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SEIT 1386

STRUCTURES JOUR FIXE

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The Nonlinear Universe - Asymptotic Approaches to Cosmic Structures

Pretalk by Matthias Bartelmann starts at 1 pm

November 21, 2025, 1:30 PM, Phil 12 GHs

COFFEE & SNACKS IN ROOM 106

ZOOM: Meeting ID: 935 6549 3662, Code: 928036

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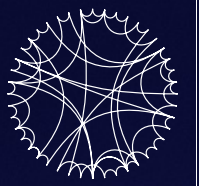

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ABSTRACT

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Shortly after the Big Bang, matter in the Universe was distributed almost homogeneously. Tiny density perturbations, originating from quantum fluctuations and stretched to cosmological scales during inflation, were amplified by gravity over cosmic time. This process gave rise to the rich hierarchy of structures we observe today — the cosmic web of filaments, voids, galaxy clusters, and their substructure.

Understanding how these structures emerge remains a central challenge in cosmology: while the linear evolution on large scales is well described, analytic control is largely lost once gravitational collapse drives nonlinear growth.

In this talk, I present new asymptotic approaches to nonlinear structure formation in dark matter. I discuss an expansion of the collisionless Vlasov–Poisson system, demonstrating how small-scale structure arises from gravitational turbulence in phase space. For cold dark matter in d dimensions, the density power spectrum P(k) exhibits a universal k^−d scaling. The same scaling emerges when P(k) is expressed as a phase-space integral within the framework of kinetic field theory, analysed via the saddle-point method.

I conclude by showing how these analytic results enable novel predictions that connect the microphysics of dark matter with measurable cosmological observables.

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