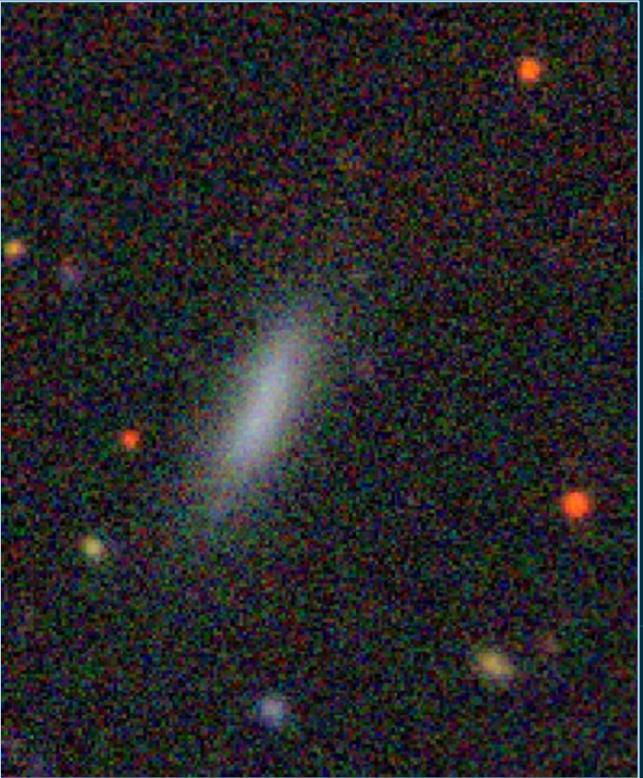




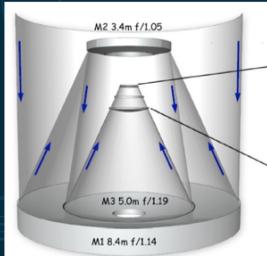
Measuring Images: Photometry



What makes these images look the way they do?



How do astronomical images come to be?



