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Can we obtain relativistic vortex electrons using linacs?

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Relativistic vortex electrons carrying orbital angular momentum (OAM) may provide a novel tool for applications in atomic, nuclear, and particle physics. A straightforward approach to produce such particles involves generating vortex electrons using conventional methods, such as fork-like holograms or magnetic monopoles, followed by their acceleration in a linac. While the azimuthal symmetry of the linac's electric and magnetic fields preserves the electron's OAM, the potential transfer of OAM to emitted photons raises a fundamental question: Can vortex electrons be effectively accelerated in linacs, or do they lose their OAM in the process? To address this question, we construct localized wave-packet vortex solutions to the Klein-Gordon equation in the presence of longitudinal electric and magnetic fields. The probability of photon emission by these states is calculated in the first order of perturbation theory. We estimate the rate of OAM loss and the characteristic acceleration length over which the electron's vorticity is lost, using parameters relevant to typical linac setups.

Footnotes

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