Astro 321: Problem Set 5
Due Feb 11

This problem set requires the code from Problem Set 4.

1 Problem 1: Filters

- Define the spherical top hat window as

$$W(r) = \text{const.} \qquad (r < R) \tag{1}$$
$$= 0 \qquad (r \geq R) \tag{2}$$

and normalize the window to $\int d^3x W(r) = 1$. Derive the window function in Fourier space $W(k)$ (given in class, but do the integrals). Plot it out as a function of kR.

2 Problem 2: Variance

- Write a code to calculate

$$\sigma_R^2 \equiv \int \frac{d^3k}{(2\pi)^3} |W(k)|^2 P(k) \tag{3}$$
$$= \int d\ln k |W(k)|^2 \Delta^2(k) \tag{4}$$

using the power spectrum code of the last problem set. Take R to be defined in h^{-1} Mpc. Be careful with checking convergence of the integral, you can see from above that it rings in a nasty manner. For the $\Omega_m = 0.27$, $h = 0.7$, $n = 0.966$, $A_S = (4.657 \times 10^{-5})^2$ (note -5 not -4) cosmology of the previous problem set, plot σ_R between $0.1 < R/(h^{-1}\text{Mpc}) < 100$. What is the value of σ_8, where "8" denotes the $R = 8h^{-1}$ Mpc.

- Convert scale to mass in non-relativistic matter inside the spherical tophat assuming the average background density. For the given cosmology plot $\sigma(M)$ where M is in units of $h^{-1}M_\odot$. For what mass is $\sigma = 1$?