Combining Weak and Strong Lensing in Galaxy Cluster Mass Reconstruction

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Gravitational Lensing

- Deflection of light by massive objects, described by general relativity.
- The lensed images of background sources contain information about the lens.

**Weak lensing**

- Slight image distortions of background galaxies.
- Point sources would appear elliptical.
- Galaxies also carry intrinsic ellipticity.
  ⇒ Weak lensing has to be treated statistically.
- Observable over a wide field.

**Strong lensing**

- Spectacular distortion of background galaxies to giant arcs or even rings.
- Well resolved and observable effect.
  ⇒ No statistics necessary
- Takes place only near the cores of massive objects.
- No reconstruction of extended objects possible.
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Some Lensing Pictures
In our reconstruction method we try to combine the advantages of both lensing regimes into a joint method:

- Fully non-parametric, adaptive grid method using finite differences.
- Reconstruction quantity is the lensing potential $\psi$.
- Maximum-likelihood method. We are searching for that lensing potential which is most likely to have caused the observations:

$$\chi^2(\psi) = \chi^2_W(\psi) + \chi^2_s(\psi)$$

- Input data are:
  - Ellipticity catalogue
  - Arc positions
  - Flexion catalogue (given a reliable measurement, work in progress)
  - Multiple image positions (Bradač et al. 2005-08)
- $\chi^2$-function is the minimised with respect to the potential on every grid position.
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Two different kinds of Grids
A Synthetic Test

Cluster Reconstruction

Distance from origin [arcsec]

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8

-100 -80 -60 -40 -20 0 20 40 60 80 100

convergence

original cluster
pure weak lensing
weak+strong at low res
weak+strong at high res

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One Example of a Realistic Test

(Meneghetti, JM et al. in prep.)
Sorry for the missing total mass, but we wanted to be sure about the calibration (JM et al. in prep.).