# Astro 321: Halo Model 1

## Mass Functions and Bias

Consider the Jenkins et al (2001) mass function:

$$\frac{dn}{d\ln M} = 0.315 \frac{\rho_m}{M} \frac{d\ln\sigma^{-1}}{d\ln M} \exp[-|\ln\sigma^{-1} + 0.61|^{3.8}] \,. \tag{1}$$

and dig out your code for computing $\sigma(M)$ from the previous problem set.

- Modify your code to also calculate $d\ln\sigma^{-1}/d\ln M$. Hint: again start with the tophat in $R$ and compute $d\sigma_R^2/d\ln R$ by differentiating the window under the integral; the rest is just chain-ruling $M(R)$.
- Integrate the mass function above $3\times 10^{14} h^{-1} M_\odot$. What is the number density of such (cluster sized) objects in $h^3$ Mpc$^{-3}$ in the same cosmology as the previous problem sets?
- An alternate form of the mass function by Sheth & Torman is more accurate at low masses and the consideration of halo bias.

$$\frac{dn}{d\ln M} = \frac{\rho_m}{M} f(\nu) \frac{d\nu}{d\ln M} \tag{2}$$

$$\nu f(\nu) \propto \sqrt{\frac{2}{\pi} a\nu^2} [1 + (a\nu^2)^{-p}] \exp[-a\nu^2/2] \tag{3}$$

  where $a = 0.75$, $p = 0.3$, $\nu = 1.69/\sigma$ and the proportionality is chosen such that $\int d\nu f(\nu) = \int d(\ln\nu)\nu f(\nu)$. Show that the two mass functions differ significantly only at low masses.

- The bias as a function of mass is given in Press-Schecter theory as

$$b(M) = 1 + \frac{a\nu^2 - 1}{\delta_c} + \frac{2p}{\delta_c[1 + (a\nu^2)^p]} \tag{4}$$

  Take $\delta_c$ the threshold for spherical collapse to be $\delta_c = 1.68$. Plot $b(M)$ from $10^{11} M_\odot$ to $10^{16} M_\odot$. By integrating over the Sheth-Torman mass function, find the average bias of objects $> 3\times 10^{14} h^{-1} M_\odot$.