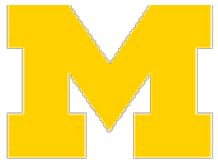
DARK ENERGY
SURVEY



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The Dark Energy Survey and primordial non-Gaussianity

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May 14, 2011

The Dark Energy Survey

- Study Dark Energy using
  4 complementary techniques:
  I. Cluster Counts
  II. Weak Lensing
  III. Baryon Acoustic Oscillations
  IV. Supernovae

- Two multiband surveys:
  Main: 5000 deg^2 ≈ 5 (h^{-1}Gpc)^3
  300 million galaxies
  g, r, i, z, Y to 24th mag
  SNe: 15 deg^2 repeat

- Build new 3 deg^2 FoV camera
  and Data management sytem in Blanco 4-m telescope
  Survey 2012-2017 (525 nights)
  Camera available for community use the rest of the time (70%)

www.darkenergysurvey.org

The DES Collaboration

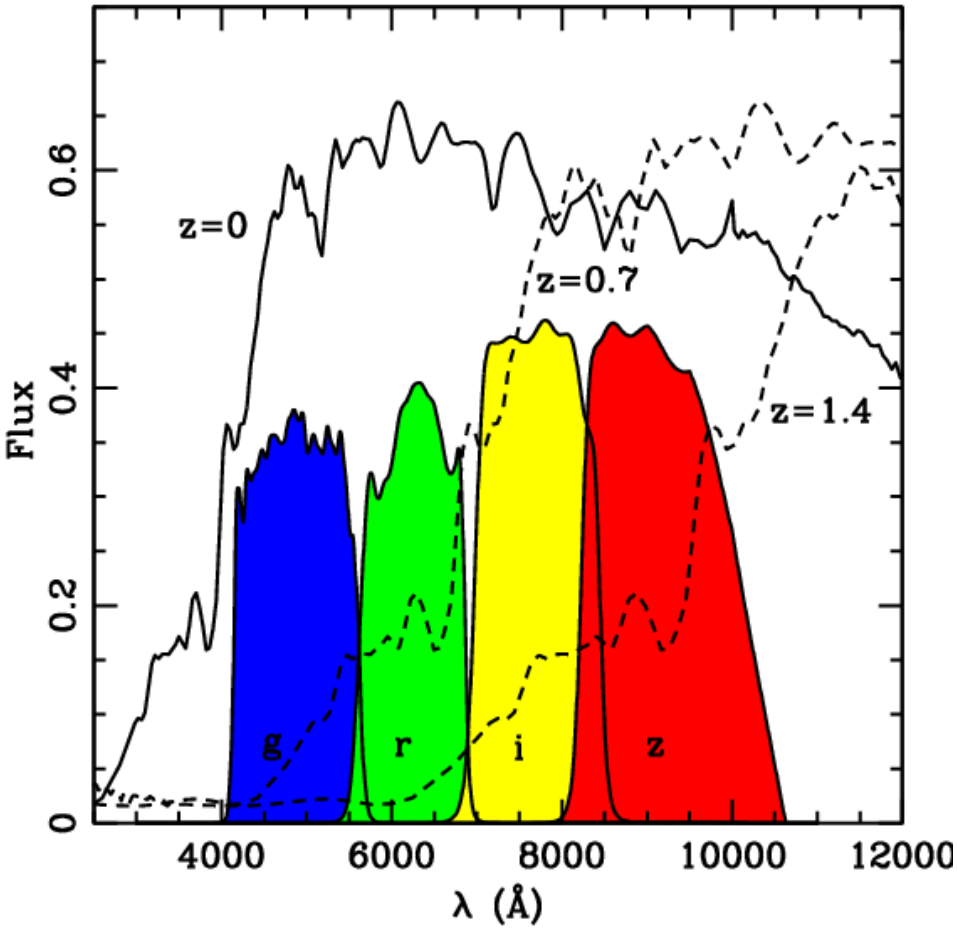
Fermilab
University of Illinois at Urbana-Champaign/NCSA
University of Chicago
Lawrence Berkeley National Lab
NOAO/CTIO
DES Spain Consortium
DES United Kingdom Consortium
University of Michigan
Ohio State University
University of Pennsylvania
DES Brazil Consortium
Argonne National Laboratory
SLAC-Stanford-Santa Cruz Consortium
Universitats-Sternwarte Munchen
Texas A&M University

Over 120 members plus students & postdocs

Funding: DOE, NSF, STFC, MEC, FINEP, Excellence Cluster, collaborating institutions

Photometric surveys for theorists

- Collect light from galaxies in several broad-band filters in optical and near-IR.
- grizY (DES) + JK (Vista)
- Use flux in each filter to determine:
  - type:star/gal./QSO
  - gal. type: spiral, elliptical, …
  - (photometric) redshift
- Also have angular and shape information



Terminology:

magnitude = A – log(flux)
color = magnitude - magnitude

Observational issues for f_{nl} measurement

- Artificial correlations can mimic f_{nl}. For $f_{\rm NL}^{\rm local}$, separations >100 Mpc (several degrees) are crucial.

