PHY-765 SS18: Gravitational Lensing. Worksheet Week 9

1 Journal Club #2: Paper presentation

Last week (exercise 1) you selected a recent lensing paper based on title and abstract. You have prepared a ∼5 minute overview which will be presented in class this week in a journal club setting.

2 Statistics of Exo planets

There are many websites trying to track the constantly increasing number of planets detected. And due to the new discoveries on almost a daily basis, some of these are outdated. This exercise will present a couple of examples of online catalogs and nice tools for exploring the ∼currently known exoplanets.

2.1

Using the plotting tools at `http://exoplanets.org/plots` estimate the mass range that currently contains microlensing planets. What is the typical separation for these microlensing events?

2.2

Estimate the fraction of planets discovered with microlensing (and other methods) according to `http://exoplanets.org/plots`. How does this compare to the fractions given in this week's slides taken from `https://exoplanets.nasa.gov`.

2.3

Using the "New Worlds Atlas" provided by `https://exoplanets.nasa.gov`, determine how many of the currently known planets have host stars visible to the naked eye. How many microlensing planet systems have currently been found to contain more than 1 planet?

3 Image positions for lens-star, lens-planet and source alignment

In this week's slides the special case where the lens-star, lens-planet and source-star of a double point mass lens system are aligned on a single axis (call it x), was described.

3.1

Show that the location of the three multiple mages of the background star are given by x_p, x_+ and x_-, where $x_i = \frac{\theta_i}{\theta_\mathrm{E}}$ and the latter two positions are the multiple images formed by the single point mass lens, described in week 4.

4 The magnification of a planet + star lens

As defined in week 6 the lens magnification can be calculated as

$$\mu = \left|\frac{\partial y_i}{\partial x_j}\right| = \frac{1}{\det \mathcal{A}} \tag{1}$$

where $\mathcal{A}$ is the Jacobian matrix and y and x are the source plane and image plane positions normalized by the effective Einstein radius introduced last week.

4.1

Use this to show that the magnification of a double point mass lens is given by

$$\mu = \left[1 - \left(\frac{1}{x_x^2} + \frac{q}{(x - x_{\rm p})_x^2}\right)^2\right]^{-1} \tag{2}$$

where the x-subscript refers to the x-component of the image positions and the y-components have been set to 0, cf. the aligned geometry described in exercise 3.