DES Supernova Cosmology with Gemini

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UC SANTA CRUZ
THE DARK ENERGY SURVEY
GEMINI OBSERVATORY
DES is a 5-year survey to probe the dark energy using galaxy clusters, weak lensing, large-scale structure, and type Ia supernovae.
SN Ia cosmology

Using SNe Ia as distance indicators

DES is a photometric survey, but the spectroscopic follow-up plays an important role in:

1. Classification
2. Redshift
3. SN properties (e.g., ejecta velocity)

(Betoule+ 2014)
DES SN Ia sample for Gemini

$r \sim 21 - 24$ mag

$z \sim 0.2 - 0.9$
## Program overview

**PI: Foley**

<table>
<thead>
<tr>
<th>Program ID</th>
<th>Time awarded</th>
<th>Ranking</th>
<th>Time used</th>
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<td>GN-2015B-Q-10</td>
<td>21.5 hrs</td>
<td>band 1</td>
<td>100%</td>
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<td>GS-2017B-LP-10</td>
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<td>band 2</td>
<td>64%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>223.0 hrs</strong></td>
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Instrumental setup

GMOS R400 grating + OG515 block filter, central wave=750nm
Spectral coverage ~5000-10000 Ang (in obs. frame)
Scheduling

• Put in 3-4 targets in queue each time.

• Renew the targets in a ~3-day cadence to keep them “fresh”.

• Try to maximize the diversity of the position and luminosity to increase the chance to be scheduled by coordinators.
Data reduction

1. Merge CCD chips and overscan/bias correction
2. Flat-fielding and cosmic-ray removal
3. 1D spectrum extraction
4. Wavelength calibration
5. Flux calibration and telluric correction
Data reduction

1. Merge CCD chips and overscan/bias correction
Data reduction

2. Flat-fielding and cosmic-ray removal

SN trace
Data reduction

3. 1D spectrum extraction
4. Wavelength calibration

apply the solution to the SN spectrum
Data reduction

5. Flux calibration and telluric correction
Results

• Total 106 DES objects were observed by our Gemini program.

• 90 of them were successfully classified as SN Ia (~85% success rate), with the most distant one up to $z \sim 0.9$. 

SN Ia spectra from Gemini
**DES15E2mlf: A spectroscopically confirmed superluminous supernova at z=1.86**

![DECam image](image)

![Gemini spectra](image)

(July 20, 2017)

**Gemini Confirms Super-distant, Superluminous Supernova**

Spectroscopy using the Gemini Multi-Object Spectrograph on the Gemini South telescope in Chile verifies the extreme distance of one of the most distant superluminous supernovae ever studied. The following text is reproduced from the University of California Santa Cruz press release issued on July 21, 2017. The paper is available here.

At a distance of 10 billion light years, a supernova detected by the Dark Energy Survey team is one of the most distant ever discovered and confirmed.

SANTA CRUZ, CA—The death of a massive star in a distant galaxy 10 billion years ago created a rare superluminous supernova that astronomers say is one of the most distant ever discovered. The brilliant explosion, more than three times as bright as the 100 billion stars of our Milky Way galaxy combined, occurred about 3.5 billion years after the big bang at a period known as "cosmic high noon," when the rate of star formation in the universe reached its peak.

Superluminous supernovae are 10 to 100 times brighter than

See more at the Gemini Observatory website.
Thank you!

For more interesting science of our program, please go to Ryan Foley’s talk on Thursday!