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Cosmology

Pre-class reading 7

1) For mode with k1 < k_eq, the modes were outside the horizon during radiation era and grew as ‘a^2’. Who the Universe become matter dominated, growth slowed to ‘a’. After the mode enters the horizon during the matter era, the growth still goes as ‘a’. For mode with k2>k_eq, before horizon entry, modes grow as ‘a^2’. After horizon entry (still during radiation era), the growth becomes logarithmic in ‘a’ or almost constant. This mode grows again as ‘a’ once the Universe becomes matter dominated. The ratio of linear growth factors of the k2 mode with respect to the k1 mode is (a_k2/a_eq)^2 or (k_eq/k)^2 < 1

2) Accurately normalizing the power spectrum requires a method that doesn’t depend on non-linear growth (variance of galaxy distribution measured ~8/h Mpc will trace the perturbations when they may have become non-linear) and that doesn’t depend on assuming galaxies tracing mass distribution. Thus, \sigma_8 is calculated as \sigma_m (8/h Mpc) from the initial power spectrum evolved the present time according to linear theory

3) From the spherical (non-linear) model, we see that at t=t_collapse (\theta = 2\pi), the density contrast diverges. This corresponds to a density contrast of 1.69 if we extrapolate the linear model to t_collapse. So, the reason this number is so low is just math? Dark matter halos are significantly more dense compared to the average density of the Universe because they underwent non-linear collapse.

4) For halos that deviate even slightly from spherical symmetry, shells start crossing and halo ultimately virializes- balancing out potential and kinetic energies. By applying viral theorem and energy conservation, we find that virtualized DM halo has a density contrast ~178 times greater than the background density

5) The viral radius is the radius when the halo has virialized i.e its total energy is given by -(1/2)*3/5GM^2/R_vir. This is set by energy conservation between energy at turn-around and energy after virialization. This is not a good definition I think because it grows with time as more and more dark matter from outside the viral radius gets accreted?