Exploring the relation between Vlasov and the Schrödinger-Poisson as unifying dynamical description for CDM and massive neutrinos

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This talk presents an introduction into the "Schrödinger method”, a method to solve the Vlasov equation via the Schrödinger-Poisson equation, together with a prescription to construct a phase space density from the wave function. The Vlasov equation describes the collisionless dynamics of self-gravitating systems, in particular CDM and also hot DM to which non-relativistic massive neutrinos belong. For the first time, we implemented the Schrödinger method in two spatial dimensions in CUDA, extending the previous one-dimensional studies. We present a quantitive comparison of our code and the Vlasov solver ColDICE, finding excellent agreement. We review how the fully fledged phase space dynamics can be encoded in a wave function with its mere 2 spatial degrees of freedom, and how vorticity, and all higher cumulants can be easily decoded.
Although the only difference between CDM and hot DM is the initial velocity dispersion, conventional Vlasov solvers are usually specialised to either deal exclusively with hot or cold initial conditions. The Schrödinger method turns out to be more versatile: simply adjusting the initial conditions is sufficient to turn a CDM simulator into a hot DM simulator. This shows how the Schrödinger method can be used as a unifying framework to accurately describe larges scale structure formation in CDM + massive neutrino cosmologies both in cosmological simulations as well as semi-analtytical calculations.

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