(Pixe)Lens Reconstruction: Issues for the Next Decade

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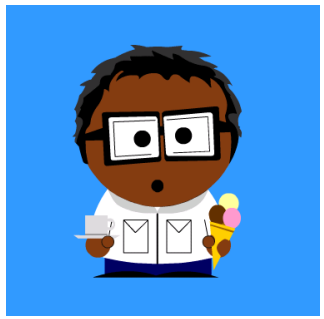
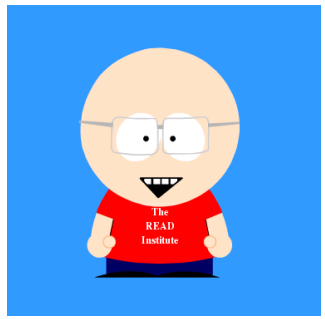


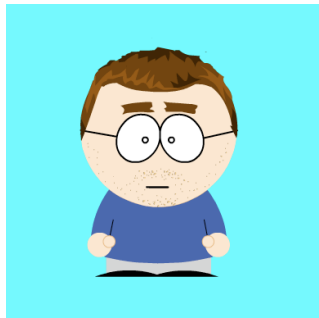
Prasenjit Saha

Jonathan Coles

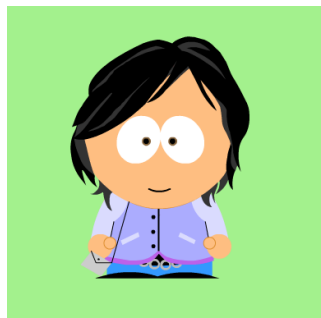


Justin Read

Andrea V. Maccò



Robert Feldmann



Liliya L.R. Williams

Overview of past work

- Known problems
- Free-form modeling, PixeLens, and model ensembles
- Estimating H_0

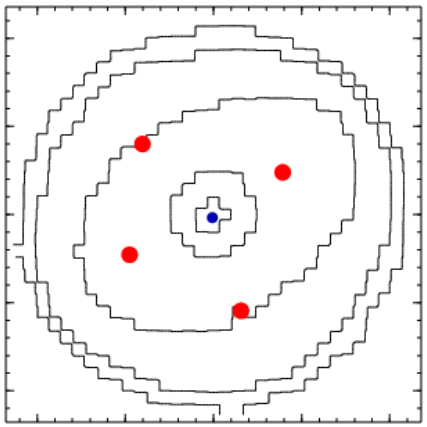
We consider here strong lensing of quasars by galaxies.

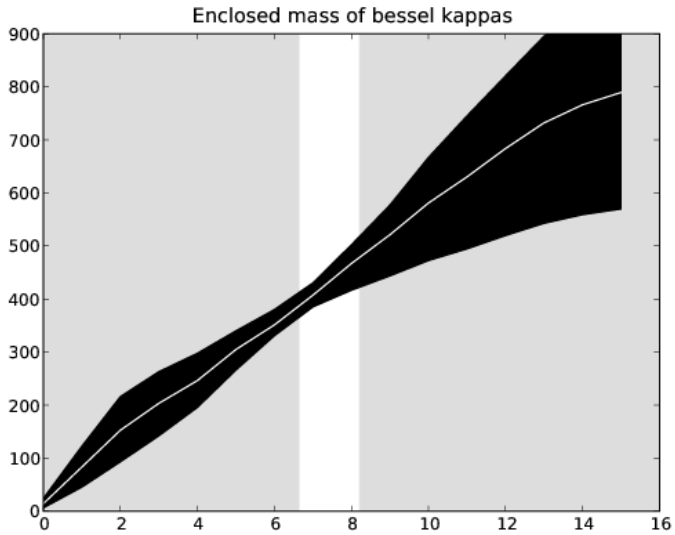
Known problems

- Steepness degeneracy (a.k.a. mass-sheet degeneracy)
- Twisting, stretching degeneracies (Saha and Williams 2006)
- Superposition of mass rings degeneracy (Liesenborgs et al. 2008) Not sure how physical this is though...
- First order perturbations of an isothermal fit produce zeroth-order changes in the time delays (Read et al. 2007)

Free-form modeling, PixeLens, and model ensembles

- PixeLens discretizes the image plane and finds mass distributions and source positions that exactly reproduce the input data. May also solve for H_0 or time delays.
- We apply a series of priors to keep the solutions physical. (Mass > 0, density gradient inward, min/max steepness, etc.)
- We generate hundreds of models that sample the solution space.





