

Hubble parameter:

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

Comoving distance:

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

The physical distance relates the angle to 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 $Rh^{-1}\text{Mpc}$. In the flat universe, the search radius in unit of degree is

$$\begin{aligned} D_A(z)\theta &= a(z)\omega(0, z)\theta = \frac{1}{1+z} \frac{c}{H_0} \alpha(0, z)\theta = \frac{\theta\alpha(0, z)}{1+z} \frac{c \times 10^5 \text{Km} \cdot \text{s}^{-1}}{100h \text{Km} \cdot \text{s}^{-1} \cdot \text{Mpc}^{-1}} = Rh^{-1}\text{Mpc} \\ \Rightarrow \theta &= \frac{(1+z)R}{1000c\alpha(0, z)} \frac{180}{\pi} = \frac{0.18}{c\pi} \frac{1+z}{\alpha(0, z)} R \end{aligned}$$

The angular distance between z_1 and z_2 is

$$D_A(z_1, z_2) = a(z_2) f_k(\omega(z_1, z_2)) = \frac{a(z_2)c}{H_0} [\alpha(0, z_2) - \alpha(0, z_1)]$$

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

The critical surface density in comoving distance:

$$\begin{aligned} \Sigma_{crit}(z_1, z_2) &= \frac{c^2}{4\pi G} \frac{\omega(0, z_2)}{[\omega(0, z_2) - \omega(0, z_1)]\omega(0, z_1)(1+z_1)}, z_1 < z_2 \\ &= \frac{c^2}{4\pi G} \frac{H_0}{c} \frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1+z_1)} \\ &= \frac{c \times 10^8 \text{m} \cdot \text{s}^{-1} 100h \text{Km} \cdot \text{s}^{-1} \text{Mpc}^{-1}}{4\pi G \times 10^{-11} \text{m}^3 \cdot \text{s}^{-2} \cdot \text{Kg}^{-1}} \frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1+z_1)} \\ &= \frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1+z_1)} \frac{c \cdot h}{4\pi G} \times 10^{24} \text{Kg} \cdot \text{m}^{-1} \cdot \text{Mpc}^{-1} \\ &= \frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1+z_1)} \frac{c \cdot h \cdot m_{pc}}{4\pi G \cdot m_s} \times 10^4 \text{M}_{\text{sum}} \cdot \text{pc}^{-2} \\ &= \frac{\alpha(0, z_2)}{[\alpha(0, z_2) - \alpha(0, z_1)]\alpha(0, z_1)(1+z_1)} 3.88283351 \times 10^2 \text{M}_{\text{sum}} \cdot \text{pc}^{-2} \end{aligned}$$

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

Tangential shear and cross shear:

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

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".

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"mpirun -np .... prepare_data.py collect"
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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".

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"mpirun -np .... prepare_data.py select"
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4). Run the C++ program to build the grid and assign the source to each grid for final calculation.

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"mpirun -n .... "
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