ON THE FREQUENCY SHIFT IN THOMSON SCATTERING

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In a recent note Prakash (1967) while discussing the effect of radiation reaction on Thomson scattering, has reported that due to 'an instantly switched radiation' the electron gains an additional acceleration and "average" momentum depending on the initial phase of the radiation. The vector potential is taken in Prakash (1967) as

$$A(r, t) = A_0\theta(X) \cos (wX+\chi), \quad X = t-(n.r)/c \qquad \ldots \quad (1)$$

where θ is the usual step function. This form of A, with step function replaced by a suitable growth function was also considered by Kibble (1965). The physical condition that the field is switched on sharply at an instant say $t = 0$ is clearly not depicted by A as given in eq. (1). The step function is non-vanishing on the forward light-cone with origin as vertex. Perhaps, the point in taking X as the argument of θ, is that the Lorentz equation of motion (without radiation raction) is then exactly integrable, because the field is now expressible as the function of a single parameter (1965). However, this seems superfluous, as the fact that field is switched on at $t = 0$, is incorporated in the problem as initial value (1966a,b) Apart from this the step function introduces an unwanted singularity of the electromagnetic field. It may be due to this the solution of the equation of motion (in Dirac form), as stated in Prakash (1967), does not agree with the author's solution (1966b). They cannot differ so long as the particle velocity is continuous and small in comparison to c. Moreover, the intensity effects in question are shown clearly to be non-relativistic in nature (1925)

On the other hand, the second point raised in Prakash (1967), namely the dependence of the frequency shift and other effects, on the phase of the incident radiation is quite a pertinent one. If one works with an arbitrary phase of the incident wave this is taken as zero in Sengupta (1966b) in the system in which the electron is initially at rest (Σ), then one will arrive at a frequency shift which depends on the phase. But what may be observed is an average over a system of electrons; (note that it is not time-average for a single electron in its motion). It is easy to see the conse quence of this arbitrariness of the initial phase, after averaging, is to introduced a broading of the scattered line and the mean magnitude of intensity dependent frequency shift is changed by an unimportant numerical factor from the expression as quoted in Sengupta (1966b). However, it whould be emphasized that the shift remain isotropic in (Σ). It is quite clear that the phase of the radiation cannot change the qualitative nature of the problem because the phase may be made zero by suitable translation of space and time, and this translation will only change the initial values as initial velocity in general is not zero at the new origin.

It is not irrelevant to mention here that some of the features of the motion of electron in the field of plane electro-magnetic wave was reported by Frenkel (1925) much earlier than the author's first paper Sengupta (1965). The author regrets very much that it escaped his previous notice.

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