly proportional, the observational consequence of this would be in apparent difference between gravitational and inertial mass for different objects. This was studied experimentally quite extensively by Eotvos up to about 1920 and he found that the ratio between gravitational and inertial mass is constant for all objects with an accuracy of 1 part in \( 10^{-8} \). Since the packing fraction in nuclei varies by a factor of 1000, this means that the repulsive force postulated here can be at most only \( 10^{-5} \) of the gravitational force. This
accuracy could be sharpened by comparing objects with a very large difference in packing fraction directly, such as hydrogen and oxygen. The negative experimental results seem to indicate either that the idea that every conservation law is associated with a gauge transformation is groundless, or that one needs to look for another type of group to generate the constitution of heavy particles. In reply to a question of Feynman's, Yang noted that the coupling constant associated with this force cannot go to zero since then the phase, which is proportional to the coupling constant, vanishes and one cannot preserve the invariance. In response to a question of Breit's as to whether this violates the principle of equivalence, Oppenheimer noted that there is no difficulty here since the transformation law obeyed by this field is different from that of the gravitational field. He noted, however, that there might be a much more sensitive test, in that with a vector field velocity dependent effects could be quite large in nuclei, and these might contribute terms which would go the other way from the static term given here. Foldy raised the point that since the sun is largely composed of hydrogen, one might also be able to find a sensitive test in astronomical effects.

Fierz had some remarks to make on the dangers of using certain models to give a clue as to the behavior of quantum electrodynamics. For example Thirring has shown that part of the propagation function of the theory whose Hamiltonian is

$$H = (\text{grad } \phi)^2 + \phi^2 + q \phi^3$$

cannot be expanded in powers of the so-called coupling constant. However one can see very immediately that such a theory cannot be developed at all in powers of the coupling constant. In such a theory the classical limit is contained, so one can simply look at the classical theory. The energy of such a field is not positive definite, so it is always possible to make the system unstable. One can write down the solutions of the classical theory and show in fact that they