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The THU-NAOC transient survey: the performance and results from the first year*

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Abstract The Tsinghua University-National Astronomical Observatories, Chinese Academy of Sciences (NAOC) Transient Survey is an automatic survey that conducts a systematic exploration of optical transients. This project utilizes a 60/90 cm Schmidt telescope at the Xinglong Station of NAOC. This survey repeatedly covers $\sim$ 1000 square degrees of the northern sky with a cadence of 3–4 d. With an exposure of 60 s, the survey reaches a limiting unfiltered magnitude of about 19.5 mag, which enables us to discover supernovae in their relatively young stages. We describe the overall performance of our survey during the first year and present some preliminary results.

Key words: supernovae — quasars and active galactic nuclei — stars

1 INTRODUCTION

Time-domain astronomy has been recognized as one of the most active and promising research fields in astrophysics and has grown rapidly over the past few years. It investigates different types of known and unknown transients (or outburst phenomena) in the universe, such as variables, supernovae (SNe), gamma-ray bursts, quasars, active galactic nuclei (AGNs), tidal disruption events (TDEs), etc. Wide-field surveys of transients in the universe open new frontiers in astrophysics.

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Owing to diverse scientific objectives, many consortiums have thus put efforts into conducting such surveys by using small- to medium-sized wide-field telescopes, including the Palomar Transient Factory (PTF; Law et al. 2009), the La Silla-QUEST Southern Hemisphere Variability Survey (LSQ; Baltay et al. 2013), the Panoramic Survey Telescope and Rapid Response System (PanSTARRS; Kaiser et al. 2002), the SkyMapper Southern Sky Survey (Keller et al. 2007), and the Catalina Real-Time Transient Survey (CRTS, Drake et al. 2009). The next generation of large telescopes such as the Large Synoptic Survey Telescope (LSST; Tyson et al. 2003) will also focus on time-domain astronomy in the near future.

The Tsinghua University-National Astronomical Observatories, Chinese Academy of Sciences (NAOC) Transient Survey (TNTS) is an optical survey, which operates with a relatively short cadence (e.g., 3–4 d) compared to other existing wide-field transient surveys, aiming primarily at detections of relatively young SNe in the local universe. The early detection enables us to better understand the progenitor system and the explosion physics of SNe. The spectroscopic identifications of our discoveries are obtained primarily with the Yunan Observatories (YNAO) 2.4-m telescope at Lijiang Station and the NAOC 2.16-m telescope at Xinglong Station. Follow-up photometric observations are obtained with the Tsinghua University-NAOC 0.8-m telescope (TNT[1]) at Xinglong Station.

In this paper, we present the performance and the first year results of our survey. The observations and data reduction are described in Section 2, and Section 3 presents the results. Our summaries are given in Section 4.

2 DESCRIPTION OF THE PROJECT

2.1 Instruments

The TNTS is conducted using a telescope that is different from the one used for follow-up observations. The survey utilizes a Schmidt telescope (with a 90-cm spherical primary mirror and a 60-cm Schmidt corrector plate), located at Xinglong Station of NAOC. One 4096×4096 CCD camera with a plate scale of 1.3 arcsecond per pixel is mounted at the Schmidt focus of the telescope. The field of view (FoV) of the CCD is $90' \times 90'$. A detailed description of this telescope was given by Zhou et al. (2003). Under conditions of a Moonless and clear night at Xinglong Station, this telescope and the CCD system can reach a detection limit of about 19.5 mag (3σ) with the clear filter for an exposure of 60 s. This magnitude limit can detect a normal SN Ia at $z \sim 0.04$ about two weeks before its maximum light in the B band.

2.2 Survey Strategy

The TNTS is designed to operate for four years starting from October 2012. This survey covers a sky area of ~ 1000 square degrees with Galactic latitude $|b| > 10°$ and longitude in the range $0° < \delta < 60°$. Nearby galaxy clusters such as the Coma cluster and most of the Virgo cluster are also included in our survey field, with the intent of catching events of some extremely young SNe. It usually takes about 2 min to acquire an image for a specific sky field, including a 60 s exposure, 22 s readout time and 30 s for movement and stabilization of the telescope. In order to efficiently rule out cosmic rays and moving objects, we record two exposures of each sky field with a temporal interval of about 1.0–1.5 h. The transients with very short timescales in their light variations will also benefit from such an observation mode. This means that the whole survey area can be repeatedly visited every 3 to 4 d.

Figure 1 shows the sky areas covered by the TNTS, and the red dots are the SN candidates discovered during the first year of the survey.

[1] This telescope is co-operated by Tsinghua University and NAOC.