Credit: John
Peterson (Purdue)
and the PhoSim
Team

Optics

+Tracking

+Diffraction

**+Detector
Misalignments &
Perturbations**



+Lens Misalignments

**+Mirror Misalignments
Perturbations,
& Micro-roughness**

+Detector

**+High Altitude
Atmosphere**



**+Mid Altitude
Atmosphere**

**+Low Altitude
Atmosphere**

+Pixelization

**+Saturation &
Blooming**

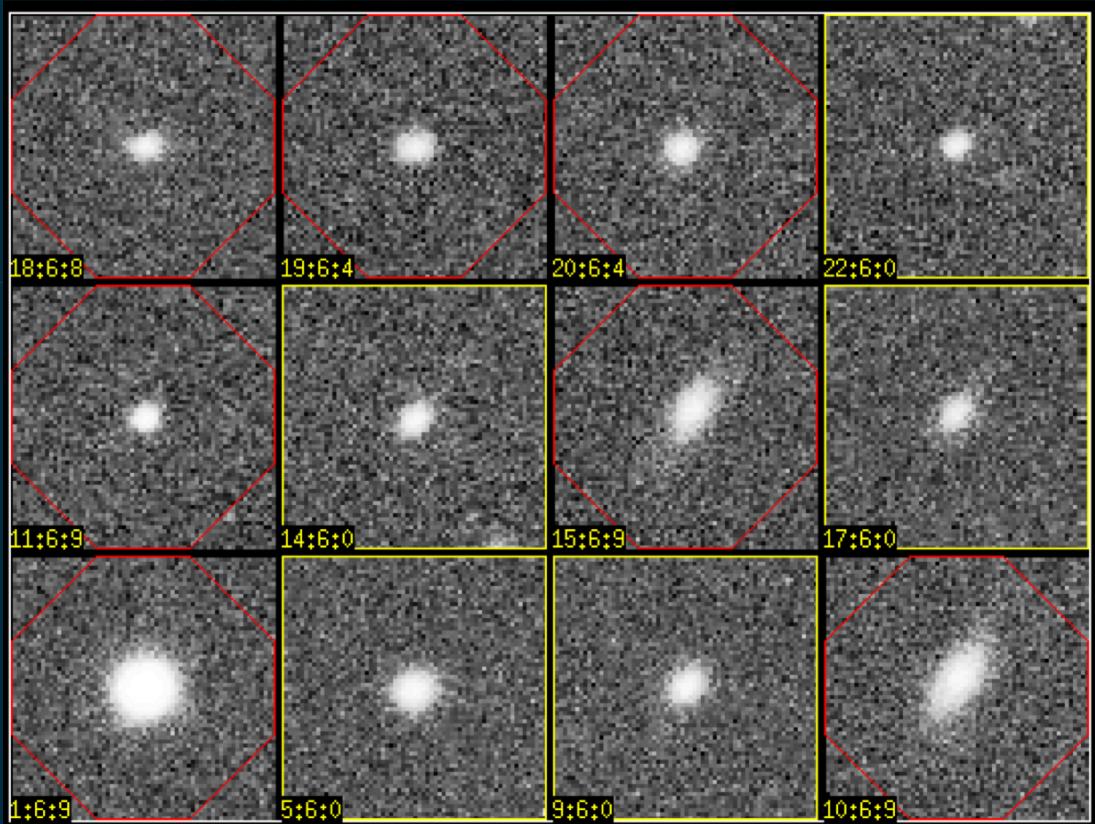
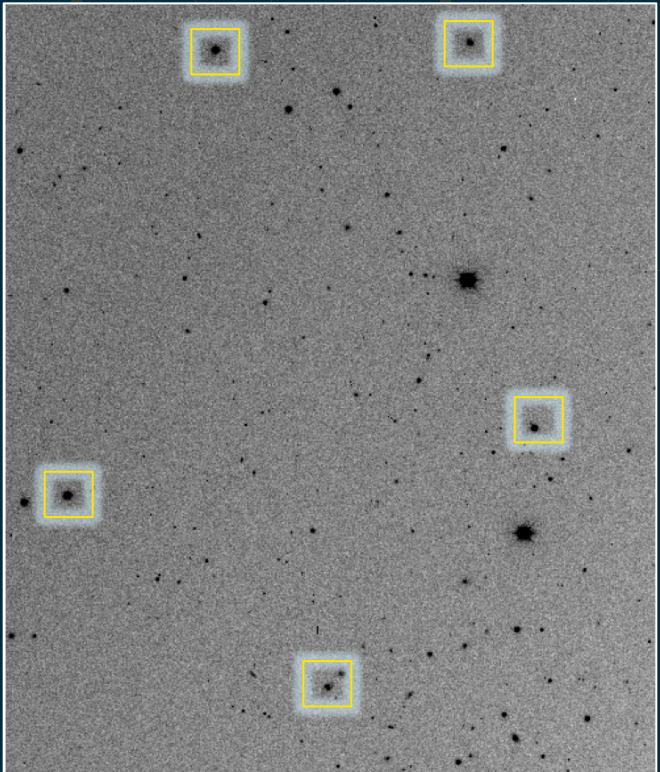