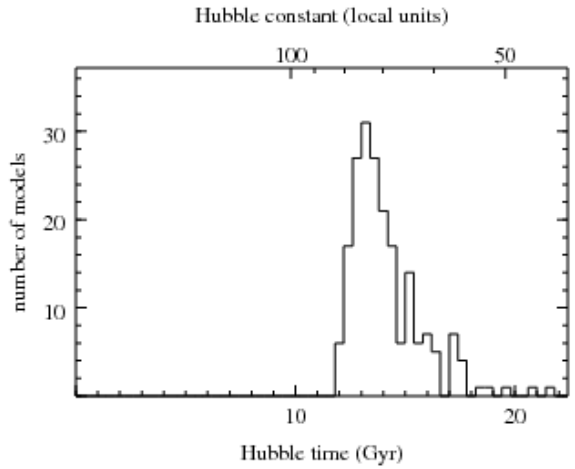
Estimating H_0

PixeLens can model multiple lenses simultaneously and require H_0 be constant across all lenses in a given solution.

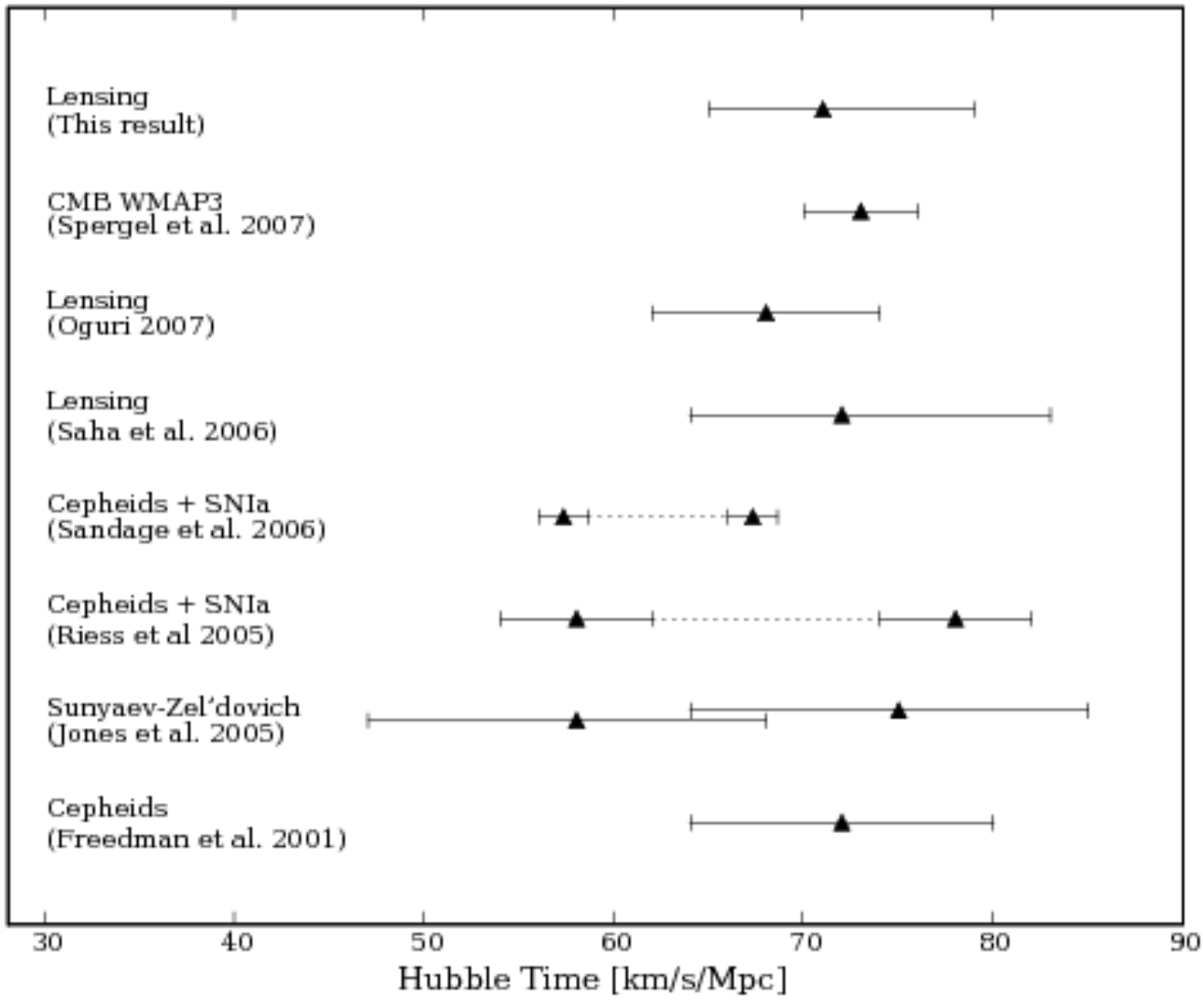
- Various papers have used 3, 5, 10, and 11 lenses.

