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A Probe into the Schrodinger-Newton equation

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Unification of gravity and quantum theory is still an unattained problem of modern physics. The traditional approach of quantizing the gravitational field
has not yet provided us with a satisfying theory of quantum gravity. A different resolution is to modify quantum dynamics by adding nonlinear terms with gravitational origins. This line of research is highly motivated by semi-classical models of gravity, which bring about Schrodinger-Newton (SN) equation: a deterministic nonlinear Schrodinger equation with Newtonian self-gravity as nonlinearity. We will quantify the regime where SN equation can be distinguished from Schrodinger equation. We also argue that SN equation does not describe the collapse of the wave function, thus one still needs the collapse postulate. Then, we explicitly show that SN equation gives rise to superluminal effects, as expected from any deterministic nonlinear Schrodinger equation. We finally discuss that combining Newtonian nonlinearity with stochastic terms to avoid superluminality and to describe the collapse, as in Diosi-Penrose model, is still problematic.

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