Because of $1/k^2$ scale dependence of bias

$$b(k) = b_G + f_{NL}\frac{const}{k^2}$$

- Artificial correlations can be due to:
  - photometric calibration
  - photometric redshifts
  - star/galaxy separation

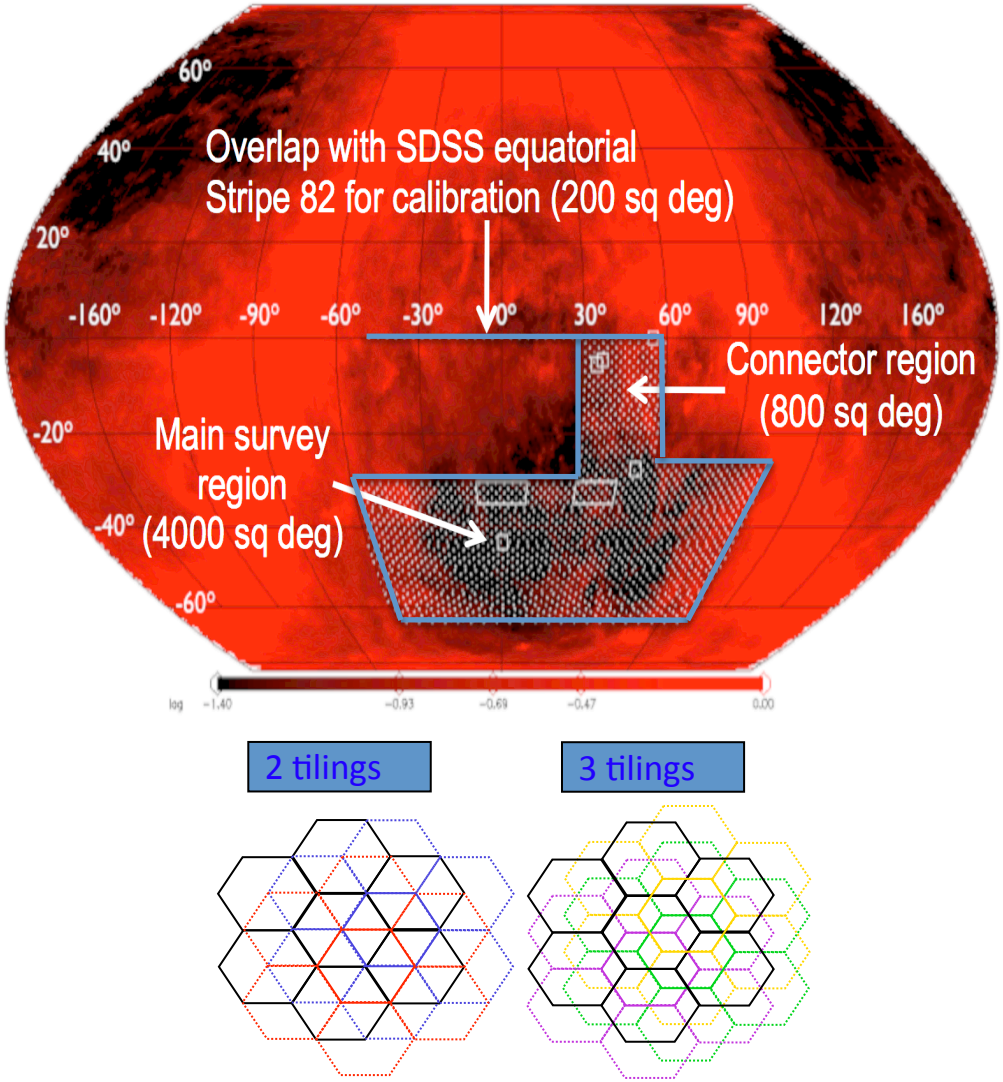
  } More relevant for galaxies than clusters

- Clusters have own selection issues (more later … maybe)

