

Astro 321: Problem Set 5  
Due May 8 (in my box at LASR)

This problem set requires the code from Problem Set 4.

## 1 Problem 1: Filters

- Define the spherical top hat window as

$$W(r) = \text{const.} \quad (r < R) \quad (1)$$

$$= 0 \quad (r \geq R) \quad (2)$$

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

$$\sigma_R^2 \equiv \int \frac{d^3k}{(2\pi)^3} |W(k)|^2 P(k) \quad (3)$$

$$= \int d \ln k |W(k)|^2 \Delta^2(k) \quad (4)$$

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  $\Omega_m = 1 - \Omega_\Lambda = 0.27$ ,  $h = 0.72$ ,  $n = 1$  cosmology of the previous problem set, plot  $\sigma_R$  between  $0.1 < R/(h^{-1}\text{Mpc}) < 100$ . What is the value of  $\sigma_8$ , 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  $h^{-1}M_{\text{sun}}$ . For what mass is  $\sigma = 1$ ?

Halo model people: save this code.