CLASSICAL THEORY OF SPINNING PARTICLES

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It is well known that the heavy particles, namely the proton and neutron, have an interaction with the meson field characterised by the "charge" g_1 and an explicit spin moment g_2. The latter is known to lead to a scattering of neutral mesons which increases as the square of their energy, and it has often been thought that in consequence this term would lead to the type of explosions investigated by Heisenberg. It is clear, however, that in quantum theory, the reaction of the emitted or scattered radiation has not been taken into account, the effect of which would be to diminish the scattering. This radiation damping cannot at the moment be included properly in a quantum theory, but one can approach the problem if one can build up a complete classical theory including radiation damping. The point at which radiation damping begins to become important in the classical theory may then be taken to indicate the point at which one might expect the quantum theory to fail due to its neglect of this factor. Indeed, the well-known limitation of the correctness of the quantum theory of the electron upto energies of roughly $137\,m$ (the velocity of light is put equal to unity in this paper) is based on a comparison with the classical theory of the electron by Lorentz, in which radiation damping became important at these energies.

An attempt at a non-relativistic treatment of damping has already been made by Heisenberg (1939) for a dipole of *finite extension* by a method which is analogous to that of Lorentz. His results do not agree with those of this paper even in the limit of a point dipole and we believe that this discrepancy is due to the method being inherently unsound. It consists in taking retardation into account for the field produced at one point of the dipole by a portion of the dipole at another point, while the different parts of the dipole are assumed to move together simultaneously. In the case where the field is the Maxwell field which propagates itself with light velocity, this procedure is inherently absurd, for it assumes that different parts of the dipole know what the other parts are doing in a time far less than that required for light to travel from one point to the other.

In this paper therefore we shall deal with a *point dipole* with no extension, and it will be shown that completely consistent relativistic equations free