Hubbule parameter:

$$
\begin{aligned}
H^2 &= H_0^2[\frac{\Omega_r}{a^4}+\frac{\Omega_m}{a^3}-\frac{Kc^2}{a^2H_0^2}+\Omega_\Lambda] \\
&= H_0^2[\frac{\Omega_r}{a^4}+\frac{\Omega_m}{a^3}+\frac{1-\Omega_0}{a^2}+\Omega_\Lambda]
\end{aligned}
$$

Comving distance:

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

$$
\begin{aligned}
\omega(z_1,z_2) &= \frac{c}{H_0}\int_{a(z_2)}^{a(z_1)}\frac{da}{\sqrt{a\Omega_m+a^2(1-\Omega_m-\Omega_\Lambda)+a^4\Omega_\Lambda}}, z_1<z_2 \\
&= \frac{c}{H_0}\int_{z_1}^{z_2}\frac{dz}{\sqrt{(1+z)^3\Omega_m+(1+z)^2(1-\Omega_m-\Omega_\Lambda)+\Omega_\Lambda}}, z_1<z_2 \\
&= \frac{c}{H_0}\alpha(z_1,z_2)
\end{aligned}
$$

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

$$
\begin{aligned}
D_A(z)=a(z)\omega(0,z)\theta=\frac{1}{1+z}\frac{c}{H_0}\alpha(0,z)\theta=\frac{\theta\alpha(0,z_2)}{1+z}\frac{c\times10^5\mathrm{Km}\cdot\mathrm{s}^{-1}}{100h\mathrm{Km}\cdot\mathrm{s}^{-1}\mathrm{Mpc}^{-1}}=Rh^{-1}\mathrm{Mpc} \\
\Rightarrow \theta=\frac{(1+z)R}{1000c\alpha(0,z_2)}\frac{180\times60}{\pi}=\frac{10.8}{c\pi}\frac{1+z}{\alpha(0,z_2)}R
\end{aligned}
$$

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 $\omega_k\geq 0$ (see astro-ph/9905116 or Principles of Physical Cosmology pp 336–337, Peebles)

The critial surface density in comoving distance:

$$
\begin{aligned}
\Sigma_{crit}(z_1,z_2) &= \frac{c^2}{4\pi G}\frac{\omega(0,z_2)}{[\omega(0,z_2)-\omega(0,z_1)]\omega(0,z_1)(1+z_1)}, z_1<z_2 \\
&= \frac{c^2}{4\pi G}\frac{H_0}{c}\frac{\alpha(0,z_2)}{[\alpha(0,z_2)-\alpha(0,z_1)]\alpha(0,z_1)(1+z_1)} \\
&= \frac{c\times10^8\mathrm{m}\cdot\mathrm{s}^{-1}100\mathrm{hKm}\cdot\mathrm{s}^{-1}\mathrm{Mpc}^{-1}}{4\pi G\times10^{-11}\mathrm{m}^3\cdot\mathrm{s}^{-2}\cdot\mathrm{Kg}^{-1}}\frac{\alpha(0,z_2)}{[\alpha(0,z_2)-\alpha(0,z_1)]\alpha(0,z_1)(1+z_1)} \\
&= \frac{\alpha(0,z_2)}{[\alpha(0,z_2)-\alpha(0,z_1)]\alpha(0,z_1)(1+z_1)}\frac{c\cdot h}{4\pi G}\times10^{24}\mathrm{Kg}\cdot\mathrm{m}^{-1}\cdot\mathrm{Mpc}^{-1} \\
&= \frac{\alpha(0,z_2)}{[\alpha(0,z_2)-\alpha(0,z_1)]\alpha(0,z_1)(1+z_1)}\frac{c\cdot h\cdot m_{pc}}{4\pi G\cdot m_s}\times10^4\mathrm{M}_{\mathrm{sum}}\cdot\mathrm{pc}^{-2} \\
&= \frac{\alpha(0,z_2)}{[\alpha(0,z_2)-\alpha(0,z_1)]\alpha(0,z_1)(1+z_1)}3.88283351\times10^2\mathrm{M}_{\mathrm{sum}}\cdot\mathrm{pc}^{-2}
\end{aligned}
$$

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

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 .... "