First Light for SNIFS

SuperNova Integral Field Unit Spectrograph

Peter Nugent (LBNL)
Collaboration

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Kavli Institute for Cosmological Physics, Chicago, IL: R. Kessler

Laboratoire de Physique Nucléaire et de Haute Energies de Paris:

Yale: C. Baltay, D. Rabinovitz, J. Snyder
The acceleration is 6 years old...

...well more like 6 Gyr, we’re just slow at figuring it out.

Peter Nugent  
Type Ia Supernovae and Cosmology
Systematics not Statistics
Systematics not Statistics

The Nearby Supernova Factory will obtain and study a uniform high-quality dataset of flux-calibrated optical spectra at 10-15 epochs, starting 5-15 days before maximum light, for each of approximately 300 nearby type Ia supernovae.

When combined with current (SCP, HZSST, SNLS, ESSENCE) and future (JDEM, LSST) datasets of high-redshift SNe Ia, the Nearby SN Factory dataset will substantially improve the statistical measurements of the dark energy equation of state.

*This project will also improve our understanding of the physics of SNe Ia.*
Nearby SN Factory
Redshift Range
Making a Nearby SN Factory

So how do you make a Supernova Factory?

- Buy a telescope for follow-up.
- Become good friends with those who already own one a have wide-field search capabilities.
- Make new friends who know how to build IFU spectrographs.
Nearby SN Factory

Searching is conducted primarily at the Palomar Oschin Schmidt telescope.

Spectrophotometric follow-up will be done on the UH 2.2m.

Anticipate a late August early September start.
Searching
Sky Coverage

Asteroids…

One man’s garbage is another man’s gold!
Discoveries... 80Gb/night

The subtraction isn’t great, but this one is OBVIOUS.

In fact, at mag 16, it may be known already.

1999–03–24 00:01:56.00

Peter Nugent
Type Ia Supernovae and Cosmology
Supernovae

The SNe Ia are located in the smooth Hubble flow and are discovered in the same way as the high-z supernovae.
SNIFS will deliver multi-epoch spectrophotometry

Completely automated from the UH 2.2-m

The best way to constrain systematics.
### SNIFS

**Spectrograph**

<table>
<thead>
<tr>
<th>Channel</th>
<th>Blue</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>3500-5500 Å</td>
<td>5500-10000 Å</td>
</tr>
<tr>
<td>Spectral Resolution</td>
<td>2.3 Å</td>
<td>3.3 Å</td>
</tr>
<tr>
<td>Grism</td>
<td>300 l/mm ($\lambda_B = 4200$ Å)</td>
<td>300 l/mm ($\lambda_B = 6500$ Å)</td>
</tr>
<tr>
<td>Detector</td>
<td>Marconi 2k × 4k</td>
<td>E2V-DD 2k × 4k</td>
</tr>
<tr>
<td>Calibration</td>
<td>He/Hg/Cd + flat</td>
<td>Ne/Ar/Xe + flat</td>
</tr>
</tbody>
</table>

**Integral Field Unit**

| Scale             | 0.4″/lens               |
| Field of View     | 6″ × 6″                 |

**Guider/Focuser Camera (Fixed)**

| Scale             | 0.14″/pixel             |
| Field of View     | 4.7′ × 9.4′             |
| Detector          | E2V 2k × 4k             |
| Filters           | none                    |

**Auxiliary Camera**

| Scale             | 0.14″/pixel             |
| Field of View     | 4.7′ × 9.4′             |
| Detector          | E2V 2k × 4k             |
| Filters           | UBVRI Z + extinction monitor |
Theorist’s view...

Multi-filter or uBVgriz

Guide channel

Pick-off mirror for spectra.
A Night’s Run…discovery

S2004-17 discovery image in the Palomar driftscan data on May 30th.

Finding chart is generated (fits file with coordinates of target in header).

Before  After  Subtraction
A Night’s Run…follow-up

Commands:
“start_night” (~10 min.)
• opens dome, slit, etc.
• moves in mirror
• zero’s telescope
• performs focus run

“do_object s2004-17” (~2 min.)
• slews to target
• takes acquisition image (5s)
• compares with finding chart
• finds target and guide star
• moves telescope
• guides and integrates

Image quality is very nice <0.75”
Spectroscopic Reduction

The collapsed data cube, 15x15 lenslets.
Spectroscopic Reduction

The red-channel spectra from the data cube.

A zoom in on the supernova.
Spectroscopic Reduction

Type Ia SN 2004da -- 30 July 2004

Data cube collapsed into 50nm wavelength bins.
A 1 hr run before twilight...

SNe 2004da, 2004dd, 2004dh

16-17th mag. supernovae. 15 min. integrations
Our First Supernova

The Nearby Supernova Factory: G. Aldering, C. Day, B.C. Lee, S. Loken, P. Nugent, S. Perlmutter, J. Siegrist, R. Scalzo, R. C. Thomas, L. Wang, W. M. Wood-Vasey (Lawrence Berkeley National Laboratory, Berkeley, CA), G. Adam, R. Bacon, C. Bonnaud, L. Capoani, D. Dubet, F. Henault, B. Lantz, J-P. Lemonnier, A. Pecontal, E. Pecontal (Centre de Recherche Astrophysique de Lyon), N. Blanc, G. Boudoul, S. Bongard, A. Castera, Y. Copin, E. Gangler, G. Smadja (Institut de Physique Nucléaire de Lyon), R. Kessler (Kavli Institute for Cosmological Physics, Chicago, IL), P. Antilogus, P. Astier, E. Barrelet, G. Garavini, S. Gilles, L-A. Guevara, D. Imbault, C. Juramy, R. Pain, R. Taillet, D. Vincent (Laboratoire de Physique Nucléaire et de Haute Energies de Paris), C. Baltay, D. Rabinovitz, J. Snyder (Yale), report that a spectrum (range: 540 to 1000 nm) obtained on June 8.0 UT with the SuperNova Integral Field Spectrograph on the UH 2.2-m is that of a type Ia supernova prior to maximum light. Adopting the NASA/IPAC Extragalactic Database recession velocity of 5338 km/s for the host galaxy, the expansion velocity derived from the minimum of the Si II line (635.5 nm) is 13,000 km/s.

2.5 nights later:

Further to IAUC 8338, T. Matheson et al. report that a spectrum (range 340-730 nm) of SN 2004ca, obtained by M. Calkins on June 10.46 UT, shows it to be a type-Ia supernova near maximum spectral-feature age 2 +/- 2 days before maximum light. Adopting the NED recession velocity of 5338 km/s for the host galaxy, the supernova expansion velocity is 12800 km/s for Si II (rest 635.5 nm) and 20400 km/s for Ca II (rest 395.1 nm).