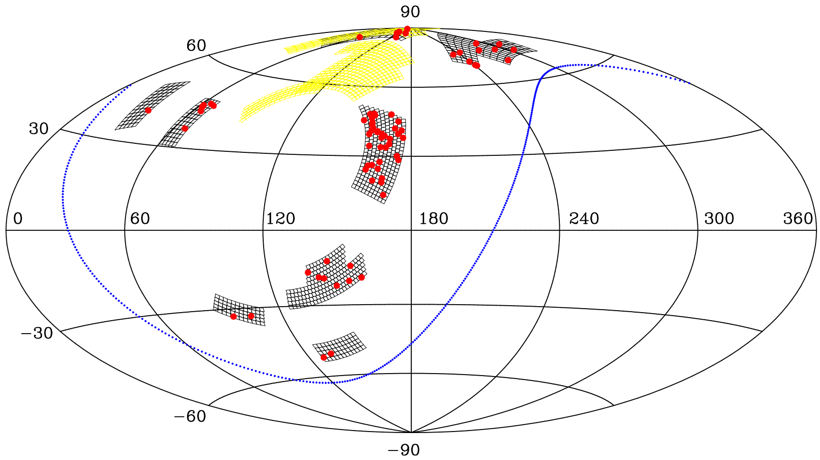

Fig. 1 The sky area covered by the TNTS in the Galactic coordinate system. Each small square represents the FoV that the TNTS can cover with one exposure. The yellow regions are the fields that will be covered in the next stage. The red dots represent the SN candidates discovered by the TNTS. The blue line is the celestial equator.

2.3 Data-Reduction Pipeline

An image processing pipeline has been developed for the TNTS based on some open source softwares. The software *SExtractor* is used to find objects and produce the catalogs for each image (Bertin & Arnouts 1996). With these catalogs, the astrometric parameters are obtained by *SCAMP* (Bertin 2006). The software *SWarp* is used to resample and align the new images to the reference images (Bertin et al. 2002). After performing the above steps, we apply the image-subtraction technique to detect possible candidates on the residual images. The residual image is obtained by subtracting the reference image from the new image with the High Order Transform of Point Spread Function (PSF) and Template Subtraction (*HOTPANTS*[2]). This code is effective in detecting SNe exploding near the central regions of their host galaxies. All these codes and softwares are executed with $bash$ scripts used in Linux. Hundreds of sources can be detected on each residual image due to the large field of view of the TNTS, but most can be attributed to artifacts of image subtraction. A series of criteria, such as ellipticity, FWHM and contamination from bright stars, is applied to rule out false detections. The remaining candidates will be examined carefully by eye. The most probable candidates will be posted on ATels or CBAT to instantly alert the community and initiate follow-up observations.

2.4 Follow-Up Observations

For SNe or other interesting transients discovered by TNTS that are brighter than 18.0 mag and on the rise, we will generally initiate follow-up observations in photometric and spectroscopic modes. In particular, extensive follow-up observations will be obtained for those SNe discovered at relatively young phases. The photometric observations are performed with the 0.8-m TNT located at Xinglong Station (Wang et al. 2008; Huang et al. 2012) in the standard Johnson UBV (Johnson et al. 1966) and Kron-Cousins RI (Cousins 1981) filters, with a 1340 $\times$ 1300 pixel back-illuminated CCD and an FoV of $11.5' \times 11.2'$ (pixel size $\sim 0.52''$ pixel^{-1}). Spectroscopic observations are taken by the

