15th June 2020

1 Basic reading

Dodelson ch-7. Inhomogeneities : reproduce the plot in figure 7.11 using the BBKS transfer function - read the whole chapter and reproduce other plots.

2 Advanced reading

Read the introduction of `https://arxiv.org/pdf/1706.09906.pdf` and summarize it.

3 Try N-body sims

Do a particle mesh code following the tutorial by Andrey Kravstov `https://astro.uchicago.edu/~andrey/Talks/PM/pm.pdf`

22nd June 2020

- Do σ_8 normalisation of BBKS power spectrum and generate gaussian random field with that power spectrum.
- Visualise the generated gaussian random field in physical space and compare with the power law one.
- Read more about halo bias.

σ_8 normalisation

It is defined as the root mean square of density variation after smoothing by correlating with spherical tophat function of radius 8 h^{-1} Mpc. In fourier space, this is equivalent to multiplying by the fourier transform of that tophat .

$$W_s(k) = 3\ \frac{j_1(kR_8)}{kR_8} \quad \text{where } R_8 = 8\ \mathrm{h}^{-1}\ \mathrm{Mpc} \tag{1}$$

$$\sigma_8 = \sqrt{\frac{1}{(2\pi)^3} \int W_s^2(k)\ |\delta(\vec{k})|^2\ d^3k} \tag{2}$$

$$\sigma_8^2 = \frac{1}{(2\pi)^3} \int W_s^2(k)\ |\delta(\vec{k})|^2\ d^3k \tag{3}$$

$$= \frac{1}{(2\pi)^3} \int W_s^2(k)\ |\delta(\vec{k})|^2\ k^2 dk\ d\Omega \tag{4}$$

$$= \frac{1}{(2\pi)^3} \int W_s^2(k)\ k^2 dk \int |\delta(\vec{k})|^2\ d\Omega \tag{5}$$

$$= \frac{1}{(2\pi)^3} \int W_s^2(k)\ k^2\ 4\pi P(k)\ dk \tag{6}$$

$$= \frac{1}{2\pi^2} \int W_s^2(k)\ k^2\ P(k)\ dk \tag{7}$$

That integrand drops away from the that 8 h^{-1} Mpc scale

Large Scale Structure notes

Inhomonenous evolution can't be done completely analytically, eventhough it can be simulated. Analytical tools/models are important to gain deeper understanding. Simulations help in making, testing and refining these analytical tools along with the observations.

1 FLRW background evolution

2 Newtonian equations for imhomogeneous CDM

3 Growth of Structure

3a Linear solutions to inhomogeneous CDM

3b Eulerian - 2nd order perturbation theory

3c Lagrangian approach - Zel'dovich approximations

3d Spherical collapse

4 Halo Model

4a Halo Bias

Split $\delta(\vec{x})$ into small scale and large scale components.

Halo assembly bias

Calculations

$$P(\vec{k}) = \int \xi(\vec{r})\ e^{i\vec{k}\vec{r}}\ d^3r \tag{8}$$

$$\xi(\vec{r}) = \frac{1}{(2\pi)^3} \int P(\vec{k})\ e^{-i\vec{k}\vec{r}}\ d^3k \tag{9}$$

$$\xi(r) = \frac{4\pi}{(2\pi)^3} \int_0^\infty P(k)\ k^2\ \frac{\sin(kr)}{kr} dk \tag{10}$$

$$\xi(r) = \frac{1}{2\pi^2} \int_0^\infty P(k)\ k^3\ \frac{\sin(kr)}{kr} d(\ln k) \tag{11}$$

$$\xi(r) = \int_0^\infty \Delta^2(k)\ \frac{\sin(kr)}{kr} d(\ln k) \tag{12}$$