DES Photometric Calibration

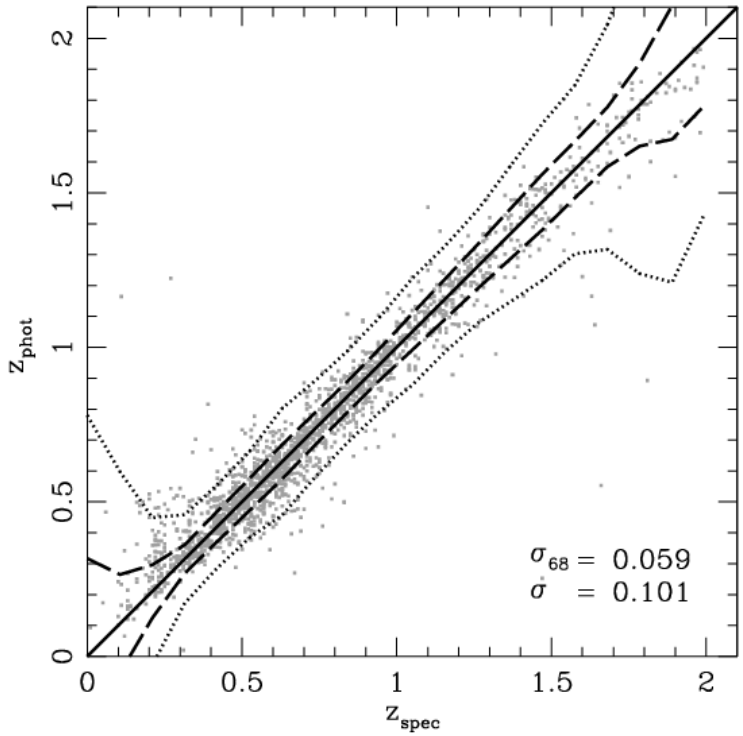
- Deal with: telescope/camera, atmosphere, seasons, Moon, Milky Way.
- Multiple overlapping tilings with varying orientations + standard stars + …
- DES: 2 survey tilings/filter/year
- Need contiguous area that overlaps existing surveys.

DES Goal: 1% photometry over all survey area (BaO requirement is 2%).



DES Photo-zs

- Combination DES (optical)+Vista (IR) yields robust photo-zs.
- LRGs have even better scatter.
- Errors need to be modeled carefully, but f_{NL} requirements weaker than WL.
- For clusters σ_z=0.02.

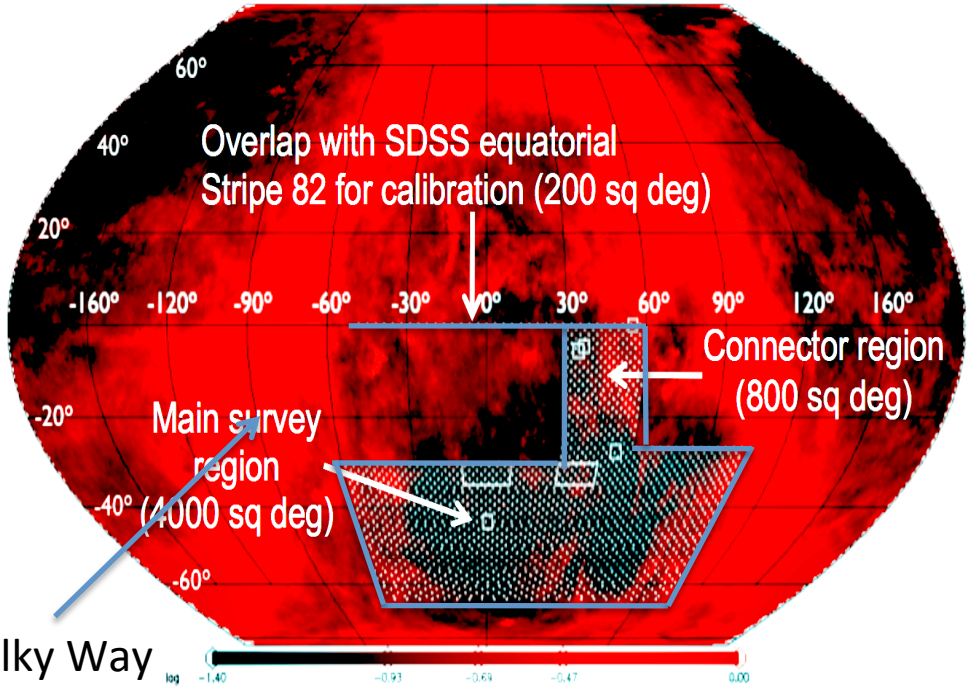


Rough numbers:
Δz=0.1 ➔ Δd_c =1-2×10^{2}h^{-1} Mpc over survey redshift range.

