Supernova Science at LCOGT

D. Andrew Howell (*Las Cumbres Observatory Global Telescope Network and University of California, Santa Barbara*)

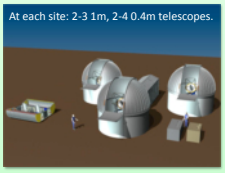
What is LCOGT?

LCOGT is a privately funded global telescope network with headquarters in Santa Barbara, California, loosely affiliated with UCSB. We are building a robotic network of 15 1-meter telescopes and 20 0.4-meter telescopes to supplement our existing 2 meters: Faulkes Telescope North and South.

Our focus is time-domain astronomy, especially supernovae and extrasolar planets (approximately half the science staff study supernovae and the other half study extrasolar planets).

Each site will have 2-3 1m telescopes (primarily for science) and 2-4 0.4m telescopes (primarily for education).

We have >50 employees at LCOGT headquarters in Santa Barbara, including 13 PhD astronomers. Others are based at Liverpool, Cardiff, Hawaii, and Australia.



People

Institutionally, LCOGT is involved in the Pan-STARRS1 and Palomar Transient Factory (PTF) collaborations. In addition, various scientists are involved in their own collaborations. The SN group is:

D. Andrew Howell *Staff Scientist, Adjunct Faculty, UCSB*
Involved in Supernova Legacy Survey, La Silla Supernova Search, the HST UV program, and co-leader of the PTF SN Ia program.

David Sand *CfA/LCOGT Fellow*
Founder of MENEACS cluster SN search. Building FLOYDS low-resolution spectrograph for Faulkes Telescopes for studying supernovae.

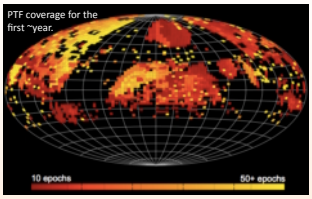
Federica Bianco *Postdoctoral Fellow*
Using SNLS data to search for signs of SN Ia progenitors (see oral session 308.07 today).

Ben Dilday *Postdoctoral Fellow*
Involved in SDSS-II SN search, Magellan cluster SN search.

Melissa Graham *Postdoctoral Fellow*
Involved in MENEACS cluster SN search (see oral session 308.06 today), SNLS.

Jerod Parrent *Graduate Fellow*
Studying Carbon in early SN Ia spectra

Collaborations

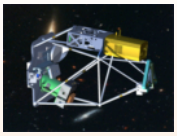


The **Palomar Transient Factory (PTF)** is a sky survey visiting thousands of square degrees on a 1 to 5 day cadence in g or R band, discovering ~800 SNe/yr. It uses the CFHT12k camera on the Palomar 48-inch, giving a 7.8 sq. deg. FOV. 60s exposures reach limiting mags of R=20.5, g=21.

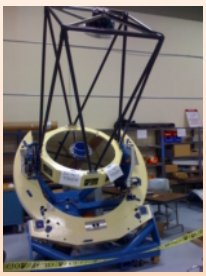
Pan-STARRS1 is a *griz* sky survey using a dedicated 1.8m telescope in Haleakala with a 7 square degree FOV. The Medium Deep survey is finding SNe at 0.1<z<0.7 by repeat imaging of 70 square degrees.

Telescopes and Instruments

The network currently features two 2m robotic telescopes: Faulkes North in Haleakala, Hawaii, and Faulkes South in Siding Spring, Australia. They have optical imaging cameras. A spectrograph is being built.



FLOYDS is the **F**olded **L**ow **O**rder **whY**te-pupil **D**ouble-dispersed **S**pectrograph being built for the 2m telescopes. It is designed for SN studies: low resolution (R~400) and has 350 — 1100 nm coverage in one pointing (cross dispersed).



The first 1m telescope is built and is being commissioned in Santa Barbara with a temporary camera. Several more 1m telescopes are being assembled. The first will go to CTIO.

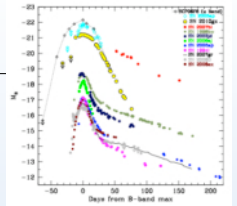
The prototype 1m camera, SINISTRO (above, 26 sq. arcmin., 0.389 "/pix.), is being built in Santa Barbara.

Science

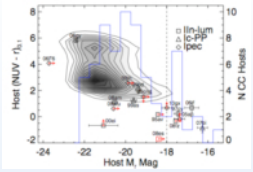
2010 Supernova papers with LCOGT authors (24 total).