[2] See *http://www.astro.washington.edu/users/becker/hotpants.html* for details

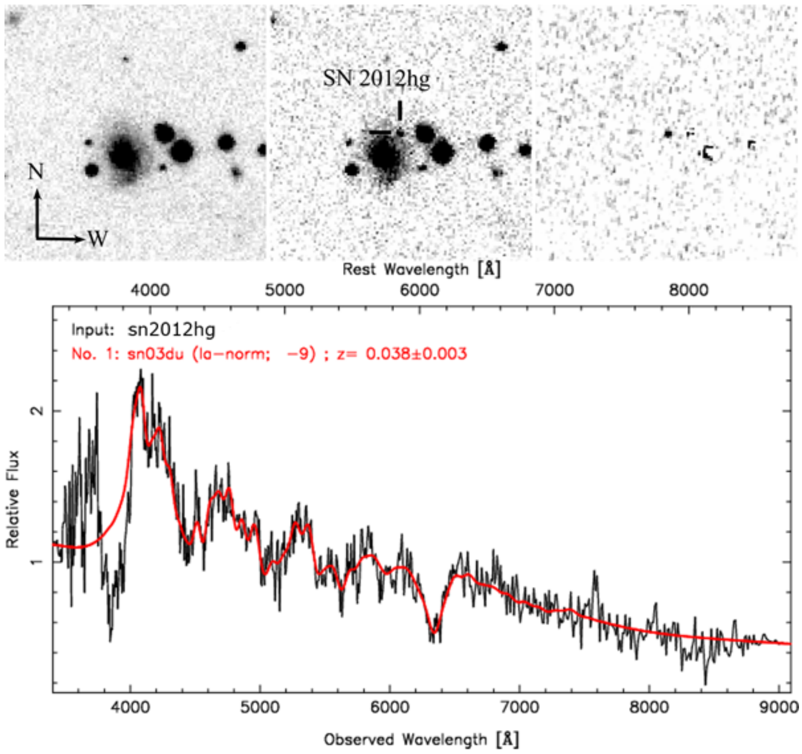

Fig. 2 The discovery images and spectroscopic identifications of SN 2012hg. *Upper-left*: the template without the SN; *Upper-middle*: the discovery image with the SN; *Upper-right*: the subtracted image with only the SN. *Lower panel*: the spectrum of SN 2012hg taken by the 2.4-m telescope. The red line is the best-fit spectrum from SN 2003du at –9 days from the library of SNID (Blondin & Tonry 2007).

Cassegrain spectrograph and BAO Faint Object Spectrograph & Camera (BFOSC) mounted on the 2.16-m telescope and the Yunnan Astronomical Observatory (YNAO) Faint Object Spectrograph & Camera (YFOSC) mounted on the 2.4-m telescope at Lijiang Station of YNAO (Zhang et al. 2012a). Our goal is to obtain a uniform SN sample with well-sampled $UBVRI$ light curves and spectroscopic data covering premaximum-, maximum- and post-maximum phases.

3 THE FIRST-YEAR RESULTS

A total of about 30 000 images were obtained during the first-year survey, which yielded over 50 SN candidates and many other transients such as variable stars, novae, and quasars/AGNs. 44 SNe finally received spectroscopic identifications from the observations by us and other groups, and the discovery and classifications were published on the CBETs and ATels (see also Table 1).

Figure 2 shows the first SN detected by the TNTS, SN 2012hg. It was discovered on Nov. 25.8 UT at a magnitude of about 18.0 mag. The light curve shows that this SN was actually discovered about 16 d before its maximum light (see also Fig. 5). In Figure 3, we show the spectrum of a type IIn SN, SN 2013dw, which is the most distant SN discovered by the TNTS with a redshift of 0.136 (Zhou et al. 2013i). The relevant parameters of the SNe discovered during our first-year survey are listed in Table 1.