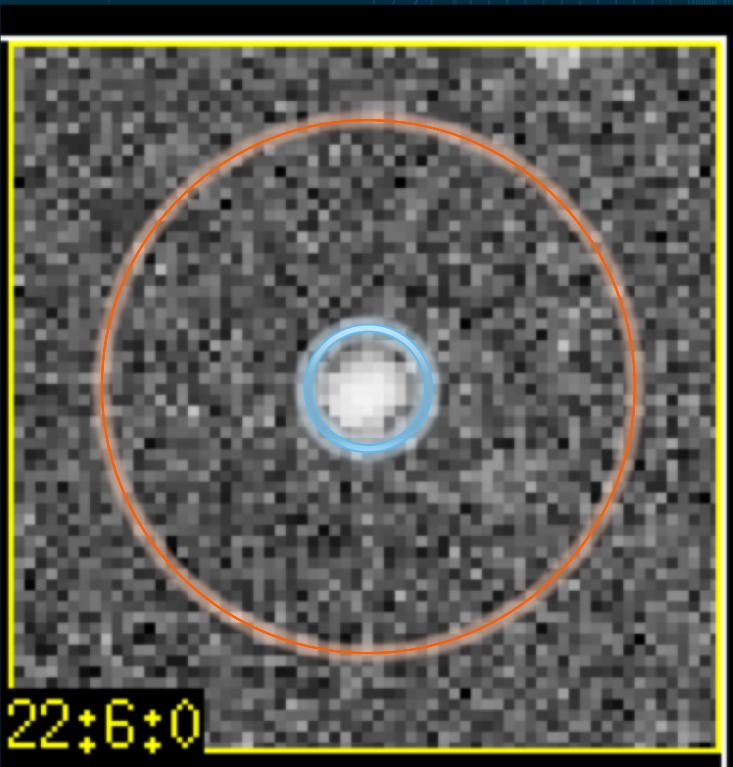
Modeling the PSF

- The simplest thing to do is to model the PSF with an analytic profile
 - Gaussian (or a linear combination of gaussians)
 - Moffat
- More sophisticated methods
 - PCA analysis
 - Delta functions
 - Combinations

PSF Estimation in Practice



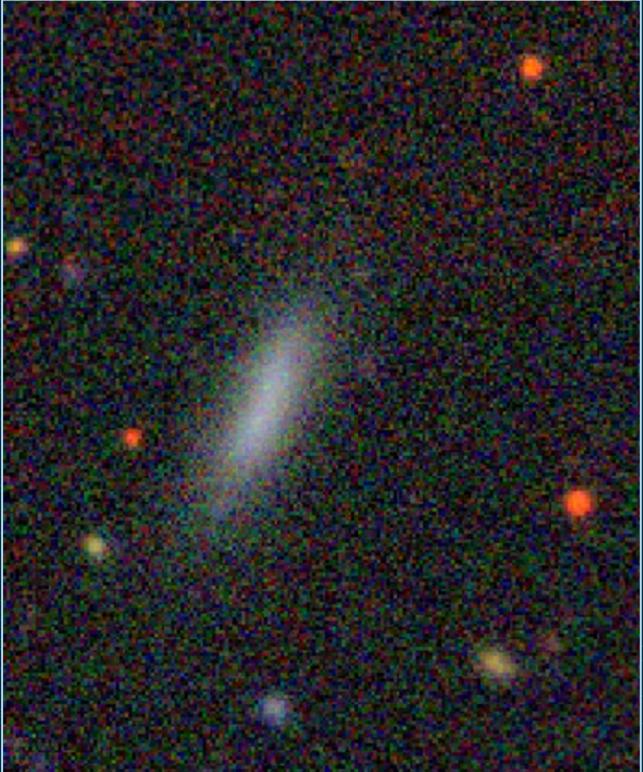
How should we measure the flux of an object?



Solution: Forward Modeling

What do astronomers care about?

