Quantum Mechanics in Phase Space and the Scattering Theory II: Nonrelativistic two-body problem

Pedro D. Matos Pereira, Karla P. Oliveira, Andreia S. Simões, Caio G. Ressureição, M. Graças R. Martins
Instituto de Física, Universidade Federal da Bahia, Salvador, BA, Brasil

J. David M. Vianna
Instituto de Física, Universidade de Brasília, Brasília, DF, Brasil

A line of research of increasing interest is the formulation of scattering process by means of the Schrödinger equation in phase space. The phase space picture of quantum mechanics, also known as Moyal quantization, is based on Wigner quasi-distribution function proposed in 1932, and the Weyl’s correspondence law of 1927; it is useful in many branches of physics, for example, in describing the quantum transport process, and in quantum optics, nuclear physics and non-commutative field theory models. Since the original Wigner paper many efforts have been made in order to develop this formulation, and a Schrödinger equation has been obtained and applied to problems as harmonic oscillator, Hydrogen atom, Helium atom and Landau problem, for instance. Wigner introduced his formulation by using a kind of Fourier transform of the density matrix $\rho(q, q')$ giving rise to what is known as Wigner function $f_w(q, p)$ where $(q, p)$ are the coordinates of a phase space manifold; the function $f_w(q, p)$ is real but not positive definite. A great effort has also been made to explore alternative distribution functions which are nonnegative everywhere in phase space. In this communication, however, we use the traditional Wigner function in the scattering theory and analyse the nonrelativistic two-body problem. Equation of motion in the $(p, q)$ basis is considered, proprieties of the retarded Green’s function in the phase space are discussed, and comparison between classical mechanics and quantum scattering theory realized under certain conditions. (P. D. M. P.: CAPES, A. S. S.: CNPq, C. G. R.: CAPES)