Table 1 Information of Confirmed SNe Discovered by the TNTS

Designation	Type	R.A.	Dec	Redshift	Discovery Mag	Discovery Date (UT)	Reference
SN 2012hg	Ia	07:07:25.60	+56:18:19.2	0.038	18.0	Nov. 25.8 2012	CBET 3330 (Zhao et al. 2012)
SN 2012hm	Ia	02:33:23.32	+39:40:16.9	0.036	17.8	Dec. 07.6 2012	CBET 3336 (Zhang et al. 2012b)
SN 2012hq	Ia	02:07:30.50	+44:06:19.3	0.090	18.6	Dec. 07.7 2012	CBET 3344 (Wang et al. 2012)
SN 2012hw	IIP	09:41:38.02	+48:40:25.5	0.038	17.9	Dec. 22.9 2012	CBET 3353 (Howerton et al. 2012)
SN 2012ic	Ia	03:13:53.71	+33:58:03.7	0.040	17.4	Dec. 22.7 2012	CBET 3360 (Zhou et al. 2012)
SN 2012ie	Ia	02:24:22.35	+40:51:03.2	0.048	18.0	Dec. 23.5 2012	CBET 3362 (Tomasella et al. 2012a)
SN 2012ih	Ia	06:56:42.91	+48:54:10.3	0.019	16.4	Dec. 10.8 2012	CBET 3366 (Tomasella et al. 2012b)
SN 2012ii	Ia	07:16:55.48	+51:45:47.6	0.060	19.0	Dec. 23.8 2012	CBET 3369 (Zhou et al. 2013a)
SN 2012ij	Ia	11:40:15.84	+17:27:22.2	0.010	18.0	Dec. 31.8 2012	CBET 3370 (Marion et al. 2013)
SN 2012ik	Ia	07:35:26.91	+51:52:50.4	0.064	19.4	Dec. 23.8 2012	CBET 3383 (Luppi et al. 2013)
SN 2013N	Ia	11:50:04.13	+21:16:46.0	0.026	15.9	Jan. 26.8 2013	CBET 3394 (Zhou et al. 2013b)
SN 2013O	Ia	08:52:05.98	+52:36:06.2	0.053	18.3	Jan. 21.7 2013	CBET 3395 (Zhang et al. 2013f)
SN 2013S	Ia	03:35:30.29	+38:16:59.3	0.019	16.1	Jan. 25.6 2013	CBET 3406 (Zhou et al. 2013c)
SN 2013Z	IIP	13:27:54.89	+30:22:29.4	0.050	19.0	Jan. 24.9 2013	CBET 3415 (Inserra et al. 2013)
SN 2013ac	IIP	09:45:08.79	+58:40:07.3	0.035	18.2	Feb. 15.7 2013	CBET 3424 (Zhang et al. 2013g)
SN 2013af	IIP	09:13:55.17	+55:46:56.7	0.036	18.9	Mar. 01.5 2013	CBET 3427 (Zhou et al. 2013d)
SN 2013ah	Ia	09:44:33.80	+55:45:44.4	0.025	18.6	Feb. 22.6 2013	CBET 3430 (Elenin & Molotov 2013)
SN 2013ap	Ia	12:58:24.92	+12:35:53.3	0.086	19.5	Feb. 18.9 2013	CBET 3443 (Zhou et al. 2013e)
SN 2013ar	Ia	08:37:45.02	+49:28:32.2	0.052	18.9	Mar. 14.5 2013	CBET 3446 (Zhang et al. 2013h)
SN 2013ax	Ia	07:20:03.51	+55:55:48.4	0.040	17.4	Mar. 07.6 2013	CBET 3455 (Zhou et al. 2013f)
SN 2013be	Ia	12:36:27.67	+11:45:28.1	0.066	19.6	Apr. 05.7 2013	CBET 3470 (Silverman et al. 2013)
SN 2013bf	Ia	08:58:36.07	+54:19:25.7	0.084	18.8	Mar. 28.5 2013	CBET 3471 (Koff et al. 2013)
SN 2013bv	Ic	08:41:21.28	+52:43:30.3	0.060	18.7	Apr. 09.5 2013	CBET 3499 (Zhang et al. 2013a)
SN 2013bx	Ia	12:47:24.22	+32:32:50.0	0.078	19.8	Apr. 09.7 2013	CBET 3501 (Zhou et al. 2013g)
SN 2013ca	IIP	11:58:43.25	+19:08:56.2	0.043	18.1	May 01.5 2013	CBET 3508 (Zhang et al. 2013b)
SN 2013cb	Ia	11:35:01.74	+16:07:16.8	0.051	18.1	May 01.5 2013	CBET 3509 (Zhang et al. 2013i)
SN 2013co	Ic	12:55:50.51	+30:30:41.5	0.050	17.7	May 06.5 2013	CBET 3527 (Zhang et al. 2013e)
SN 2013cp	Ia	16:19:52.22	+38:56:07.9	0.075	18.5	May 07.6 2013	CBET 3528 (Zhang et al. 2013c)
SN 2013cr	Ia	16:11:46.47	+40:51:22.2	0.027	17.5	May 14.8 2013	CBET 3532 (Zhang et al. 2013j)
SN 2013cv	Ia	16:22:43.16	+18:57:35.6	0.035	16.5	May 20.8 2013	CBET 3543 (Zhou et al. 2013h)
SN 2013cx	Ia	17:04:16.05	+41:30:37.6	0.033	17.7	May 21.7 2013	CBET 3545 (Wang et al. 2013)
SN 2013dw	IIn	16:13:58.84	+42:41:59.0	0.136	18.8	Jul. 02.6 2013	CBET 3585 (Zhou et al. 2013i)
SN 2013ec	Ia	16:27:50.26	+40:28:21.3	0.081	19.0	Jul. 02.6 2013	CBET 3595 (Zhang & Wang 2013a)
SN 2013eh	Ia	16:16:09.19	+38:32:53.0	0.038	16.6	Jul. 19.5 2013	CBET 3601 (Zhang et al. 2013d)
SN 2013fo	Ia	01:20:31.94	+12:03:12.2	0.054	17.7	Sep. 24.6 2013	CBET 3663 (Denisenko et al. 2013)
SN 2013gf	Ia	09:05:26.46	+56:24:12.4	0.100	18.3	Nov. 06.9 2013	CBET 3702 (Zhang et al. 2013k)
SN 2013gm	IIP	11:34:21.16	+15:39:33.1	0.017	17.5	Nov. 20.9 2013	CBET 3726 (Zhang & Wang 2013b)
SN 2013gs	Ia	09;31:08.87	+46:23:05.4	0.017	17.3	Nov. 29.8 2013	CBET 3734 (Zhang et al. 2013l)
SN 2013hp	Ia	23:13:59.72	+24:53:38.9	0.028	18.0	Dec. 12.4 2013	CBET 3764 (Li et al. 2013)
PSN J12541585	Ia	12:54:15.85	+09:26:25.9	0.045	17.4	Feb. 18.3 2013	ATEL 4808 (Cao et al. 2013)
PSN J12393328	Ic	12:39:33.28	+15:25:52.0	0.072	19.4	Feb. 22.8 2013	ATEL 4851 (Walton et al. 2013)
PSN J12533306	Ia	12:53:33.06	+27:42:51.7	0.092	19.2	Mar. 03.8 2013	ATEL 4860 (Nicholl et al. 2013)
PSN J09040805	II	09:04:08.05	+47:42:28.0	0.047	18.8	Nov. 17.8 2013	ATEL 5623 (Arcavi et al. 2013)
PSN J12452873	II	12:45:28.73	+29:51:04.0	0.050	18.6	Dec. 22.8 2013	ATEL 5700 (Challis 2013)

