ID de Contribution: **128** Type: **Talk**

Universal Mass Accretion Rates and Concentrations of Dark Matter Halos

mardi 27 juillet 2010 12:00 (20 minutes)

Dark matter halos constitute cosmic structures, host galaxy formation, bend light from faraway galaxies and so are very important objects to study. In the past few years, a large amount of observations have constrained cosmological parameters and the initial density fluctuation spectrum to a pretty high accuracy. However, cosmological parameters change with redshift and the power index of the power spectrum varies with mass scale dramatically in the so-called concordance Lambda CDM cosmology. Thus, any successful model for cosmic structural evolution should work well simultaneously for various cosmological models and different power spectra.
With a large set of high-resolution N-body simulations of a variety of structure formation models (scale-free, standard CDM, open CDM, and Lambda CDM), we disentangled and modeled the dependences of halo mass accretion rate (MAR) on all relevant factors and connected halo interior mass concentrations with their mass accretion histories (MAHs) in a simple way. These models can be used to predict the MAHs, the mass & redshift dependence of concentrations and the individual concentration evolution histories of dark matter halos, which significantly disagree with the much-used empirical models in the literature. These models are accurate and universal: the same set of model parameters works well for different cosmological models and for halos of different masses at different redshifts and the model predictions are highly accurate even when the histories are traced to very high redshift. These models are also simple and easy to implement. A web calculator and a user-friendly code to make the relevant calculations are available from http://www.shao.ac.cn/dhzhao/mandc.html
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We also explained why histories of Lambda CDM halos on nearly ALL mass scales consist of two phases which are distinct in many physical characteristics, as found by Zhao et al. (2003a, 2003b).

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Classification de Session: Parallel Session : Structure Formation & N-body simulations 1

Classification de thématique: Structure Formation & N-body simulations