Hubbule parameter:

$$H^2 = H_0^2 \left[\frac{\Omega_r}{a^4} + \frac{\Omega_m}{a^3} - \frac{Kc^2}{a^2 H_0^2} + \Omega_\Lambda \right]$$

$$= H_0^2 \left[\frac{\Omega_r}{a^4} + \frac{\Omega_m}{a^3} + \frac{1 - \Omega_0}{a^2} + \Omega_\Lambda \right]$$

Comving distance:

$$dt = \frac{da}{\dot{a}} \Rightarrow -dw = \frac{cdt}{a} = \frac{cda}{a\dot{a}} = \frac{cda}{a^2 H}$$

$$\omega(z_1, z_2) = \frac{c}{H_0} \int_{a(z_2)}^{a(z_1)} \frac{da}{\sqrt{a\Omega_m + a^2(1 - \Omega_m - \Omega_\Lambda) + a^4 \Omega_\Lambda}}, z_1 < z_2$$

$$= \frac{c}{H_0} \int_{z_1}^{z_2} \frac{dz}{\sqrt{(1+z)^3 \Omega_m + (1+z)^2(1 - \Omega_m - \Omega_\Lambda) + \Omega_\Lambda}}, z_1 < z_2$$

$$= \frac{c}{H_0} \alpha(z_1, z_2)$$

The physical distance relates the angle and the size of a distant object is the angular diameter distance D_A.

$$D_A(z) = a(z) f_k(\omega(0, z))$$

The search radius is $Rh^{-1}\mathrm{Mpc}$. In the flat universe, the search radius in arcmin is

$$D_A(z) = a(z)\omega(0,z)\theta = \frac{1}{1+z}\frac{c}{H_0}\alpha(0,z)\theta = \frac{\theta\alpha(0,z_2)}{1+z}\frac{c \times 10^5 \mathrm{Km \cdot s^{-1}}}{100h\mathrm{Km \cdot s^{-1} Mpc^{-1}}} = Rh^{-1}\mathrm{Mpc}$$

$$\Rightarrow \theta = \frac{(1+z)R}{1000c\alpha(0,z_2)}\frac{180 \times 60}{\pi} = \frac{10.8}{c\pi}\frac{1+z}{\alpha(0,z_2)}R$$

The angular distance between z_1 and z_2 is

$$D_A(z_1, z_2) = a(z_2) f_k(\omega(z_1, z_2))$$

It is valid only for $\omega_k \leq 0$ (see astro-ph/9905116 or Principles of Physical Cosmology pp 336–337, Peebles)

The critial surface density in comoving distance:

$$\Sigma_{crit}(z_1, z_2) = \frac{c^2}{4\pi G}\frac{\omega(0, z_2)}{[\omega(0, z_2) - \omega(0, z_1)]\omega(0, z_1)(1 + z_1)}, z_1 < z_2$$

$$= \frac{c^2}{4\pi G}\frac{H_0}{c}\frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1 + z_1)}$$

$$= \frac{c \times 10^8 \mathrm{m \cdot s^{-1}} 100h\mathrm{Km \cdot s^{-1} Mpc^{-1}}}{4\pi G \times 10^{-11}\mathrm{m^3 \cdot s^{-2} \cdot Kg^{-1}}}\frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1 + z_1)}$$

$$= \frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1 + z_1)}\frac{c \cdot h}{4\pi G} \times 10^{24}\mathrm{Kg \cdot m^{-1} \cdot Mpc^{-1}}$$

$$= \frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1 + z_1)}\frac{c \cdot h \cdot m_{pc}}{4\pi G \cdot m_s} \times 10^{16}\mathrm{M_{sum} \cdot Mpc^{-2}}$$

$$= \frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1 + z_1)}3.88283351 \times 10^{14}\mathrm{M_{sum} \cdot Mpc^{-2}}$$

$$h = 0.7, \quad c = 2.99792458 \quad m_{pc} = 3.085677581 \quad m_s = 1.98847 \quad G = 6.6740831313$$

Tangential shear and cross shear:

$$\begin{aligned}
(g_1 + ig_2)\exp(-2i\phi) &= g_1\cos(2\phi) + g_2\sin(2\phi) + i(g_2\cos(2\phi) - g_1\sin(2\phi)) \\
g_t &= -g_1\cos(2\phi) - g_2\sin(2\phi) \\
g_\times &= g_1\sin(2\phi) - g_2\cos(2\phi)
\end{aligned}$$

Process

1). Run Prepare_data.py collect data from each field. The data will be selected by some cutoffs. The name of the result file is "cata_result_ext.hdf5".

"mpirun -np …. prepare_data.py collect"

2). Run the sym_mc_plot_cfht.py for cutoffs. Then determine the cutoff threshold (flux_alt or ..) according to the results (multiplicative bias and additive bias).

3). Run prepare_data.py to select the data needed. The name of the result file is "cata_result_ext_cut.hdf5".

"mpirun -np …. prepare_data.py select"

4). Run the C++ program to build the grid and assign the source to each grid for final calculation.

"mpirun -n …. "