Figure 4 presents some statistical properties of the SN sample acquired during the first year by the TNTS, including the discovery magnitudes, redshift of the SNe, discovery phase and the spectral types. Figure 4(a) shows a histogram distribution of the discovery magnitudes for our SN sample. The mean discovery magnitude is ~ 18.2 mag, which is brighter than the detection limit of TNTS by about 1.0 mag. Figure 4(b) shows the redshift distribution of the first-year TNTS SN sample, which has a mean value of 0.05. In this sample, 31 are type Ia SNe, 10 are type II, 3 are type Ibc and 6 are probable SNe without spectral classification (see Fig. 4(d)). The observed fractions of SNe with different spectral types are consistent with those obtained from other magnitude-limited samples

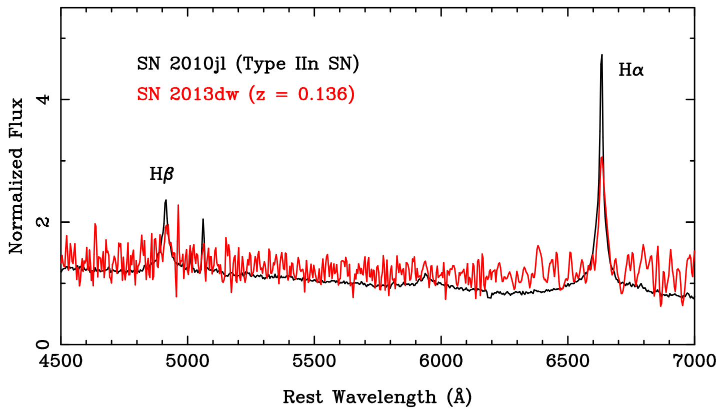

Fig. 3 The spectrum of a bright type IIn SN, SN 2013dw, taken with the 2.16-m telescope. The redshift of the host galaxy has been corrected. The black line is the spectrum of SN 2010jl about one month after maximum for comparison (Zhang et al. 2012c).

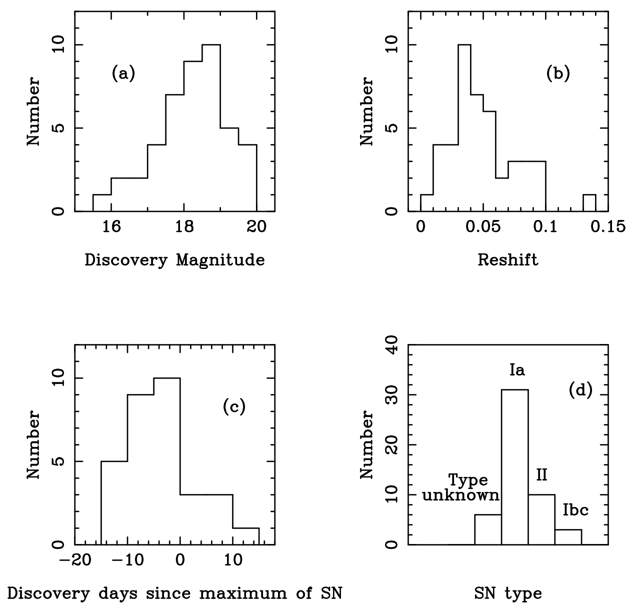

Fig. 4 The statistical properties of TNTS SNe. (a) histogram of the SN magnitude at discovery; (b) the redshift distribution of the TNTS SN sample; (c) histogram of SN Ia age at discovery; (d) histogram of SN type.

(e.g., Li et al. 2011). In the Li et al. sample, 17% are SNe II, 79% are SNe Ia and 4% are SNe Ibc. A higher fraction of SNe Ia is expected in a magnitude-limited survey, as they are on average much brighter than SNe II and SNe Ibc. For SNe Ia, we notice that about 80% were detected before or around their maximum light, as shown in Figure 4(c). The ages of these SNe Ia at discovery were estimated from the unfiltered light curves.

