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Superluminal Tunneling of a Relativistic Half-Integer Spin Particle Through a Potential Barrier

Friday 7 July 2017 17:00 (30 minutes)

In this talk is presented the problem of a relativistic Dirac half-integer spin free particle tunneling through a rectangular quantum-mechanical barrier. It is supposed that the energy difference between the barrier and the particle is positive and that, within the barrier, the particle behaves like a localized evanescent wave described by the Schrödinger equation. If the barrier width is large enough, there is proof that the tunneling of particle states is always superluminal. For antiparticle states, the tunneling may be either subluminal or superluminal instead, depending on the barrier width. These results derive from studying the tunneling time in terms of phase time. For particle states these are always negatives while for antiparticle states they are always positives, whatever the height and width of the barrier. The scattering also leads to an anomalous distortion of the Dirac spinor (and, consequently, of the density function) that tends to disappear as the particle velocity approaches the speed of light. Moreover, the phase time tends to zero, increasing the potential barrier both for particle and antiparticle states. This agrees with the interpretation of quantum tunneling that the Heisenberg uncertainty principle provides. This study's results are innovative with respect to those available in the literature since consider the particle within the barrier as an intermediate state where the energy is confined and released like a quantum boom. Moreover, they show that the superluminal behavior of particles occurs in those processes with high-energy confinement and might have relevant implications in cosmology.

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