Astro 321: Problem Set 4
Due Feb. 6

This problem set requires the code from Problem Set 3.

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 $\Omega_m = 1/3$, $h = 1/\sqrt{2}$, $n = 1$ cosmology, 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 inside the spherical tophat assuming the average background density. For the given cosmology plot $\sigma(M)$ where M is in units of $h^{-1}M_{\rm sun}$. For what mass is $\sigma = 1$?

Save this code. You will use it again when we come to mass functions.