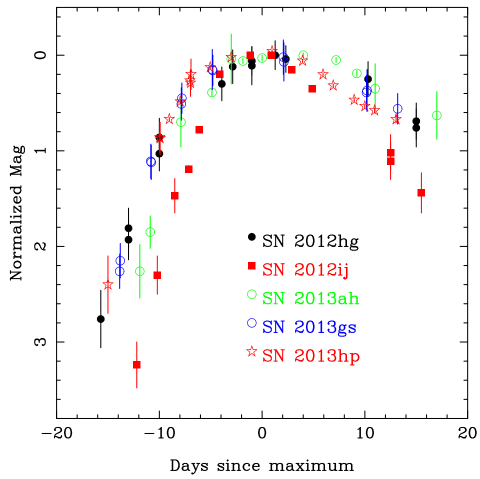

Fig. 5 The R-band (unfiltered) light curves of some young type Ia SNe discovered by the TNTS. All the light curves are normalized to the peak magnitudes and dates for a better comparison.

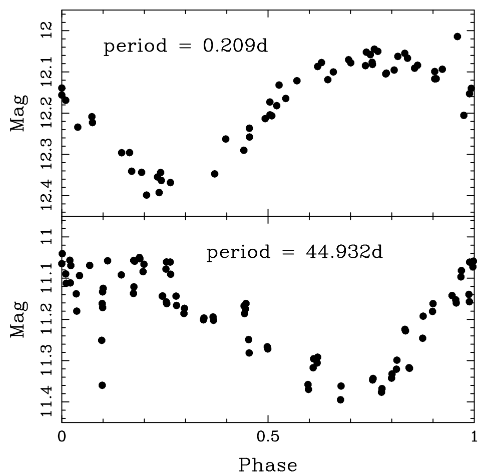

Fig. 6 Example of two periodic variable stars newly discovered during the survey. Top panel: the unfiltered folded light curve that has a period of 0.209 d; Bottom panel: folded light curve of another variable that has a period of 44.932 d.

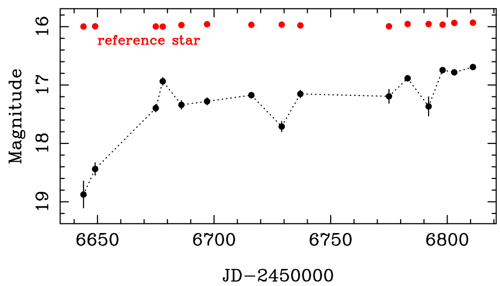

Fig. 7 The unfiltered light curve of a known quasar FSRQ J131059.4+323334 obtained by the TNTS. The red dots are the light curve of the reference star.

Figure 5 illustrates the unfiltered (R-band) light curves of five young SNe Ia discovered from the TNTS, which were discovered about two weeks before the maximum light. These facts demonstrate the capability of TNTS to detect SNe at a relatively young phase. Extensive follow-up observations have also been obtained for these SNe discovered at young phases. The light curve of SN 2012ij indicates that it is a subluminous SN Ia discovered about two weeks before its maximum light. It exhibits spectroscopic features similar to the subluminous object SN 1991bg (Chen et al. 2014 in preparation). SN 2013gs is another young SN Ia with extensive optical and *Swift* UV observations. The spectra of SN 2013gs are characterized by high-velocity Si II absorption and it seems to be bright in UV bands (Zhang et al. 2014 in preparation).

Besides SNe, a number of other optical transients have also been detected during our survey. These include five cataclysmic variables (CVs) or nova candidates, 15 AGNs and about 150 variables (Yao et al. 2014 in preparation). Among the 150 variables, 37 are new detections. All of the optical transients discovered by the TNTS can be automatically monitored in an unfiltered mode during the survey. The statistical analysis of variance method, applied to this field by Stetson (1996), is used to search for periodicity in these possible variables. As an example, in Figure 6 we show the folded light curves of two periodic variables found by this method (see Yao et al. 2014 (in preparation) for details). The preliminary results about the variables demonstrate that the TNTS has the capability to detect variables with different periods from hours to months. The survey data can also be used to study light variations of AGN/quasars.

Figure 7 shows the light variations in the flat-spectrum radio quasar (FSRQ) J1310+3233 that has a redshift of 1.6 (Healey et al. 2008). The unfiltered light curve indicates that the luminosity of this quasar has a long-term rise with a possible variation on a time scale of days. Analysis of this light variation could help in understanding the contribution of flux from the accretion disk to quasar emission at different timescales.

