Comments on Dark Energy Experiments

Tim Mckay
July 14, 2001

Outline:
• General comments on techniques
• Some scary lensing details
• Comments on survey depths
Measurements of dark energy

Basic approaches:

Cluster counting
- X-ray selection: Flux limited
- SZ surveys: redshift independence
- Lensing surveys: clean mass selection?
- Optical surveys (!)

Structure Formation
- Galaxy LSS from spectroscopic surveys
- Weak lensing power spectrum

Angular diameter distance
- Strong lensing statistics

Luminosity distance
- Type Ia SNe
What to worry about…

Age of statistical astronomy, large samples are not a problem

Systematics will limit all these experiments: Predictions must include estimates of these

Cluster counting:

Mass thresholds, cluster evolution…

Structure formation:

Bias, selection function….

Strong lens surveys:

Selection effects, halo profiles….
An example from lensing, mass scale...
Some predictions…

SNe will play a key role:

– Discovered dark energy
– Local physics….
– Systematics known
  Evolution
  Dust
  Malmquist bias
  Lensing magnification

Ground or space?
**Comparison of ground and space based optical surveys**

We have completed detailed comparisons of ground based and space based optical surveys from first principles  

Gary Bernstein, 2001, submitted to PASP

- Calculations for PSF photometry
- Includes undersampled and dithered images
- Includes cosmic ray rates
- Includes intra-pixel sensitivity variations (10% gutters)
- Calculated for point source and galaxy photometry
- Determines astrometric errors
- Determines galaxy shape errors

Allows us to answer some commonly arising questions about imaging strategies:

- What amount of dithering is ideal?
- What pixel size optimizes the productivity of a camera?
- Which is more efficient; space-based or ground-based observing?
Supernova survey efficiency for SNAP and LSST:

- LSST is better at \( z < 0.7 \)
- SNAP is much faster for high-\( z \) objects

Brightness and B band wavelength of SNe Ia at peak

Brightness and V band wavelength of SNe Ia at peak

Discovery brightness to prevent Malmquist bias
Weak Lensing Survey Speed: including effects of galaxy size

Galaxies must be resolved for use in weak lensing analyses. HDF studies (Gardner & Satyapal, 2000) show that galaxies become much smaller at faint magnitudes.

Approximately 85% of galaxies with $r<30$ are between $r=27$ and 30....
A few conclusions

Many techniques required to constrain dark energy
All will be systematics limited
Sensitivity estimates should include reasonable systematics guesses
Only SNe have detected dark energy and faced systematics:
They will play a key role in the coming decade