Trompetter, W. J.

Electromagnetic angular momentum of an orbiting charge. (English) Zbl 1476.78003

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Summary: The electric field of an orbiting charge or electron observed in the rotating frame takes on a circular trajectory with a maximum radius of $R = \frac{c}{\omega'}$. The resultant extended electromagnetic structure is used to derive the spin-orbit energy of the orbiting electron. A surprising result of the derived expression is that the orbital velocity has a specific value ($\beta_0 = \frac{1}{136.96}$) in close agreement (99.94%) with the experimentally determined value for the fine structure constant ($\hbar = \frac{ke^2}{c}\frac{1}{\alpha_{\text{exp}}} = \frac{ke^2}{c}\frac{1}{\beta_0} \rightarrow \alpha_{\text{exp}} = \beta_0$). Furthermore, the derived spin-orbit expression does not include a g-factor (i.e $g = 1$) which means that the Larmor and Thomas precessions are equal and opposite, resulting in zero net precession in the lab frame. These results suggest that the quantised fine structure constant and by extension Planck's constant, are a natural extension of classical electromagnetism and conservation of energy in a rotating frame.

MSC:

78A35 Motion of charged particles

Keywords:

electromagnetic mass; angular momentum; spin-orbit interaction; relativity in rotating frames; fine structure constant; Planck's constant

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