100 Mpc ≈ 3 deg at z=1.

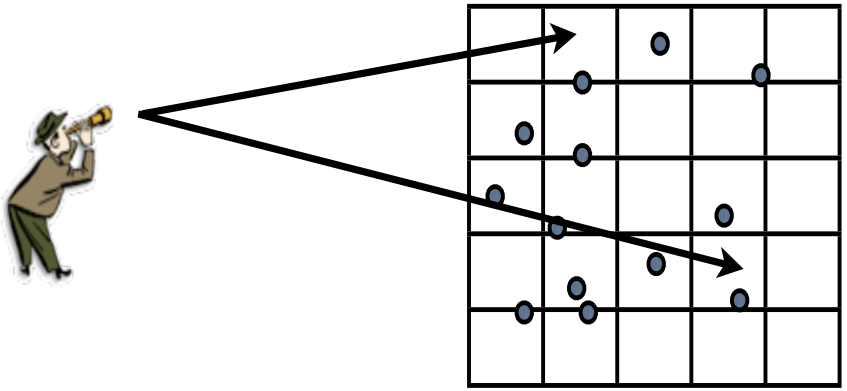
Star/Galaxy separation

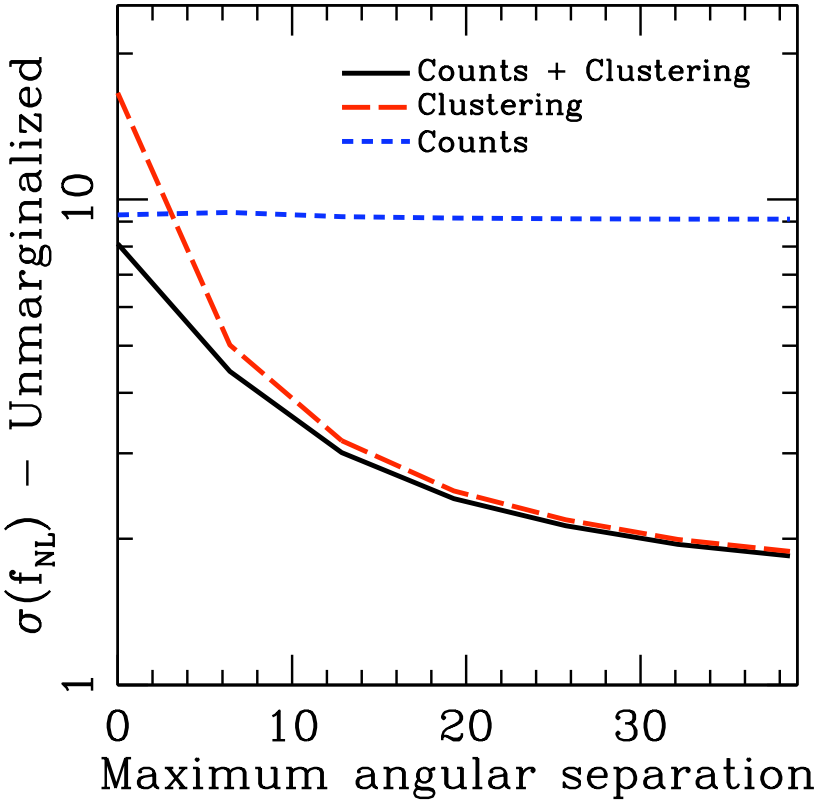
- Distribution of stars is not random. Pronounced variation with latitude.
- Classification using colors (magnitudes)
- BAO requirement:
  - probabilities accurate to 1%
  - stellar contamination and distribution of misclassified galaxies smaller than 9% over all survey (< 2% on scales < 4 degree
- Good enough for f_{NL}?



f_{NL} constraints with DES clusters

Cluster counts-in-cells and sample covariance





About 1.7×10^5 clusters expected
($M_{th} = 10^{13.7}\ h^{-1}\ M_{sun}$)

Cunha, Huterer, Dore 2010

Many cluster systematics under control

The effects of photo-z uncertainties				
Nuisance parameters				
Halo bias	$M_{\rm obs}$	$\sigma(\Omega_{\rm DE})$	$\sigma(w)$	$\sigma(f_{\rm NL})$
Known	Known	0.016	0.041	**6.49**
Marginalized	Known	0.021	0.053	**6.69**
Known	Marginalized	0.106	0.36	**9.39**
Marginalized[a]	Marginalized[a]	0.23[a]	0.77[a]	**18.8**[a]

Mass calibration with:
- Weak Lensing
- SZ clusters (South Pole Telescope)
- IR clusters (Spitzer)
- X-Ray clusters

With reasonable priors can get $\sigma(f_{NL})$ of a few.

Cunha, Huterer, Dore 2010

Clusters vs. Galaxies

- Galaxy catalogs will be much bigger but,
- It's the large halo-halo separations that have the signal.
- Clusters are more directly related to the haloes.
- Clusters can be binned by mass.
- Combination of different tracers potentially very powerful. See N. Hamaus' talk.

Conclusions

- DES should place tight constraints (better than Planck) using several complementary strategies (WL, galaxies, clusters, QSO's).
- Cross-check between techniques will be key to controlling systematics.
- Major focus for calibration of photometric surveys has been on BaO and WL constraints for Dark Energy. Need to check what's happening on larger scales.