GR 18: Cosmology III

Time: Friday 11:00–11:45 Location: KH 01.016

GR 18.1 Fri 11:00 KH 01.016

Effective Pressure and Viscosity Analogies in Schrödinger*Poisson Models of Structure Formation — •Aoibhinn Gallagher — Bielefeld University, Universitätsstraße 25, 33615 Bielefeld, Germany

Recent advances in wave-mechanical approaches to cosmic structure formation have highlighted the usefulness of the Schrödinger*Poisson (or Schrödinger*Newton) system as an alternative description of collisionless matter. Beyond its role in models of ultra-light dark matter, this framework offers a compact way to capture gravitational dynamics across linear and non-linear regimes, motivating renewed interest in how its behaviour relates to familiar concepts from classical physics.

In this talk, I explore how certain features of Schrödinger*Newton evolution can be reinterpreted through the lens of classical fluid dynamics, in particular through effective *pressure* and *viscosity* analogies. I show that the parameter \nu, often introduced in practical implementations of the formalism, can play a role akin to a kinematic viscosity, and I assess when a pseudo-Reynolds number description becomes meaningful. This reinterpretation provides intuitive insight into non-linear structure formation, especially beyond shell-crossing where standard fluid approaches fail. At the same time, I outline the fundamental limitations of the analogy: a full classical fluid correspondence would require additional physical ingredients (such as dissipation and entropy production) that do not arise in strictly unitary Schrödinger*Newton dynamics. The resulting picture is therefore not a complete fluid model, but a useful heuristic framework that clarifies the behaviour of wave-mechanical cosmological systems.

GR 18.2 Fri 11:15 KH 01.016

Exotic compact binary mergers at ultra-high redshift - parameter estimation with pulsar timing array data — •Woo-Seok Yim and Jürgen Schaffner-Bielich — Institut für Theoretische Physik, Goethe University, Frankfurt am Main, Germany

The origin of the nanohertz stochastic gravitational-wave background (SGWB) reported in 2023 remains under active discussion, with supermassive black hole binaries (SMBHBs) still being the leading astrophysical explanation. However, a discrepancy between the predicted SMBH abundance and the measured SGWB amplitude remains. This could be explained by a sub-dominant group of merging exotic compact objects (ECO), which are compact objects formed from dark matter at ultra-high redshift. We find and present combinations of binary parameters of such ECOs, namely the binary mass and merger redshift, that could significantly contribute to the total gravitational-wave energy density spectrum Ω_{gw} at nanohertz scales.

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GR 18.3 Fri 11:30 KH 01.016

Cumulants in the Cosmos: Tools for Compressing the Universe — •Cora Uhlemann — Bielefeld University

Central nonlinear physics problems in cosmology can be characterized by an infinite hierarchy of cumulants. For a simple one-dimensional probability density function, the first cumulant is the mean, the second cumulant is the variance, and the higher-order cumulants capture non-Gaussian information. Cumulants thus serve as useful compression of the underlying probability density function. I will explain why characterising the higher-order cumulants is essential for beyond 2-point statistics of dark matter and show how they can be predicted by leveraging symmetries and large-deviation theory. I will then connect this to key observables in galaxy clustering and weak lensing and discuss challenges related to their survey applications.