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Negative time scales in quantum systems

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In the classical world, while a typical variable can vary continuously, in the quantum world uncertainty principle restrains this notion of realism. No one has defined a time operator and within the spatial envelop of uncertainty a particle can exist in several positions simultaneously. We consider quantum mechanical scattering of electrons through particular scatterers in quasi one dimension. Although a low energy scattering phenomenon, it may have some similarity with three or two spatial dimensions with curled up extra dimensions. A meaningful time scale can be defined that is consistent with our classical notions although there are finer details in case of scattering in quasi one dimension. Whether time scales can be negative is still an open problem. On applying the concept of burgers circuit on Argand diagram of scattering amplitude, we can prove its negativity. In fact, time can be reset to zero and the proof does not depend on explicit calculations for the specific scatterers but uses the topological properties and is general. Realistic potentials comprising a large class of mesoscopic systems has been shown to behave similarly and show negative time scales. It has also been argued that such negative time scales can have several physical consequences including a mechanism for electron-electron attraction. We can also prove that semiclassical Friedel sum rule can become exact in a purely quantum regime. This can help us to experimentally determine time scales and hence mesoscopic thermodynamic and transport properties without knowing the exact potential or impurity configuration inside the sample.

Biography

P Singha Deo did his PhD in 1996 and has remained associated with research and teaching in physics in premier institutions and universities abroad and in India. He has published more than 50 papers in international journals. He is a Professor at S N Bose Centre, Kolkata since 1999 and successfully guided several PhD theses. He has worked on various issues and problems in mesoscopic physics and correlated systems. Some of his current research topics include quantum devices, quantum capacitance, bosonization in higher dimensions, quantum mechanical scattering phase shift in low dimensions, etc.

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