Astro 321: Halo Model Final

Non-Linear Matter Power Spectrum

Put together the various pieces of the last few problem sets to form the two and one halo terms of the non-linear power spectrum $P_{\rm nl}(k,z)$ from the linear power spectrum $P(k,z)$:

$$P_{\rm nl}(k,z) = I_2^2(k,z)P(k,z) + I_1(k,z) \tag{1}$$

where

$$I_2(k,z) = \int d\ln M \left(\frac{M}{\rho_m(z=0)}\right) \frac{dn}{d\ln M} b(M) y(k,M) \tag{2}$$

$$I_1(k,z) = \int d\ln M \left(\frac{M}{\rho_m(z=0)}\right)^2 \frac{dn}{d\ln M} y^2(k,M) \tag{3}$$

Show that $P_{\rm nl}(k,z) \to P(k,z)$ for $k \to 0$ for the Sheth-Torman mass function (what happens with if you take the Jenkins mass function). Plot the logarithmic power spectra $\Delta_m^2(k)$ at $z=0$ and $z=1$ for the cosmology of the previous problem sets. Separate the total contribution into the two and one halo terms.

Extra credit: add in galaxy occupation to form the galaxy power spectrum. See the Physics Reports review by Sheth & Cooray for details. For definiteness, take $N(M) = C + S(M)$ where $C = 1$, $S(M) = M/30M_{\rm th}$, if $M > M_{\rm th} = 10^{12}h^{-1}M_\odot$ (else $C = S = 0$).