THE THEORY OF PARTICLES OF SPIN HALF AND THE COMPTON EFFECT

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It is generally accepted that the Dirac equation correctly describes the behaviour of a particle of spin half $\hbar$. However, the theory is definitely untenable in its original form since it also allows a free particle to exist in states of negative mass and energy, and particles of this type are not known in nature. We will call this formulation of the theory the " original " Dirac theory for brevity. Dirac removed the difficulty by the addition of the assumption that all the negative energy states are normally filled in nature each with one particle. Together with the further necessary assumption that the particles obey the Pauli exclusion principle this stops an actual particle in a positive energy state from jumping into a negative energy state. As is well known, this assumption leads at once to the conclusion that particles must appear in nature like the original particle but with the opposite electric charge, and that such a particle and an electron must be capable of being created in pairs. The existence of the positron, and the observed process of pair creation are considered as two of the most successful predictions of this formulation of the theory, which we will call the ' hole ' theory for brevity. It also provides the long looked for reason why particles of spin half must obey the Pauli exclusion principle.

Now a large number of very common processes in nature take place as second order processes in two steps by way of an intermediate state, and it is generally considered to have been demonstrated that the ' original ' Dirac theory and the ' hole ' theory lead to the same probabilities for these. The purpose of this paper is to show that in our opinion this demonstration is fallacious. Indeed, Weisskopf (1934) has already shown that the transverse self-energy of an electron is different in the two theories, but since the self-energy is infinite in either theory, although to a different degree, not much attention has been paid to this point.

The demonstration that the original Dirac theory and the hole theory give the same probabilities for all second order processes is mainly the following. In the original theory, one of the ways by which the double transition can take place is that in which the existing particle jumps into an

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