

Introduction to cosmological (super)computer simulations: methods, algorithms and a general overview

I will give a general overview of numerical simulation methods widely used in contemporary cosmology. Computer simulations are absolute necessity in studying properties and evolution of large-scale structures (LSS) in the Universe. In the era of modern grand-design observational campaigns like SDSS/BOSS, DESI, Euclid or LSST only computer methods allow for enough precision in modeling of the highly non-linear process of galaxy formation and their arrangement in the large-scale cosmic web. We will describe general algorithms and methods that allow us to study the gravitational instability mechanism that drive the cosmic structure formation over 11-orders of magnitude in mass density and some 13 billions years of cosmic evolution. We will also describe the basic physics behind formation of galaxies and LSS.

Recommended prerequisites: *a general knowledge of the standard cosmological model: LCDM based on flat Friedmann-Lemaitre background space-time filled with non-relativistic dark matter (~26%), baryons (~5%) and dark energy/cosmological constant (~69%). General understanding of calculus, linear algebra and Newtonian dynamics.*

Useful materials and references for the course:

- Lecture-notes on our older lecture on this subject can be downloaded from here: <http://adsabs.harvard.edu/abs/2015pta..conf...58H>
- GD2 Galactic dynamics (2nd edition): Binney & Tremaine, Princeton series in Astrophysics
- LH Formation and Evolution of Galaxies: Lectures given as Les Houches, Simon White, arXiv:astro-ph/9410043
- HE Computer simulation using particles, Hockney&Eastwood
- BH Barnes and Hut, 1986, Nature, 324, 446
- J10 Jenkins 2010, MNRAS, 403, 1859
- FW Frenk & White, Annalen der Physik, 524, 9 (arXiv:1210.0544)
- S01 Springel, Ypshida and White, New Astronomy, 6, 79 (GADGET-1)
- S05 Springel 2005, MNRAS, 364, 1105 (GADGET-2)
- KK Knollman&Knebe, ApJS, 182, 2 (AMIGA Halo Finder)
- BWW Behroozi, Wechsler, Wu, 2013 ApJ, 762, 109 (ROCKSTAR Halo Finder, arXiv:1110.4372)