4 SUMMARY

This paper introduces the performance of TNTS during the first year. The observation system and the data reduction pipeline worked well overall during the first year survey, and more than 50 SNe and a lot of other transients (e.g. CVs, novae, quasars/AGNs and variables) have been detected. For some bright SNe and other interesting transients, the photometric and spectroscopic follow-up observations were triggered immediately after their discoveries. From the statistics related to the first-year sample of SNe Ia, we found that 80% of them were discovered before or close to their maximum light. In particular, it should be pointed that 5 out of 30 SNe Ia were detected at phases around or earlier than two weeks before their maximum light. This number will increase significantly once two other telescopes (one is located at Xinjiang Observatory near Urumqi and the other is at Xuyi Observatory) join our survey network in the next year. Based on current statistics, our survey can provide the supernova community with a sample of more than 50 extremely young SNe Ia (e.g., $t < -10\,\mathrm{d}$) during its four years of operation. Such a sample with early observations will definitely increase our knowledge about the diversity of SNe Ia and their physical origins.

Analysis of a small portion of the survey field has led to the discovery of about 150 variables (including 37 new ones) of different types, with periods ranging from hours to years. From our current data, we estimate that about 1500–2000 variables can be detected from the entire survey field of the TNTS, which will be a significant contribution to the study of variable stars. Another by-product of the TNTS is the automatic acquisition of light variations for hundreds of known and unknown AGN/quasars, which may help understand the complicated processes of accretion.

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References

Arcavi, I., Gal-Yam, A., De Cia, A., et al. 2013, The Astronomer's Telegram, 5623, 1
Baltay, C., Rabinowitz, D., Hadjiyska, E., et al. 2013, PASP, 125, 683
Bertin, E. 2006, in Astronomical Society of the Pacific Conference Series, 351, Astronomical Data Analysis Software and Systems XV, eds. C. Gabriel, C. Arviset, D. Ponz, & S. Enrique, 112
Bertin, E., & Arnouts, S. 1996, A&AS, 117, 393
Bertin, E., Mellier, Y., Radovich, M., et al. 2002, in Astronomical Society of the Pacific Conference Series, Data Analysis Software and Systems XI, eds. D. A. Bohlender, D. Durand, & T. H. Handley, 228
Blondin, S., & Tonry, J. L. 2007, ApJ, 666, 1024
Cao, Y., Kasliwal, M. M., & Nugent, P. E. 2013, The Astronomer's Telegram, 4808, 1
Challis, P. 2013, The Astronomer's Telegram, 5700, 1
Cousins, A. W. J. 1981, South African Astronomical Observatory Circular, 6, 4
Denisenko, D., Gorbovskoy, E., & Lipunov, V. 2013, Central Bureau Electronic Telegrams, 3663, 1
Drake, A. J., Djorgovski, S. G., Mahabal, A., et al. 2009, ApJ, 696, 870
Elenin, L., & Molotov, I. 2013, Central Bureau Electronic Telegrams, 3430, 1
Healey, S. E., Romani, R. W., Cotter, G., et al. 2008, ApJS, 175, 97
Howerton, S., Drake, A. J., Djorgovski, S. G., et al. 2012, Central Bureau Electronic Telegrams, 3353, 1
Huang, F., Li, J.-Z., Wang, X.-F., et al. 2012, RAA (Research in Astronomy and Astrophysics), 12, 1585
Inserra, C., Gall, E., Fraser, M., & Smartt, S. J. 2013, Central Bureau Electronic Telegrams, 3415, 1
Johnson, H., Mitchell, R., Iriarte, B., & Wisniewski, W. 1966, Lunar and Planetary Lab, ed. R. Wang (Cambridge: Cambridge Univ. Press), 4, 41
Kaiser, N., Aussel, H., Burke, B. E., et al. 2002, in Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, ed. J. A. Tyson & S. Wolff, 154
Keller, S. C., Schmidt, B. P., Bessell, M. S., et al. 2007, PASA, 24, 1
Koff, R. A., Silverman, J. M., Vinko, J., et al. 2013, Central Bureau Electronic Telegrams, 3471, 1
Law, N. M., Kulkarni, S. R., Dekany, R. G., et al. 2009, PASP, 121, 1395
Li, W., Leaman, J., Chornock, R., et al. 2011, MNRAS, 412, 1441
Li, W., Wang, X. F., Zhang, T., et al. 2013, Central Bureau Electronic Telegrams, 3764, 1
Luppi, F., Buzzi, L., & Koff, R. A. 2013, Central Bureau Electronic Telegrams, 3383, 1
Marion, G. H., Challis, P., & Caulkins, M. 2013, Central Bureau Electronic Telegrams, 3370, 1
Nicholl, M., Walton, N., Blagorodnova, N., et al. 2013, The Astronomer's Telegram, 4860, 1
Silverman, J. M., Vinko, J., Quimby, R., et al. 2013, Central Bureau Electronic Telegrams, 3470, 1
Stetson, P. B. 1996, PASP, 108, 851
Tomasella, L., Benetti, S., Pastorello, A., et al. 2012a, Central Bureau Electronic Telegrams, 3362, 1
Tomasella, L., Benetti, S., Pastorello, A., et al. 2012b, Central Bureau Electronic Telegrams, 3366, 1
Tyson, J. A., Wittman, D. M., Hennawi, J. F., & Spergel, D. N. 2003, Nuclear Physics B Proceedings Supplements, 124, 21
Walton, N., Blagorodnova, N., Nicholl, M., et al. 2013, The Astronomer's Telegram, 4851, 1
Wang, X., Li, W., Filippenko, A. V., et al. 2008, ApJ, 675, 626
Wang, X.-F., Chen, J.-C., Zhang, T.-M., et al. 2012, Central Bureau Electronic Telegrams, 3344, 1

