Gravitational Lensing

Commentary and Discussion

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Abstract

Provide commentaries t
the following two papers:
Chris Kochanek: Turning
AGN Micorlensing from a
Curiosity into a Tool
Gary Bernstein: Statisti
cal Challenges of We
Gravitational Lensi

Wonder of Gravitational Lensing

Thanks to Chris and Gary's papers on gravitational lensing, which vividly refreshed my memory of Pete Kernan's "trick" on messing up someone's picture:

♣ Produced by lensing Gary's picture on

http://theory2.phys.cwru.edu/˜pete/GravitationalLens/GravitationalLens.html

What's Gravitational Lensing (GL)

Massive bodies can bend/deflect the path of light rays

This effect is called GL

magnifies, distorts w. obvious traces and may procduce mutiple images

Strong Lensing

produces subtle distortion (shear, magnification)

Weak Lensing

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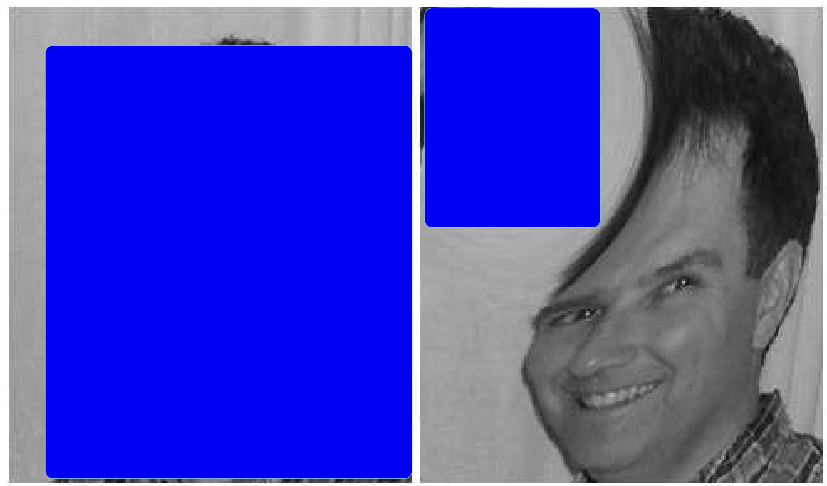

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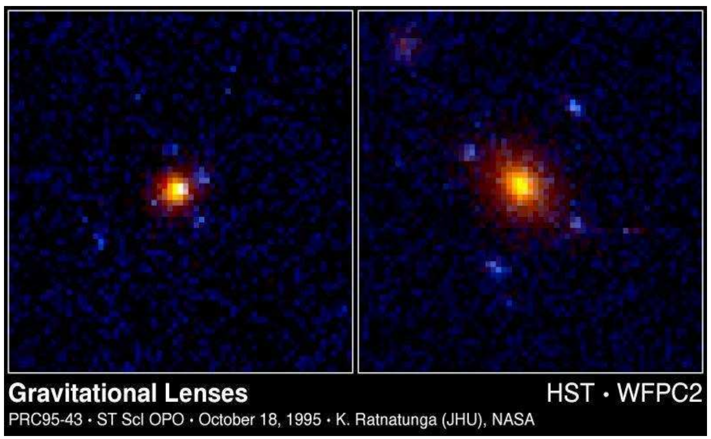

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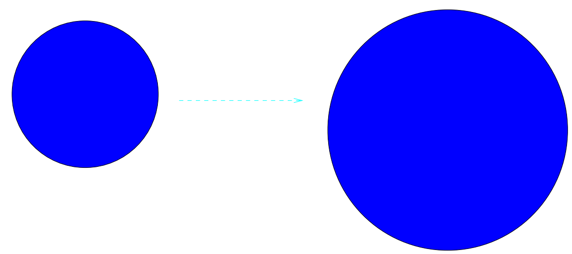

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  AN: GR, AGN, ...,

Strong Lensing by Chris

Idea: data D –> P(D|p) using χ^2 statistics
+ prior on p –> P(p|D)

where $p = (k, k_*, \gamma, < M >, R_\lambda, \nu_e)$, k is mean surface density, k_* is surface density in stars, γ is shear.

1. Generate random magnification patters on a range of $(k, k_*, \gamma, < M >)$
2. Convolve w. selected disk models R_λ
3. Generate light curves (ν_e +...)
4. Compute the χ^2 value for each light structure based on a threshold value to determine P(p)
   - Model selection vs. hypothesis testing (what are nulls)
   - Hierarchical models (ok) and final verification (data)
5. Approximate Bayesian integrals by sampling/MCMC

Strong Lensing - cont

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- Laplace approximation
- Model averaging and biases

• **Random Thoughts and comments**:
Extrapolation: Fig 2, data
Pages 6, 7, 8, 9
Comments A1-9

Weak Lensing by Gary

1. Define Shapes e_i to galaxies that are irregular

Gary's solu:

$$\hat{\gamma} = \frac{< \mathbf{e} >}{1 - < e^2 > /2}$$

where noiseless e^2 is unobserved.

- This leads to a measurement error models in statistics and need to do deconvolution. Is the error distribution (PSF) known?
- An alternative solution may be possible.

Weak Lensing by Gary - cont

Suggestions:

- Classify patterns after a Procrustes analysis (affine transformation or image registration) of the data
  —> using shape code and Procrustes parameters
- Use topology (Euler characteristics)
- Use a mixture of know shapes with some wavelets basis or other orthogonal basis (Laguerre expansion)

biases and distribution <— bootstrap

Weak Lensing by Gary - cont

2. Characterize the mass-galaxy likelihood L(m, g)

Use a mixture of Gaussian distributions

3. Find a feasible analyses scheme

Use the adaptive estimates, PEM
by Sun, Liu and Chen (06)

Conclusion

For statisticians and scientists:

- Know context
  Who? Individuals measured and observed
  What? has been measured and observed
  Why? Study Purpose
- Have good designs
- Avoid bias
- Do something about the bias if there is one.

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For scientists:

- Involve a statistician or use statistical strategies early (from the design of an experiment to the analysis of the resulting data) not just later (for the analysis part only).