Problem Set 3

Due Monday Feb 4

As always, assume a canonical cosmological model of $(\Omega_m, \Omega_\Lambda, h) = (0.3, 0.7, 0.7)$, unless otherwise stated.

1.**time-delays**

A gravitational lens consists of a source at $|\beta| = \theta_{\rm E}/2$. Assuming that the mass distribution of the lens is a point mass with Einstein Radius 1.5 arcseconds describe the morphology of the time delay surface [5pts]. The time delay between the two images is measured to be 0.47 ± 0.05 years. Determine the Hubble constant assuming $\Omega_m = 0.3$ $\Omega_\Lambda = 0.7$, knowing the lens redshift is 0.5 and the source redshift is 2.14, neglecting the effects of external convergence [10 pts]. How does the result change if external convergence is 0.05 [5pts]?

2.**mass density profiles**

Consider a point mass, a single isothermal sphere, and a simplified spherical Navarro Frenk & White profile, described by the equation

$$\rho(r) = \frac{\rho_0(r)}{(r/r_s)(1 + r/r_s)^2}, \tag{1}$$

with $r_s = 100$ kpc. Normalize them to have the same Einstein Radius [5pts].

Compute as a function of Einstein Radius, the convergence, magnification, tangential and cross components of the shear profile for each of the three mass distributions. Compute the radius corresponding to the critical lines. Describe the qualitative differences between the profiles. [10 pts]

Assume now $z_d = 0.2$ $z_s = 2$ and Einstein Radius $=30''$. Compute the mass within the Einstein Radius. What astrophysical system are we looking at? What kind of observations could we use to distinguish the three mass profiles? [5pts]