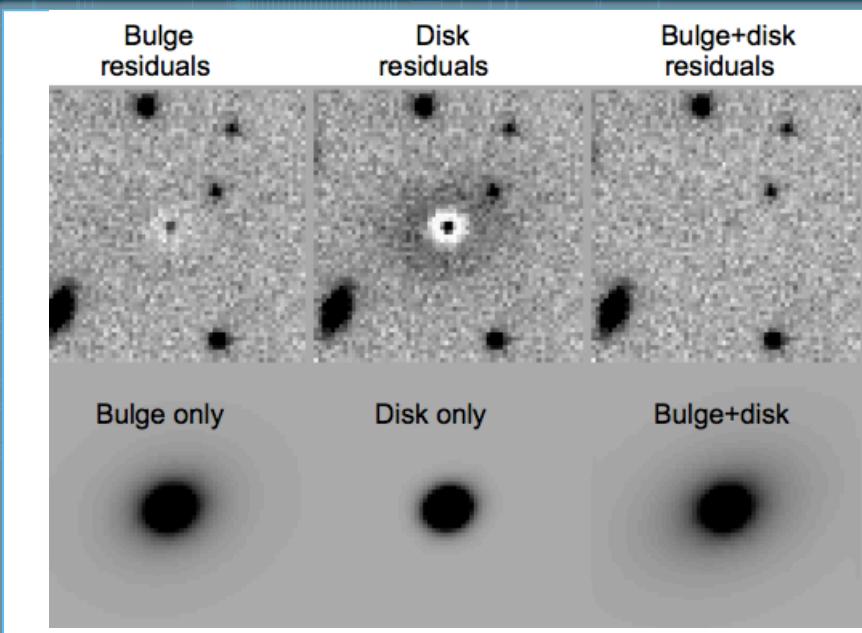
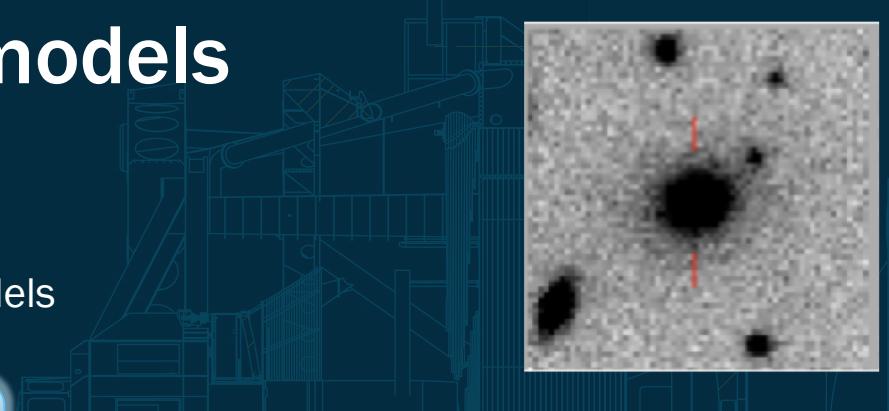
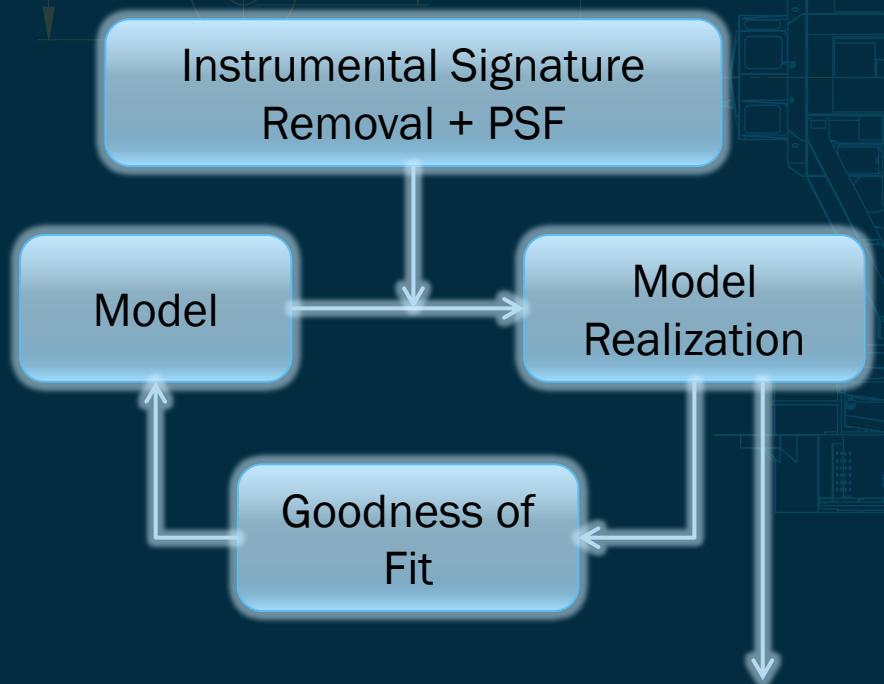
- What's on the image?
 - Stars (point sources)
 - Galaxies (extended objects)
- Where is it?
 - Relatively (in pixels, to ~few hundredths of a pixel)
 - Absolutely (coordinates on the sky)
- How bright is it?
- Is it changing in time?
- Is it moving?
- What is its shape?
 - Of a particular object
 - Statistically, for a class of objects



Learning by fitting models

Object characterization (models):

