Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

On the nonlocality of the fractional Schrödinger equation SHILIYANG XU, Syracuse University, MONWHEA JENG, Microsoft Corporation, ELI HAWKINS, University of York, J.M. SCHWARZ, Syracuse University — A wide variety of stochastic processes are more general than the familiar Brownian motion, but presumably can still be described by modifying the diffusion equation using a fractional Laplacian operator. In analogy with fractional diffusion, the fractional Schrödinger equation is the ordinary Schrödinger equation with the fractional Laplacian operator replacing the ordinary one. Over the past eight years, a number of papers have claimed to solve the fractional Schrödinger equation for systems ranging from the one-dimensional infinite square well to the Coulomb potential to one-dimensional scattering with a rectangular barrier. However, some of the claimed solutions ignore the fact that the fractional diffusion operator is inherently nonlocal, preventing the fractional Schrödinger equation from being solved in the usual piecewise fashion. We focus on the one-dimensional infinite square well and show that the purported groundstate, which is based on a piecewise approach, is definitely not a solution of the fractional Schrödinger equation for general fractional parameters α. On a more positive note, we present a solution to the fractional Schrödinger equation for the one-dimensional harmonic oscillator with $\alpha = 1$. Potential physical applications will also be discussed.

Shiliyang Xu
Syracuse University

Date submitted: 21 Nov 2008 Electronic form version 1.4