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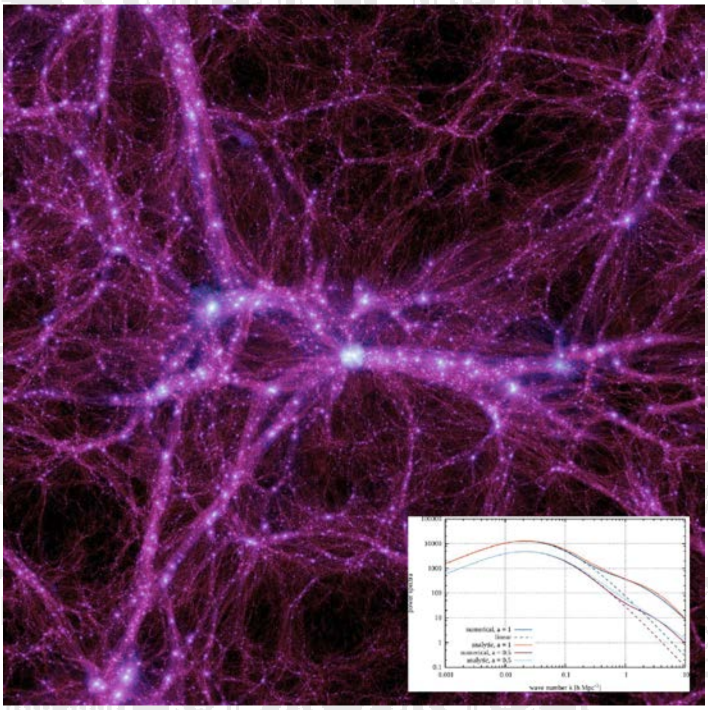
IM GROßEN HÖRSAAL



A NEW THEORY FOR OLD COSMIC STRUCTURES

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The formation of the rich pattern of cosmic structures – filaments, galaxy clusters, galaxies and others – has so far been described by detailed numerical simulations, but an analytic theory is still missing. If we want to understand certain universal features of cosmic structures, such as their radial density profiles, or even infer cosmological information from cosmic structures, we require an analytic understanding. Adopting methods familiar from non-equilibrium quantum field theory, we have developed a microscopic, non-equilibrium field theory for cosmic structure formation. The theory begins with the initial phase-space distribution of a correlated ensemble of classical particles undergoing Hamiltonian dynamics. This phase-space distribution defines a generating functional resembling the partition function familiar from thermodynamics. With the free Green's function of the Hamiltonian equations, the free generating functional can be evolved in time, and particle interactions can be taken into account by applying an interaction operator to the free generating functional. Cumulants of arbitrary order can then be extracted at the required time by applying operators for macroscopic quantities such as the density. In this approach, perturbation theory can be developed with respect to free, unperturbed particle trajectories. Since even small such perturbations can lead to high densities in convergent streams, even low orders of perturbation theory can proceed deeply into the non-linear regime. The non-linear power spectrum of cosmological density fluctuations, for example, can be accurately calculated analytically in this approach using first-order perturbation theory. In the talk, I shall outline the theory and describe some applications and extensions.