PHY-765 SS19: Gravitational Lensing. Worksheet Week 11

1 Give presentation on topic selected week 10 (first half of presentations)

In week 10's exercise 1 you prepared a scientific presentation on a topic of your choosing. As the first exercise of this week, the first half of the class will present their 8+2 minutes prepared talks to the rest of the group.

2 Modeling Lenses

As discussed in this week's slides, lens modeling is an iterative parametric or non-parametric process, trying to find a model that minimizes the disagreement with the observed data. Setting yourself in "the place of an iterative computer code", use the lens model generator https://www.physik.uzh.ch/~psaha/lens/simplens.php and/or http://virtual-universe.org/ego_cgi.html to match the observed Einstein Ring 0047-2808 and some of the QSO lenses from CASTELS sample. You can change source and lens positions, parametric setup of lens model, its size, the size of the critical curve etc. You will quickly realize that modeling includes a lot of 'knobs' to turn to fit the data.

3 The Mass Sheet Degeneracy

The main source of uncertainty of most lens models is introduced by the mass sheet degeneracy described in this week's slides.

3.1

Show that

$$\nabla^2\psi_\lambda = 2\kappa_\lambda \tag{1}$$

holds for the potential

$$\psi_\lambda(\boldsymbol{\theta}) = \frac{1-\lambda}{2}|\boldsymbol{\theta}|^2 + \lambda\psi(\boldsymbol{\theta}) \tag{2}$$

where the remaining parameters are defined in this week's slides.

3.2

Combine the lens equation for the modified surface mass density, κ_λ, and the expression for the deflection angle resulting from the κ_λ to show that

$$\frac{\boldsymbol{\beta}_\lambda}{\lambda} = \boldsymbol{\theta} - \boldsymbol{\alpha}(\boldsymbol{\theta}) \tag{3}$$

3.3

Show that the convergence and shear for the mass sheet degeneracy is given by

$$\gamma_\lambda(\boldsymbol{\theta}) = \lambda\gamma(\boldsymbol{\theta}) \qquad \text{and} \qquad (1-\kappa_\lambda) = \lambda(1-\kappa) \tag{4}$$

where the κ subscripts refers to the model where the surface mass density has been modified.