PRODUCTION OF BURSTS AND THE SPIN OF THE MESON

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IT was shown some time ago (Bhabha, 1938) that mesons, which form the main body of the penetrating component of cosmic radiation, may produce showers at least by the following process. A meson occasionally makes a very close collision with an atomic electron, communicating a large energy to it. This electron then produces a shower by the ordinary cascade process. The original calculations were however based on the assumption that the meson is described by the Dirac equation, thus attributing a spin of half a unit to it like the electron. Since it is now believed that the meson is responsible for nuclear interactions, the dependence of nuclear forces on the orientations of the spin of nuclear particles makes it necessary for the meson to have a spin of one unit. In this case it would have to be described by the equations given by Proca (1936).

Massey and Corben (1939) have recently considered the collision of a meson with an electron on the quantised theory[1] of a meson with a spin of one unit. They find that the differential cross-section for the collision of a meson of energy $\gamma \mu c^2$, μ being the meson mass, with a free electron at rest, in which the electron acquires a fraction q of the original energy of the meson is given by

$$Q^{(1)}(q)\,dq = 2\pi \left(\frac{e^2}{mc^2}\right)^2 \frac{\theta\gamma}{\gamma^2-1}\left[1 - \frac{\gamma^2-1}{\gamma^2}\frac{q}{q_m} + \frac{q\theta}{\gamma^2}(2\gamma^2+1) + \frac{q^2}{6}(1-2\theta\gamma-\theta^2) + \frac{q^3\theta\gamma}{6}\right]\frac{dq}{q^2}. \tag{1}$$

Here q_m is the maximum value of q and is given by

$$q_m = \frac{2\theta(\gamma^2-1)}{\gamma(1+\theta^2+2\theta\gamma)}. \tag{2}$$

The cross-section for the same process calculated by Bhabha (1938) assuming that the meson obeys the Dirac equation is

$$Q^{(\frac{1}{2})}(q)\,dq = 2\pi\left(\frac{e^2}{mc^2}\right)^2 \frac{\theta\gamma}{\gamma^2-1}\left[1 - \frac{\gamma^2-1}{\gamma^2}\frac{q}{q_m} + \tfrac{1}{2}\frac{\gamma^2}{\gamma^2-1}q^2\right]\frac{dq}{q^2}. \tag{3}$$

For small q the two cross-sections are practically the same, so that the ionisation loss is not affected, but for large γ and $q \sim 1$ the two cross-sections

[1] Kemmer (1938), Fröhlich, Heitler and Kemmer (1938), Bhabha (1938 *a*), Yukawa, Sakata and Taketani (1938), Stueckelberg (1938).