PHY-765 SS19: Gravitational Lensing. Worksheet Week 10

1 Select topic for presentation/talk

In the series of astronomer skill development, we have so far covered preparing and presenting a scientific poster, and staying on top of recent literature with journal clubbing. This week you will work on your presentation skills by preparing a short talk to be given one of the coming weeks. You should have been informed via email about your presentation date - if not, please contact kbschmidt@aip.de.

Giving talks is probably the most important way of communicating your research to peers and to the public. It is therefore essential to keep giving talks to improve these. At the end of this week's slides, you'll find a short summary of "a good talk".

1.1

Prepare a talk (with slides) about a gravitational lensing topic of your choice. The presentation should not be longer than 8 minutes (to which 2 minutes of questions will be added). The talk will be timed, and a warning given after 5 minutes, to make sure all have time to present their topic.

This is similar to the exam format for the course, except that here the talk and questioning will be longer. Hence, this exercise can be seen as a 'mini-exam-rehearsal'.

1.2

Send a PDF version of the slides to kbschmidt@aip.de before your presentation. The slides will then be shown from just one laptop to avoid extra time overheads.

2 Arguments for & against using microlensing for finding exoplanets

In Section 4.2 from the Gravitational Microlensing chapter of Schneider, P., Kochanek, C., & Wambsganss, J. (2006), prof. J. Wambsganss summarized the standard arguments against using microlensing to find exoplanets. He continued by disarming these arguments and then provided a list of advantages of using microlensing to find exoplanets and described how this method complements alternative methods. Read the text by J. Wambsganss and summarize the pros and cons of using microlensing to find exoplanets.

3 Statistics of exoplanets

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 And due to the new discoveries on almost a daily basis, some of these are outdated.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.

3.1

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?

3.2

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

3.3

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?

4 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.

4.1

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 5.

5 The magnification of a planet + star lens

As defined in week 7 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.

5.1

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

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

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 4.