DESY THEORY WORKSHOP
27 - 30 September 2016
Rethinking
Quantum Field Theory
DESY Hamburg, Germany

Contribution ID: **44** Type: **not specified**

# The Schroedinger method as field theoretical model to describe structure formation

*Thursday, September 29, 2016 3:00 PM (15 minutes)*

We investigate the formation of a dark matter halo using an idea that is rooted in the correspondence between phase space distributions in classical and quantum mechanics. The dynamics of cold dark matter is governed by the Vlasov (or collisionless Boltzmann) equation whose nonlinearity is induced by gravity according to the Poisson equation. Determining the evolution of density and velocity demands solving a coupled hierarchy for the cumulants of the distribution function In the presence of long-range interaction, no consistent truncation is known apart from the pressureless fluid model which is incapable of describing halo formation due to the inability to generate higher cumulants dynamically. We introduce the Schrödinger method where dark matter is modeled as self-gravitating scalar field solving the Schrödinger-Poisson equation. Using the phase space formulation of quantum mechanics, we construct a distribution function that approximately solves the Vlasov-Poisson equation without truncation. We demonstrate that the Schrödinger method is capable of emulating the dynamics of halo formation while containing only two degrees of freedom, just like the pressureless fluid model. Based on this, we discuss how the Schrödinger method can guide further modeling based on solutions with finitely generated rather than finitely many cumulants.

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**Session Classification:** Parallel Session: Cosmology & Astroparticle Physics

**Track Classification:** Cosmology & Astroparticle Physics