THE SCATTERING OF CHARGED MESONS

By H. J. Bhabha, Ph.D., and B. S. Madhava Rao, D.Sc.

Received December 3, 1940

It was shown by Bhabha (1939) that the scattering of neutral mesons due to the mesic charge of the heavy particles (g_1 interaction) as given by the quantum theory has a complete correspondence with the scattering of mesons as given by the classical theory. The classical scattering is the analogue of the Thomson formula as recently extended by Dirac, remaining approximately constant up to meson energies comparable with the rest energy of the heavy particles, after which it decreases due to the effects of radiation reaction. The quantum cross-section like the Klein-Nishina formula also decreases with increasing energy due to the appearance of quantum effects, and the introduction of radiation reaction into the quantum theory would decrease it still more for high energies. On the other hand, the scattering of charged mesons on the usual theory differs completely from the classical and quantum mechanical scattering of neutral mesons, first in being larger by a factor $(M/\mu)^2$, M and μ being respectively the neutron and meson masses, and secondly in having an entirely different dependence on energy. The scattering of charged mesons due to the g_1 interaction alone was proportional to p^4/E^2, p being the momentum and E the energy of the meson. It was shown in the paper quoted above that this difference in the scattering of neutral and charged mesons is entirely due to the fact that whereas a positive meson can only be absorbed by a neutron and emitted by a proton, a neutral meson may be absorbed or emitted by either a neutron or a proton. To avoid this difference, Bhabha put forward the idea that the heavy particles might exist in states of all integral charge, positive and negative with different rest energies, of which only the two of lowest rest energy, namely the proton and neutron, occur normally in nature. This assumption puts the scattering of charged mesons due to the g_1 interaction on the same footing as the scattering of neutral mesons, and establishes correspondence with the classical theory. (*Cf.* Heitler, 1940.)

It is our purpose in this paper to investigate the modifications which the above idea of allowing the heavy particles to exist in states of all integral charge introduces in the scattering of charged mesons by the mesic dipole of the heavy particles (g_2 interaction). The dipole interaction leads even in