Planar Dirac Diffusion

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We have presented the results of the planar diffusion of a Dirac particle by step and barrier potentials, when the incoming wave impinges at an arbitrary angle with the potential [1].

In the literature one normally encounters one-dimensional potential analysis. However, when spin and relativity are relevant, one-dimensional analysis may be too limited. For example, the absence of spin flip terms for one-dimensional step and barrier diffusion is no longer valid for planar diffusion where an angle of incidence exists. The potentials are still considered functions of a single spatial variable (z in this paper) but the incoming particle have two momentum components. This small modification produces significant differences, specifically the appearance, in general, of spin flip terms and consequent modifications in the non-flip amplitudes. These effects are a direct consequence of the angular dependence of the Dirac spinors. We have found one notable exception to the above, for which we have no simple explanation, although we believe one must surely exist. This exception is that in the case of the barrier potential there is no spin flip transmission amplitude. There are always spin flip terms for the step, be the step rising or dropping, except, of course, for the one-dimensional limit when the potential is met head on. This makes the barrier result all the more unexpected, since we know that the barrier result may be derived from a double-step analysis which uses only the step results. We have also derived the transmission amplitude for the barrier in the particle limit via the two-step method. This demonstrates that the absence of spin flip for each individual outgoing wave packet, is independent of the degree of coherence involved, i.e. it is not a resonance type phenomenon. As a side product, we have described the kinematics of Dirac planar scattering and observed that by varying the incidence angle, for a given incoming energy, we may transit through two kinematic zones, e.g. from diffusion to or from tunnelling, but never through all three kinematic zones Diffusion, Tunneling , Klein.

• The collaboration is now formalized as part of the interuniversity agreement between the State University of Campinas (Brazil) and the University of Salento (Lecce, Italy).

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