The Dark Energy Survey Collaboration

~300 scientists
US support from DOE+NSF

Fermilab, UIUC/NCSA, University of Chicago, LBNL, NOAO, University of Michigan, University of Pennsylvania, Argonne National Lab, Ohio State University, Santa-Cruz/SLAC/Stanford, Texas A&M

UK Consortium:
UCL, Cambridge, Edinburgh, Nottingham, Portsmouth, Sussex

ETH Zurich
Ludwig-Maximilians Universität

Spain Consortium:
CIEMAT, IEEC, IFAE

Brazil Consortium

CTIO
The Dark Energy Survey

- DES uses 4 complementary techniques to measure acceleration of the Universe
  - I. Cluster Counts
  - II. Weak Lensing
  - III. Large-scale Structure (BAO)
  - IV. Supernovae
- Two multiband imaging surveys:
  - 5000 deg$^2$ grizY to 24th mag
  - 30 deg$^2$ repeat griz (SNe)
- Built DECam, a 3 deg$^2$ FOV camera for the Blanco 4m telescope at CTIO
  - Survey 2013-2018 (525 nights)
  - Facility instrument for astronomy community (DES uses 30% time).
The Dark Energy Survey: Galaxy Cluster Counts

X-ray Cosmology in DES
The Dark Energy Survey: Cluster Counts
The Dark Energy Survey: Galaxy Weak Lensing Shear

- Spatially coherent shear pattern, ~1% distortion
- Radial distances depend on *expansion history* of Universe
- Foreground mass distribution depends on *growth* of structure
**DES: Weak Lensing Shear Tomography**

- Cosmic Shear Angular Power Spectrum in Photo-z Slices
- Shapes of ~200 million well-resolved galaxies, \( \langle z \rangle = 0.7 \)
- Challenges: photo-z’s, intrinsic alignments, PSF anisotropy, shear calibration, nonlinear + baryon \( P(k) \) effects
- Extra info in bispectrum & galaxy-shear: robust

**Huterer et al**

![Graph showing statistical errors shown]
DES: Large Scale Structure
The Dark Energy Survey: BAO and Large-Scale Structure

Galaxy angular power spectrum in photo-z bins (relative to model without BAO)

Photometric surveys provide angular measure

Radial modes require spectroscopy (MS-DESI)

Fosalba & Gaztanaga
DES: Type Ia Supernovae Light-curves

Bernstein, et al
DES: Cosmological Goals
Combined Probes

\[ W_\Omega = \frac{dw}{da} \]

- BAO
- Clusters
- WL
- SN
- Combined
DES: Affiliated Surveys
South Pole Telescope Survey(s)

DES survey area encompasses SPT Sunyaev-Zel’’dovich Cluster Survey
DES: Affiliated Surveys
VISTA Hemisphere Survey
DES: Affiliated Surveys
OZDES
• 2003 – 2007 planning
• 2008-2011 construction & testing
• 2011-2012 Installation at CTIO
• Sept. 2012 “1st Light”
• August 2013 – Feb. 2014 “Year 1”
• Sept 2014 “Year 2” begins
• Sept 2015 “Year 3” begins

The Dark Energy Camera on the Blanco Telescope
Dark Energy Survey:
Early Science
DES Early Results: Photometric Redshifts: Sanchez at al. 1406.4407
DES Early Results:
Galaxy Clusters: Preliminary

Red-sequence photo-z’s are unbiased with ~1-2% scatter

Sensitivity: $z=1.26$ X-ray cluster is easy to see in DES-SV data

Miller et al., under DES review
DES Early Results: Cluster Weak Lensing: Melchior et al. 1405.4285

\[ M_{200c} = 10.0^{+3.7}_{-3.4} \cdot 10^{14} M_\odot \]
\[ c_{200c} = 4.3^{+2.5}_{-2.4} \]

3' - 15'
0.75 - 3 Mpc

<table>
<thead>
<tr>
<th>Cluster name</th>
<th>( M_{200c} )</th>
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<tbody>
<tr>
<td>RXC J2248.7-4431</td>
<td>( 17.6^{+4.5}_{-4.0} )</td>
</tr>
<tr>
<td>1E 0657-56</td>
<td>( 14.2^{+10.0}_{-6.1} )</td>
</tr>
<tr>
<td>SCSO J233227-535827</td>
<td>( 10.0^{+3.7}_{-3.4} )</td>
</tr>
<tr>
<td>Abell 3261</td>
<td>( 8.6^{+8.6}_{-3.9} )</td>
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Radioactive decay of 56Ni? Or Magnetar?
DES Early Results:
Synergy with VHS: Banerji et al 1407.3801

![Graphs showing the synergy between DES and VHS](image)
DES Early Results:
Trans Neptunian Objects: Gerdes et al. in prep

TNOs live in the Lagrange points at Neptune
First discovered in 2001. Could be 10x greater in number than Jupiter Trojans
 Might help explain Solar System formation
DES Early Results: Trans Neptunian Objects
DES Early Results:
9 New Milky Way Dwarfs: Bechtol et al.
1503.02584
• DES has just started!
• Science analysis of DES Science Verification data and Y1 data underway
  • first results are coming out NOW
• Raw DES data available after 12 months via NOAO
  • Planned public releases of processed/coadd data/catalogs from 1st 2 seasons and from full survey