OBSERVING SUPERNOVAE WITH MKIDS

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SN Ia COSMOLOGY

Distance Modulus vs Redshift graph showing various data points from different studies:
- Contreras et al. (2010)
- Hicken et al. (2009)
- Kowalski et al. (2008) (SCP)
- Jha et al. (2006)
- Riess et al. (1999)
- Krisiunas et al. (2005)
- Hamuy et al. (1996)
- Miknaitis et al. (2007)
- Astier et al. (2006)
- Knop et al. (2003) (SCP)
- Amanullah et al. (2008) (SCP)
- Barris et al. (2004)
- Perlmutter et al. (1999) (SCP)
- Riess et al. (1998) + HZT
- Holtzman et al. (2009)

Cluster Search (SCP)
Amanullah et al. (2010) (SCP)
Riess et al. (2007)
Tonry et al. (2003)
SN la COSMOLOGY

**Key elements:**

**Typing**
- spectra
- photometry

**Redshift**
- spectra
- photo-z

**Calibration**
- photometry

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Marcelle Soares-Santos  •  Observing SNe with MKIDs  •  MKIDs Workshop @Fermilab  •  Aug 26-27 2013
SN Ia at $z=0.2$ confirmed at AAO
FIRST CONFIRMED DES SN

\[ z = 0.241 \]

**DES12C3a**
(642239)
SPECTROSCOPIC OBSERVATIONS

Spectroscopic observations of the SNe type, redshift (tough because SNe fade in a matter of days)

the host galaxy redshift (next best thing)
FIRST CONFIRMED DES SN

Spectroscopically confirmed by AAT

Input: C3_jan2013_v01_DES_SN_425336.dat
No. 1: sn2005hj (ia-91T; -4) ; z = 0.241\(\pm\)(2.233)0.008

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# CURRENT SURVEYS

<table>
<thead>
<tr>
<th></th>
<th>Dark Energy Survey</th>
<th>Current Major Survey (SNLS: Megacam @ CFHT)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Type Ia SNe</strong></td>
<td>~3500 (Photometric typing)</td>
<td>~500 (spectroscopic typing)</td>
</tr>
<tr>
<td><strong>Redshift range</strong></td>
<td>up to z ~ 1.2 (deep z band)</td>
<td>up to z ~ 1.0</td>
</tr>
<tr>
<td><strong>Fields</strong></td>
<td>10 pointings @ 3 deg² (8 “shallow”, 2 “deep”)</td>
<td>4 pointings @ 1 deg² (all “deep”)</td>
</tr>
<tr>
<td><strong>Cadence</strong></td>
<td>~5 day cadence over 5 months</td>
<td>(similar)</td>
</tr>
<tr>
<td><strong>Spectroscopic Follow-up</strong></td>
<td><strong>Subset of candidates</strong> observed by 4-10m class telescopes</td>
<td><strong>All</strong> SN Ia candidates confirmed at 4-10m class telescopes</td>
</tr>
</tbody>
</table>
PHOTOMETRIC TYPING

SDSS + BOSS

71% complete, 4% cont.

Campbell et al. 2013
ISN’T THIS IDEAL SCIENCE FOR MKIDS-BASED INSTRUMENTS?

- Although the SNe community has learned how to obtain typing from broadband photometric data...
  - SDSS (Cosmology results published in Campbell et al. 2013, arXiv: 1211.4408)
  - DES (Starting in 4 days; results of simulations in Bernstein et al. 2012, arXiv:1111.1969)
  - LSST (Planned for ~2020; white paper by Collaboration in arXiv:1211.0310)

- ... and the field is progressively moving away from increasingly difficult spectroscopic followups...
  - DES plans to followup most SNe hosts for redshift determination and a small fraction of SNe as control sample for photometric typing
  - Followup of most SNe hosts in LSST is very challenging for traditional spectrographs
  - There are currently no plans to build a large FOV multi-thousand fiber spectrograph in the Southern hemisphere
ISN’T THIS IDEAL SCIENCE FOR MKIDS-BASED INSTRUMENTS?

... there seems to be an opportunity here for MKIDs to add to the current CCD-based programs...

- MKID cameras provide typing, redshift and photometry with one shot
- We can take advantage of time resolution and ‘no filters’ feature to achieve superb calibration (signal-to-noise) within reasonable observing times
- We are still a bit far from a wide FOV camera to make an MKID-only SNe survey, but we can envision a program where a small dedicated MKIDs camera does follow up for a large fraction of DES or LSST SNe

... and to do better (lower systematics)

- Even at low resolutions (R~50) typing of SNe observed with MKIDs should be better than purely photometric
- Calibration of MKIDs data could be much better than 1%
- Spectrophotometric info for the host and the SNe are obtained at the same time
- 4-band light curves replaced by light curves for each wavelength
SUMMARY

● MKIDs are (in principle) ideal instrument to provide spectrophotometric information for SNe surveys

● A program entirely based on MKIDs would require large FOV, better energy resolution and a better understanding of the detector than what seems achievable in the time scale of DES
  ● But maybe we can do it for LSST?

● A followup program, in coordination with DES or LSST, seems a more realistic scenario
  ● (A lot) more work is needed to determine how much improvement we actually get
  ● We need to engage the SNe community to make this happen

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