Wang, X., Chen, J., Liang, J., et al. 2013, Central Bureau Electronic Telegrams, 3545, 1
Zhang, J.-J., Fan, Y.-F., Chang, L., & Yi, W.-M. 2012a, Astronomical Research & Technology, 9, 411
Zhang, J.-J., Zhao, X.-L., Wang, X.-F., & Zhang, T.-M. 2012b, Central Bureau Electronic Telegrams, 3336, 1
Zhang, J.-J., & Wang, X.-F. 2013a, Central Bureau Electronic Telegrams, 3595, 1
Zhang, J.-J., & Wang, X.-F. 2013b, Central Bureau Electronic Telegrams, 3726, 1
Zhang, K., Wang, X., Chen, J., et al. 2013a, Central Bureau Electronic Telegrams, 3499, 1
Zhang, K., Wang, X., Zhou, L., et al. 2013b, Central Bureau Electronic Telegrams, 3508, 1
Zhang, K., Wang, X., Zhou, L., et al. 2013c, Central Bureau Electronic Telegrams, 3528, 1
Zhang, T., Wang, X., Chen, J., et al. 2013d, Central Bureau Electronic Telegrams, 3601, 1
Zhang, T., Wang, X., Zhang, T., et al. 2013e, Central Bureau Electronic Telegrams, 3527, 1
Zhang, T., Zhou, X., Chen, J., et al. 2013f, Central Bureau Electronic Telegrams, 3395, 1
Zhang, T., Zhou, X., Wang, X., Chen, J., et al. 2013g, Central Bureau Electronic Telegrams, 3424, 1
Zhang, T., Wang, X., Wu, C., et al. 2012c, AJ, 144, 131
Zhang, T., Zhou, X., Zhou, L., et al. 2013h, Central Bureau Electronic Telegrams, 3446, 1
Zhang, T., Zhou, X., Wang, X., et al. 2013i, Central Bureau Electronic Telegrams, 3509, 1
Zhang, T., Wang, X., Zhou, L., et al. 2013j, Central Bureau Electronic Telegrams, 3532, 1
Zhang, T., Zhou, X., Wang, X., et al. 2013k, Central Bureau Electronic Telegrams, 3702, 1
Zhang, T., Wang, X., Zhou, L., et al. 2013l, Central Bureau Electronic Telegrams, 3734, 1
Zhao, X.-L., Wang, X.-F., Zhang, J.-J., et al. 2012, Central Bureau Electronic Telegrams, 3330, 2
Zhou, X., Jiang, Z., Ma, J., et al. 2003, A&A, 397, 361
Zhou, L., Chen, J., Wang, X., et al. 2012, Central Bureau Electronic Telegrams, 3360, 1
Zhou, L., Chen, J., Wang, X.and Zhang, T., et al. 2013a, Central Bureau Electronic Telegrams, 3369, 1
Zhou, L., Wang, X., Chen, J., et al. 2013b, Central Bureau Electronic Telegrams, 3394, 1
Zhou, L., Wang, X., Chen, J., et al. 2013c, Central Bureau Electronic Telegrams, 3406, 1
Zhou, L., Wang, X., Chen, J., et al. 2013d, Central Bureau Electronic Telegrams, 3427, 1
Zhou, L., Chen, J., Zhang, T., et al. 2013e, Central Bureau Electronic Telegrams, 3443, 1
Zhou, L., Zhang, K. C., Wang, X., et al. 2013f, Central Bureau Electronic Telegrams, 3455, 1
Zhou, L., Wang, X., Chen, J., et al. 2013g, Central Bureau Electronic Telegrams, 3501, 15
Zhou, L., Wang, X., Zhang, K., et al. 2013h, Central Bureau Electronic Telegrams, 3543, 1
Zhou, L., Wang, X., & Zhang, T. 2013i, Central Bureau Electronic Telegrams, 3585, 1