With 11 lenses (Coles 2008)

$$H_0 = 71^{+6}_{-8}\ \mathrm{km/s/Mpc}$$
$$H_0^{-1} = 13.7^{+1.8}_{-1.0}\ \mathrm{Gyr}$$



Estimating H_0



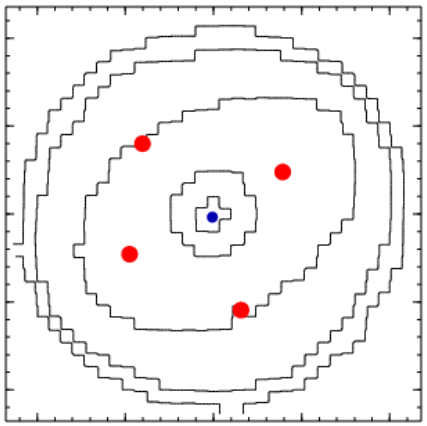
Some Current Work

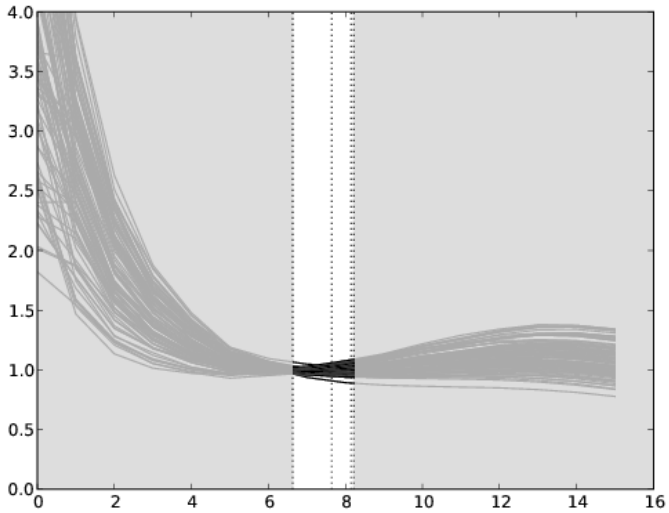
Testing against N-body simulations.

1. Take a galaxy (with gas in this case) from an N-body simulation (Feldmann et al. 2008).
2. Bin the mass into a flat sheet.
3. Create different lensing scenarios by placing source behind the mas and ray-tracing through it.
4. Generate models of the galaxy with PixeLens.
5. Compare the models with the known solution.

How well do we recover the solution?