- Stars: Point Source model
- Galaxies: Double exponential models



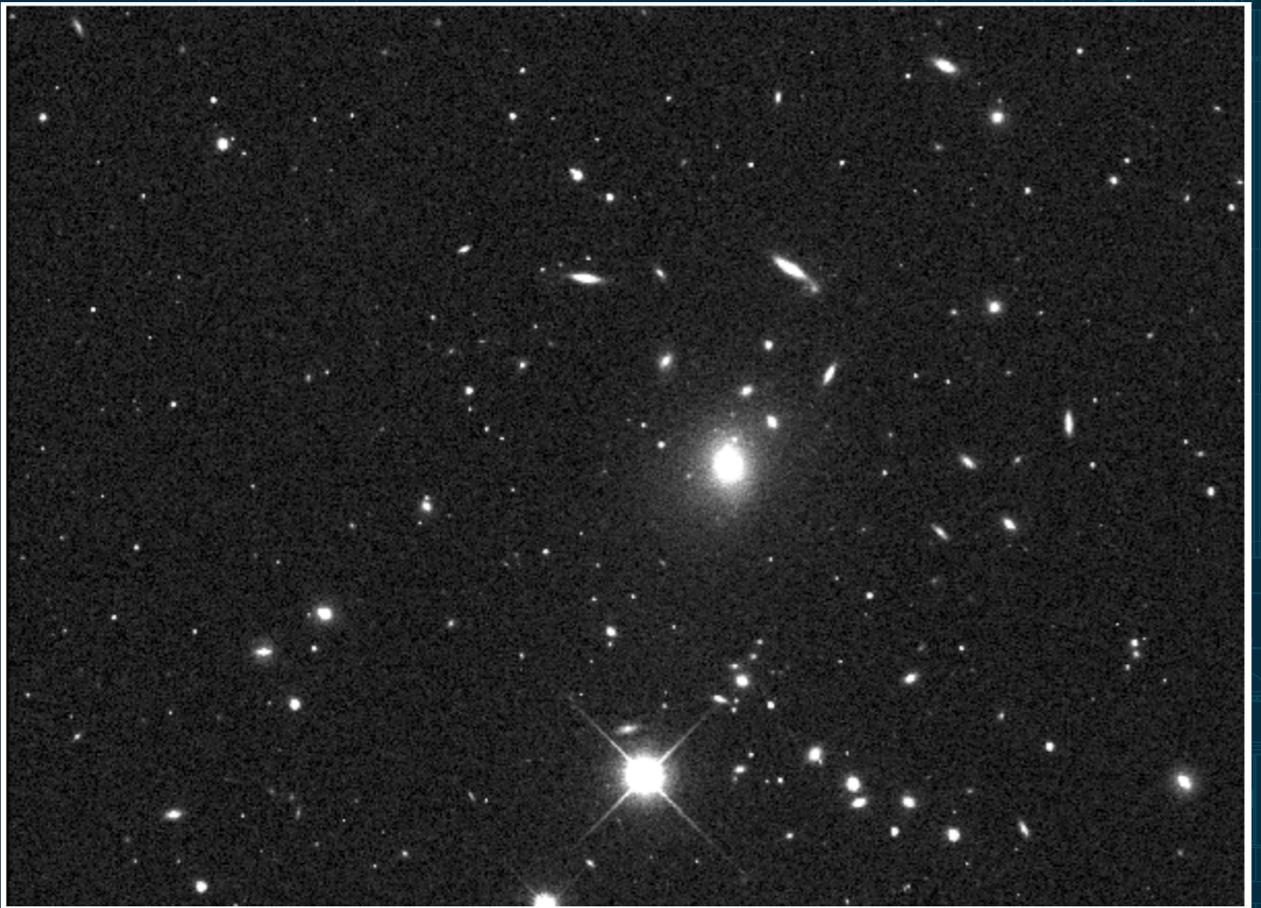


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1,231,051,050 rows (SDSS DR10, PhotoObjAll table)

~500 columns

Cataloging the Sky...



What we're doing is decomposing and modeling the sky in a way that makes physical sense.

... Modeling the Sky



What we're doing is decomposing and modeling the sky in a way that makes physical sense.

... or (Lossy) Compressing the Sky!



What we're doing is decomposing and modeling the sky in a way that makes physical sense.

But you may also think of this as developing a very fancy lossy compression technique.

Python tools for photometry

- We'll use `astropy.photutils`
- It's a relatively new package, and still very much rough around the edges
 - Example: their example notebooks don't work on the most recent version.
- Expected to get better over time, good enough for simple use cases.
- Most widely used tools:
 - SExtractor (E. Bertin)
 - DAOPHOT (Stetson)
- Emerging state-of-the-art:
 - The LSST Data Management Software Stack (Python interfaces!)
 - But a very steep learning curve