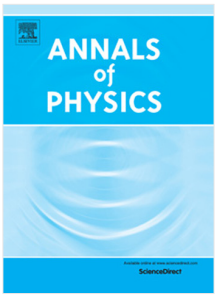

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The fractional dynamics of quantum systems

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ABSTRACT

The fractional dynamic process of a quantum system is a novel and complicated problem. The establishment of a fractional dynamic model is a significant attempt that is expected to reveal the mechanism of fractional quantum system. In this paper, a generalized time fractional Schrödinger equation is proposed. To study the fractional dynamics of quantum systems, we take the two-level system as an example and derive the time fractional equations of motion. The basic properties of the system are investigated by solving this set of equations in the absence of light field analytically. Then, when the system is subject to the light filed, the equations are solved numerically. It shows that the two-level system described by the time fractional Schrödinger equation we proposed is a measurable system.

Keywords:
Time fractional Schrödinger equation
Two-level system
Fractional dynamics

1. Introduction

The past three decades have witnessed a growing interest in applying fractional calculus to science and engineering fields. Many physical phenomena have obtained successful descriptions from fractional order models. For example, with a nature of non-locality in space and time, the first successful application of fractional calculus is the fractional diffusion equation which has been found to be useful in the study of anomalous diffusion [1-4]. Moreover, the interrelation between the continuous time random walk and the fractional diffusion equation [5-9] has promoted the development of fractional calculus in nonlinear phenomena and complex systems [10-12].

Due to the similarity of mathematical appearance between the Schrödinger equation and the diffusion equation, an expectation of incorporating the fractional derivative into the Schrödinger equation is reasonable. In 2000, by applying path integral over Levy trajectories instead of Brownian trajectories, Laskin derived the fractional Schrödinger equation (FSE) [13,14]. Since the order of time derivative is unchanged, the fractional Schrödinger

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