PHY-765 SS18: Gravitational Lensing. Worksheet Week 12

1 Essay review feedback

If you haven't done so already, make sure to send your feedback to the essay author. In class, we will evaluate the feedback exercise by sharing what you have learned from the feedback, and what you will do differently next time you write a scientific text. Continuous improvements (throughout the career!) are what makes a great author eventually.

2 Select topic for presentation/talk

In the series of astronomer skill development, we have so far covered preparing and presenting a scientific poster, staying on top of recent literature with journal clubbing, writing scientific text, and refereeing/providing feedback. This week you will work on your presentation skills by preparing a short talk to be given next week. Giving talks is one of, if not the main way of communicating your research to peers and the public (and the format of the exam for this course). 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".

2.1

Prepare a talk (with slides) about a gravitational lensing topic of you 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, and the topics are given in advance. Hence, this exercise can be seen as a 'mini-exam-rehearsal'.

2.2

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

3 Weak lensing and ellipticity.

In this week's slides it was shown that for the simplified case where $\kappa = \gamma_2 = 0$ the components of the Jacobian matrix added in qudrature is the functional form of an ellipse, describing the shearing of a circular image.

3.1

For the case where $\kappa = \gamma_1 = 0$ show that a similar expression is obtained, namely

$$1 = \frac{(\theta_1 - \gamma_2\theta_2)^2}{\beta_0^2} + \frac{(\theta_2 - \gamma_2\theta_1)^2}{\beta_0^2} \tag{1}$$

4 The ellipticity expressed from the Jacobian matrix

In this week's slides the Jacobian matrix was used to relate the ellipticity of galaxies to the gravitational potential through the convergence (κ) and the shear (γ)

4.1

From the definition of the Jacobian matrix

$$\mathcal{A}(\boldsymbol{\theta}) = (\delta_{ij} - \boldsymbol{\Psi}_{ij}) \quad \text{where} \quad \boldsymbol{\Psi}_{ij} \equiv \begin{pmatrix} \kappa + \gamma_1 & \gamma_2 \\ \gamma_2 & \kappa - \gamma_1 \end{pmatrix} \tag{2}$$

and δ_{ij} is the identity matrix, determine $\mathcal{A}^{-1}$.

4.2

Use the definition of $\mathcal{A}^{-1}$ to express the ellipticities defined in this week's slides in terms of κ and γ, showing that

$$\epsilon_i = \frac{2\gamma_i}{1-\kappa}\left[1 - \frac{\gamma^2}{(1-\kappa)^2}\right]^{-1} \tag{3}$$

for the distortion of a spherical object.

5 The characteristic sizes of lensed sheared galaxies

A key point of weak lensing studies, is to beat down the noise and uncertainties on the shape measurements by considering large samples of galaxies. To obtain these large samples (at high redshift), deep observations in large fields of view are desirable. Pushing to higher depths and to the limits of the observations (to detect as many galaxies as possible), requires detection of shapes on small noisy galaxies.

5.1

Estimate the angular size of a galaxy with half-light radius ∼10 kpc, if that galaxy was observed to be at redshift 0.05, 0.35, 1.5 and 8.0.

5.2

How do these angular sizes compare to the size of the seeing disk and/or the full width at half max (FWHM) of the point spread function for standard ground and space-based observations?