First Author	Journal	Collaboration	Title
Howell	Nature Communications	--	A Review of Type Ia Supernovae as Stellar Endpoints and Cosmological Tools
Howell	Nature	--	News & Views: Supernovae: A smashing success
Drout	ApJ, submitted	CCCP	The First Systematic Study of Type Ibc Supernova Multi-color Light-curves
Cooke	ApJL	HSTUV/PTF	HST Studies of Nearby Type Ia Supernovae: The Mean Maximum Light UV Spectrum and its Dispersion
Sand	ApJ, submitted	MENEACS	Intracluster supernovae in the Multi-epoch Nearby Cluster Survey
Pastorello	ApJL	PS1	Ultra-bright Optical Transients are Linked with Type Ic Supernovae
Neill	ApJ	PTF	The Extreme Hosts of Extreme Supernovae
Ofek	ApJ	PTF	Supernova PTF 09UJ: A Possible Shock Breakout from a Dense Circumstellar Wind
Smith	MNRAS	PTF	Galaxy Zoo Supernovae
Kasliwal	ApJL	PTF	Rapidly Decaying Supernova 2010X: A Candidate ".Ia" Explosion
Arcavi	ApJ	PTF	Core-collapse Supernovae PTF: Indications for a Different Population in Dwarf Galaxies
Amanullah	ApJ	SCP	Spectra and HST Light Curves of Six Type Ia Supernovae at 0.511 < z < 1.12 and the Union2 Compilation
Morokuma	PASJ	SCP	Subaru FOCAS Spectroscopic Observations of High-Redshift Supernovae
Hayden	ApJ	SDSS-II	Single or Double Degenerate Progenitors? Searching for Shock Emission in the SDSS-II SNe Ia
Conley	ApJS	SNLS	Supernova Constraints and Systematic Uncertainties from the First Three Years of the SNLS
Walker	ApJ	SNLS	Supernova Legacy Survey: using spectral signatures to improve Type Ia supernovae as distance indicators
Gonzalez-Gaitan	ApJ, submitted	SNLS	Subluminous Type Ia Supernovae at High Redshift from the Supernova Legacy Survey
Guy	A&A	SNLS	The SNLS 3-year sample: Type Ia supernovae photometric distances and cosmological constraints
Sullivan	MNRAS	SNLS	The dependence of Type Ia Supernovae luminosities on their host galaxies
Perrett	AJ	SNLS	Real-time Analysis and Selection Biases in the Supernova Legacy Survey
Jönsson	MNRAS	SNLS	Constraining dark matter halo properties using lensed Supernova Legacy Survey supernovae
Palanque-Delabrouille	A&A	SNLS	Photometric redshifts for type Ia supernovae in the supernova legacy survey
Kronborg	A&A	SNLS	Gravitational lensing in the supernova legacy survey (SNLS)
Graham	AJ	SNLS	The Type Ia Supernova Rate in Radio and Infrared Galaxies from the CFHT SNLS

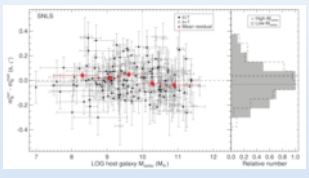
Highlights



Pastorello et al. 2010 [PS1] Yellow points show SN 2010gx, an extremely luminous CC SN discovered by PS1 and followed by FTN. The SNe seem to be connected to SNe Ic, but the explosion mechanism is unknown.



Neill et al. 2010 Extreme core-collapse SNe (those with peak M_V<-21; points), prefer dim, low mass host galaxies. Contours are GALEX galaxies, histogram and right axis is the core-collapse distribution from **Arcavi et al. 2010 [PTF].**



Sullivan et al. 2010 [SNLS] SN Ia residuals from the Hubble diagram *(after correcting for SN lightcurve shape and color)* are 0.08 ± 0.02 mag different in galaxies higher or lower than $M_*=10^{10}$ $M_\odot$.

Hayden et al. 2010 [SDSS-II] and **Bianco et al. 308.07 [SNLS],** (today, 10 am) find that Red Giants make up <10% of SN Ia progenitor secondaries. This is because a red giant (blue in the simulation from Kasen 2010, right), should shock the SN ejecta, producing distortions in early B-band lightcurves when observed from certain angles. This is not seen in survey data.