One Ring to Rule Them All

Line-of-sight shear as a new cosmological probe

Natalie Hogg
IPhT CEA Paris-Saclay
Based on a true story: **2210.07210**

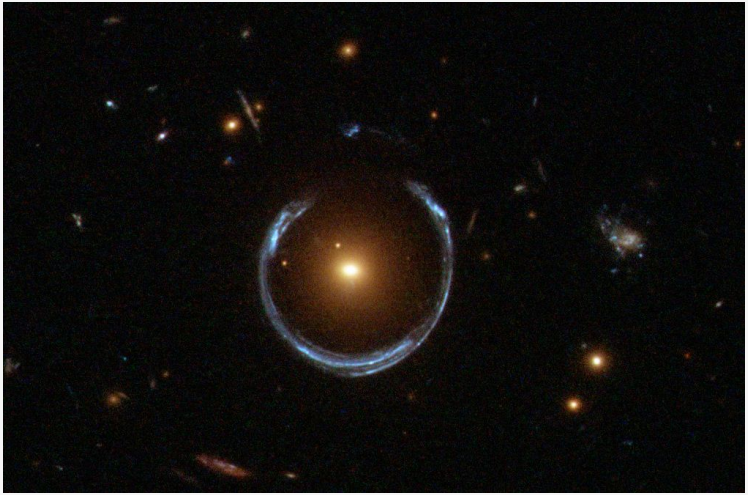
With Pierre Fleury, Julien Larena and Matteo Martinelli

What is dark matter?

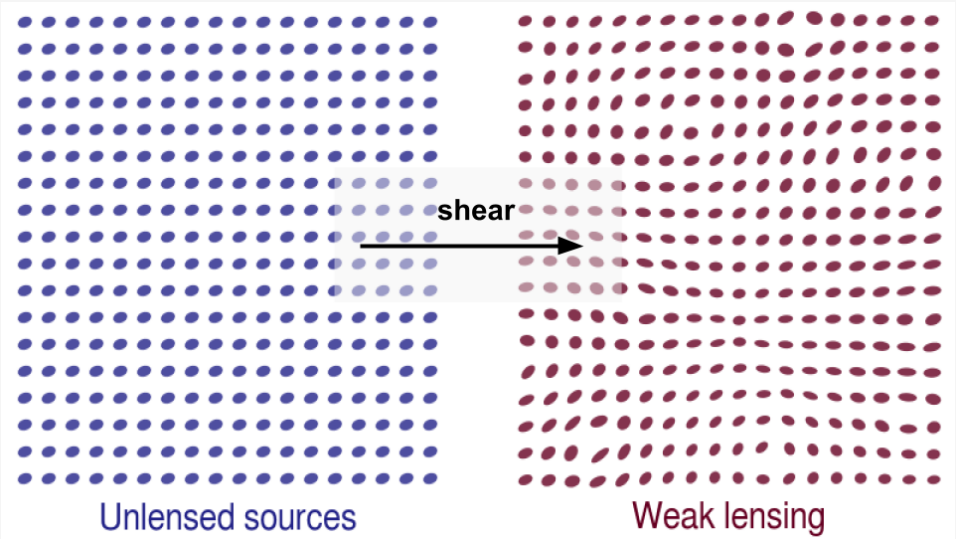
Gravitational lensing

- Mass curves spacetime
- Light, following null geodesics, also curves, producing multiple images of a source
- Most mass in the Universe is dark matter
- **Gravitational lensing can tell us about the nature and distribution of dark matter**

