SALT Follow-up of Supernova Discoveries
2012-2-HET_OTH-001
progress report
2013-05-13

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Abstract from proposal:

We propose target-of-opportunity observations of supernovae to obtain low dispersion spectra at appropriate time intervals, especially at early epochs. While any supernova may be of interest, we will concentrate on Type Ia and Type Ib/c at early epochs when circumstellar matter may be revealed and on the new category of superluminous supernovae recently discovered at Texas.

Report:

We were awarded a total of 25 ksec observing time distributed equally between dark and grey Moon phases, which was 5 ksec more than the total time we received for our previous proposal (2012-1-HET_OTH-001). Because the observability of our targets (supernovae) may extend longer than a single semester in the SALT observing system, we were able to successfully combine our proposals and follow up the most interesting objects for longer time. The list of the observed targets is as follows.

Date	Object	Proposal	Remark
2012-05-22	SN 2012au	2012-1-HET_OTH-001	
2012-07-09	SN 2012db	2012-1-HET_OTH-001	
2012-07-10	SN 2012dn	2012-1-HET_OTH-001	
2012-07-24	SN 2012dn	2012-1-HET_OTH-001	
2012-08-26	SN 2009ip	2012-1-HET_OTH-001	
2012-09-03	SN 2012el	2012-1-HET_OTH-001	
2012-09-26	SN 2009ip	2012-1-HET_OTH-001	
2012-10-11	SN 2009ip	2012-1-HET_OTH-001	
2012-10-12	SN 2009ip	2012-1-HET_OTH-001	
2012-11-08	SN 2012fr	2012-2-HET_OTH-001	
2012-11-10	SN 2009ip	2012-2-HET_OTH-001	
2012-11-13	LSQ12gdj	2012-2-HET_OTH-001	
2012-11-25	PSN 1056	2012-2-HET_OTH-001	incomplete calibration (unusable arc data)
2013-03-19	SN 2013aa	2012-2-HET_OTH-001	
2013-04-05	SN 2013ao	2012-2-HET_OTH-001	
2013-04-21	PTF13abc	2012-2-HET_OTH-001	incomplete calibration (no flat fields)

Our standard observing setup consists of the Robert Stobie Spectrograph (RSS) in longslit mode, applying the 1.25" width longslit "PL0125N001" and the 300 lines/mm grating "pg0300" centered on 5750 A. The 2D spectral images are binned by 4 in the direction perpendicular to the dispersion axis to enhance signal-to-noise and reduce frame sizes. For acquisition images we apply SALTICAM with short exposures (~ a few seconds) through a single V or R filter. The spectroscopic setup above allows us to get low-resolution spectra on a faint (~20 mag) supernova target with decent S/N within one hour

of exposure time. We spent considerable time to find the optimal camera station and grating angle in order to move the gaps between the CCD chips (where we have no data) to those spectral regions that do not contain crucial features in a supernova spectrum. The final setup is an acceptable compromise between science needs and instrumental capabilities.

Below we summarize the present status of the analysis of the objects that turned out to be the most important.

SN 2009ip

This object started its outburst in 2012 as a supernova impostor (a giant Luminous Blue Variable star) but later transformed itself into a controversial, supernova-like explosion. Our first SALT spectrum, which was among the earliest ones showing this transformation, exhibited broad P Cygni-like features of hydrogen, characteristics of Type II SNe. We devoted considerable amount of our SALT time to follow up this extraordinary object. Fig. 1 summarizes our SALT spectra collected so far. We contributed these data to a larger collaboration led by Raffaella Margutti at CfA. The collaboration has about 60 spectra from the UV to NIR, supplemented by 1-day cadence light curves in UV-optical-NIR

Fig.1: SALT spectra on SN 2009ip. The spectra have been shifted vertically for better visibility. Note that the last spectrum was obtained two days ago.

bands. There are also gamma-ray, X-ray and radio observations available. This remarkable dataset is the basis of a complex, panchromatic study, which is nearly finished (draft of the first version was circulated among the co-authors a week ago).
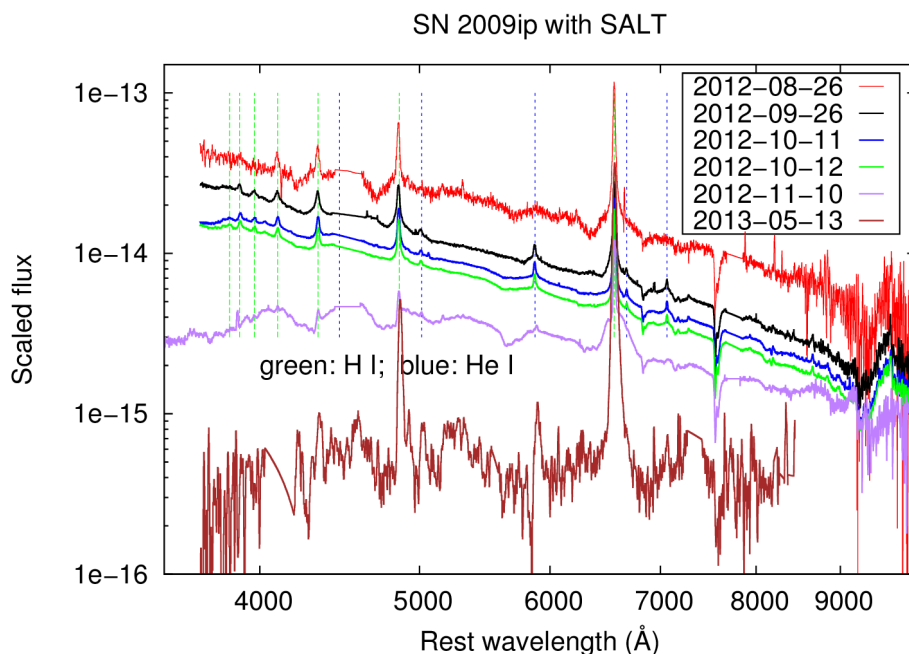
SN 2012fr
This interesting Type Ia SN was discovered at a very early phase. Our SALT spectrum was one of the earliest spectra obtained on this SN. This target was then followed up extensively with Magellan, and we plan to contribute our single spectrum to that study.

SN 2012au
This was our first target which was obtained after a request from our collaborator, Dan Milisavljevic at CfA. This target proved to be an interesting colliding CSM SN IIn, but recently Milisavljevic et al. rushed an ApJ Letter into print, so it is not quite clear what will happen to that data. It is likely that we will add our SALT data to a more extensive follow-up paper by Milisavljevic et al.

SN 2012dn
This Type Ia supernova is a candidate "Super-Chandrasekhar" object, which are thought to originate

from merging of two white dwarf stars. Our SALT data were made by request from our collaborators at LCOGT. These data are used in a study led by Jerrod Parrent, and the spectroscopic analysis is ongoing.

SN 2013ao
SN 2013ao turned out to be a young Type Ia. This event is also being followed intensively with optical and NIR observations at Magellan. We will join a collaborative paper on the latter object.
The spectra bear some resemblance to "Super-Chandrasekhar" SN Ia, but the redshift indicates it is of normal luminosity. There is a good paper to be written sorting this out, probably led by Eric Hsaio at Carnegie Observatories.