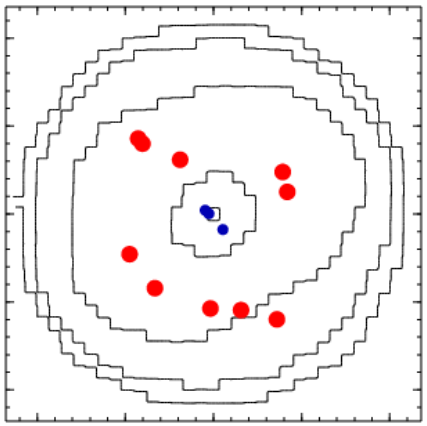
Some Current Work

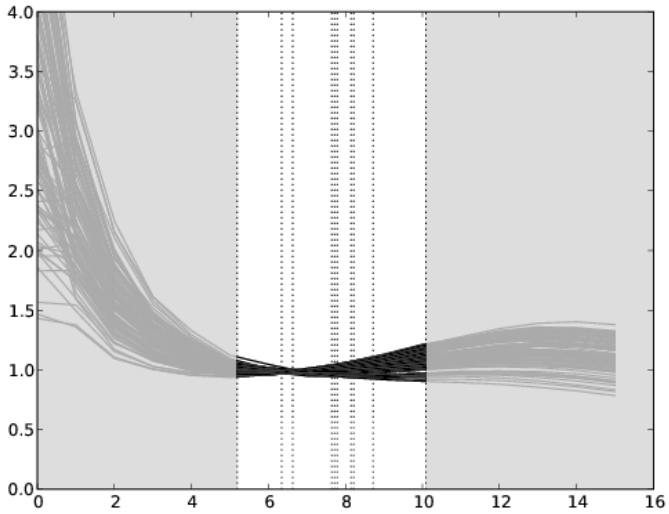




Single quad with source at $z = 0.4$.

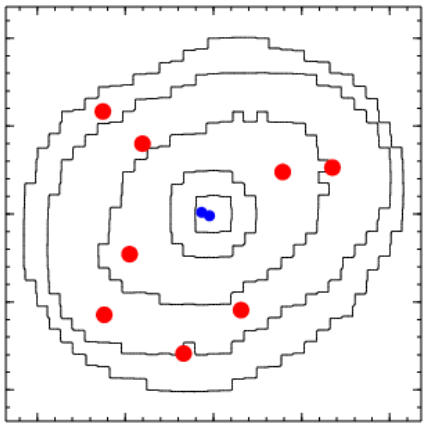
Some Current Work

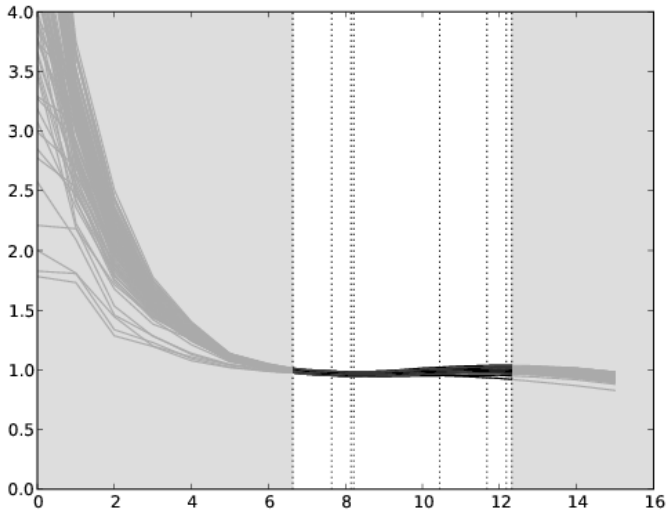




Two quads and a double (similar to B1933 – jet source).
Source is at $z = 0.4$.

Some Current Work





Two quads with sources at $z = 0.4$ and $z = 1.0$.

Future Work

Test, Test, Test!

Brain Challenges:

- Finding new degeneracies
- Developing better priors
- Integrating velocity dispersions into PixeLens
- Integrating flux ratios into PixeLens

Technical Challenges:

- Higher resolution pixels
- Cluster modeling
  (requires higher resolution, better numerical accuracy)
- Modeling 1000s of lenses simultaneously