Strong gravitational lensing and Einstein rings



Weak gravitational lensing and line-of-sight shear

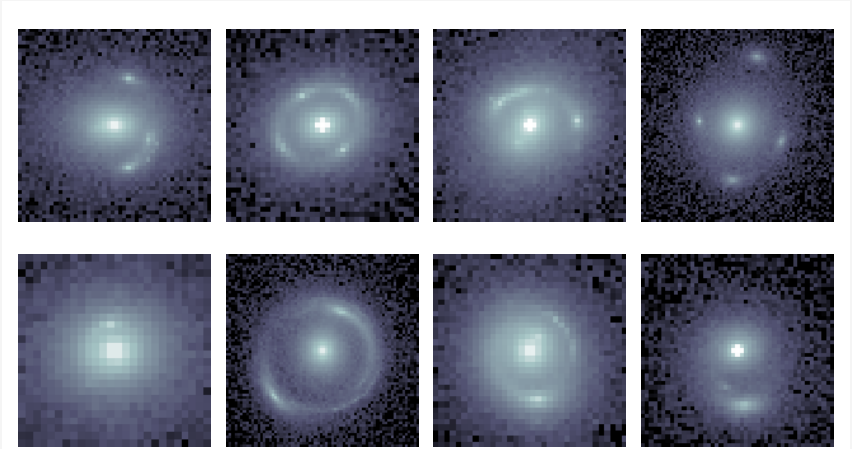


Weak lensing of strong lensing

- Measuring shear from weakly lensed galaxies alone is difficult due to the intrinsic ellipticity of galaxies
- Einstein rings can be used as “standard shapes”: we know they should be circular, so any deviation from a circular ring is due to cosmic shear, not the intrinsic shape of the lens
- Measuring the **weak lensing shear of Einstein rings** induced by objects along the line-of-sight (LOS) is therefore a potentially cleaner probe of the dark matter distribution

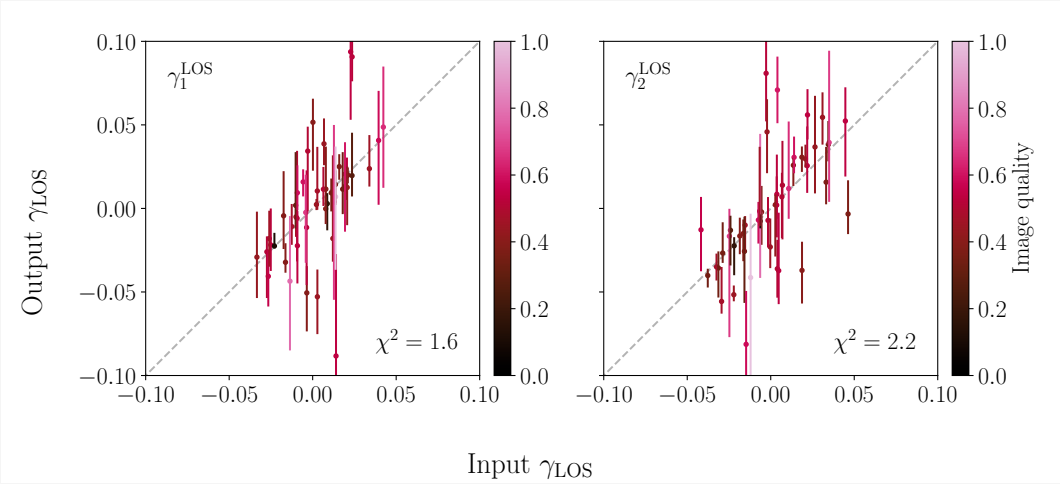
Can we measure the shear, $\gamma_{\rm LOS}$, from strong lensing images?

Mock images



We simulate 64 Hubble Space Telescope-like images in total using the `lenstronomy` software and infer the model parameter posteriors using an MCMC analysis.

Result (best of four models tested)



$\gamma_{\rm LOS} = \gamma_1 + i\gamma_2$

Conclusions

- It is possible to measure the line-of-sight shear from strong lensing images
- Cross-correlation of Einstein ring shapes with galaxy surveys will increase our knowledge of the dark matter distribution
- Much more in the paper: full theoretical description, advantage of different fitting models, statistical analysis, higher-order (beyond shear) effects...

Thanks for listening!

2210.07210

natalie.hogg@ipht.fr