PESSTO – The Public ESO Spectroscopic Survey for Transient Objects

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1 Introduction

Systematic searches for supernovae (SNe) and extra-galactic transients have historically been conducted via targeted surveys of nearby, and usually star-forming, galaxies (e.g. CHASE [1]; LOSS [2]). Such surveys have been successful in identifying core-collapse and thermonuclear SNe, luminous blue variable (LBV) outbursts, and flares from active galactic nuclei among other phenomena. However, targeted surveys of massive galaxies provide a biased sample of transients for statistical studies, and may also miss phenomena such as transients at large offsets from their host galaxies, or which are found in low surface luminosity dwarf galaxies.

Modern surveys such as PanSTARRS [3], the Catalina Real-time Transient Survey [4], the La Silla-QUEST Survey [5] and the Palomar Transient Factory [6] have attempted to address this by surveying large areas of the sky in an unbiased and uniform fashion. However, the broad areas of sky these surveys cover each night (typically $\sim$1000s of square degrees per night, to a depth of $\sim 20 - 21$ mag) and consequent large numbers of transients found has led to a situation where the limiting factor is no longer discovery rates, but rather spectroscopic classification and followup.

To address this problem, the Public ESO Spectroscopic Survey of Transient Objects (PESSTO; PI: S.J. Smartt) is conducting a large scale spectroscopic survey for the classification and followup of SN candidates using the 3.6m ESO New Technology Telescope at La Silla [7]. The survey itself has two main goals - spectroscopic confirmation and classification of a large number of SN candidates which have been reported to the community on a rapid basis, and obtaining well-sampled and publicly available spectroscopic time series for a subset of targets which are of particular scientific interest.

2 Observations

PESSTO observes for approximately 10 nights per month, over 9 months of the year. Within each month, the 10 nights of observations are split into three separate observing runs of 2-4 nights to ensure a reasonable cadence for SN followup. 4-m class telescopes, such as the NTT, are well-suited to spectroscopic observations of targets which are between magnitude 16-20, and a low (17 Å) resolution spectrum suitable for classification of a SN can be obtained in $\sim$20–60 minutes.

PESSTO observations are conducted with both EFOSC2, the optical imager and spectrograph on the NTT, and SOFI, the NIR camera and spectrograph. All PESSTO classification spectra are taken with a fixed set-up - EFOSC2 with Gr#13. Followup spectra of scientifically interesting targets are taken with EFOSC2 using Gr#11 or Gr#16, and SOFI using either the blue or red grisms, while a small amount of time may also be spent on optical and NIR imaging of targets when they become too faint for spectroscopy. Gr#13 covers from 3685-9315 Å which is ideal for SN classification, while Gr#11 and Gr#16 cover 3380-7520 Å and 6015-10320 Å respectively.

The limited set of fixed observing modes used by PESSTO has several benefits: ensuring a homogenous data set, reducing the number of decisions which have to be taken by the observer, and facilitating and simplifying the rapid pipeline reduction of data. At the telescope, the observer only has to adjust the exposure time and choose the slit width to use for spectroscopy, depending on weather conditions.

3 The PESSTO Marshall and pipeline

PESSTO observations are coordinated and documented through the PESSTO Marshall (developed by D. Young). The PESSTO Marshall is a web-based application, with a MySQL backend database, containing details of targets, observations, and ancillary data such as the redshift of host galaxies, or the current magnitude of a SN as reported by the various surveys. Users can interact with the dynamic webpages to update data and comment on any of the objects contained in the Marshall.

Prospective targets which are publicly announced by surveys are automatically ingested into the Marshall. These candidates are then either selected as potentially interesting targets for a classification spectrum, or discarded. The Marshall is also used for the management of followup targets - with requests for observations being communicated to the observer at the telescope via the Marshall.

All PESSTO data are reduced using the PESSTO pipeline. This is a PYTHON-based pipeline developed by S. Valenti which uses PYRAF routines to reduce and calibrate the observations taken each night. All classifications made by PESSTO are announced within 24 hours of the end of the Chilean night, and the spectra made publicly available via WISeREP[1] [8]. To facilitate the rapid reduction of spectra and announcement of classifications, the PESSTO pipeline can be run in "rapid" mode on a single raw spectrum, with archival sensitivity curves and wavelength solutions used to calibrate the data. The rapid reduced spectra have been checked against full reductions of the same data (using calibrations from the same night), and found to have no systematic differences.

All data are fully reduced and released to the community at the end of each year via ESO[2]. The final science-quality reduced spectra are also available via WISeREP, while in future all PESSTO data will also be available from the IA2 archive[3].

4 Conclusions

The PESSTO survey has successfully implemented a model of observing which ensures homogenous, uniform quality data, with minimal effort from observers and data reducers. In large part, this is due to the adoption of a fixed set of observing modes, largely automated pipeline reduction of data, and good communication via the PESSTO Marshall. In its first year of operations, PESSTO data has been used to study over thirty SNe in detail, including the first days after explosion of a nearby Type II SN [9] for which a progenitor candidate was identified in archival Hubble Space Telescope images [10]; a H-poor core-collapse SN which exploded in a H-rich

[1]http://www.weizmann.ac.il/astrophysics/wiserep/home
[2]http://www.eso.org/sci/observing/phase3/data_releases.html
[3]http://ia2.oats.inaf.it/index.php/

circumstellar environment [11], "faint and fast" H-poor SNe [12], a $\sim$60 $M_\odot$ star with three years of outbursts prior to its presumed demise [13], and one of the most intensively observed luminous Type Ia SNe [14].

The PESSTO survey has run for 1.5 years, and will continue for another 2.5 years (with an additional fifth year pending review by ESO). Over the full duration of the survey, PESSTO will classify some thousands of SNe, and provide detailed spectroscopic followup for $\sim$100 of these. This rich, publicly available dataset will be be of great value to the community in understanding the physics of SN explosions.

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