

On the Dynamics of Spin-1/2 particles: A Phase-space Path-integral Approach

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Abstract

The two-level quantum system is the most fundamental element in quantum-information-processing theory (QIPT) and one of its more natural physical implementations comprises a spin-1/2-system. Entangling these systems and their subsequent manipulation, based on the non-local character of quantum correlations, are the most fundamental protocols in QIPT. The non-locality that is exploited in those protocols is a non-locality between quantum systems; however, in order to get a complete picture of the quantum correlations, one has to analyze the influence of the non-local character of the quantum dynamics itself (dynamical non-locality).

We use the proposal given by Bjork *et al* [1] to construct the Wigner function in a discrete phase space, then with the aim to analyze the dynamics of the spin-1/2 particles, we develop a formula for the discrete Wigner propagator and calculate it by means of a direct method based on the path integral formalism for discrete systems[2]. Having already the explicit form for the Wigner propagator, we can see explicitly the non-local behavior of the quantum dynamics for the discrete systems.

[1] G. Björk, A. Klimov, L. Sánchez-Soto. *Progress in Optics*, **51**, 496 (2008)

[2] L.S. Schulman. *Techniques and applications of path integration. Wiley-interscience publication.* 1Ed (1996)