OBSERVING REQUEST
University of Arizona Observatories

Year: 2015 **Term:** Jan–Jul **Proposal type:** short-term

AZTEC: Arizona Transient Exploration and Characterization

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CoI(s): G. Grant Williams (SO), Peter Milne (SO), Tom Matheson (NOAO), Dennis Zaritsky (SO), Paul Smith (SO), Jennifer Andrews (SO), Wen-Fai Fong (SO), Charles Kilpatrick⋆ (SO), Christopher Bilinski⋆ (SO)

Abstract of Scientific Justification

The study of astronomical transient and variable sources (supernovae, GRBs, stellar eruptions, tidal disruption flares, binary stars, etc.) is of fundamental importance to astronomy, and a primary area of future effort as emphasized by the decadal review and the construction of LSST. In the time leading up to LSST, this is a regime where small and moderate-sized telescopes with simple broad-band photometry and low-resolution optical spectroscopy can make critical advances, because valuable new insight derives from previously unknown physical properties of transients provided by nature, rather than the newest technological capabilities. Arizona is unique among US institutions in its access to a diverse suite of small telescopes, but these telescopes are scheduled classically and we lack a system that facilitates efficient frequent monitoring of transients. Thus, our small telescopes are underutilized compared to their potential. Plans are in progress to roboticize the Kuiper telescope (and others in the future), but in the mean time we aim to set up a "poor man's queue" for transient observations that will make efficient and flexible use of Steward facilities. A critical addition is that we will leverage the flexible queue scheduling of UKIRT to ehnance the cadence and wavelength coverage of this diverse transient program. We combine efforts of several projects with different science cases, and we will provide frequent opportunities for student observing. We emphasize investigation of explosive transient sources, but the observing plan can incorporate other variable sources like AGNs, binary stars, and exoplanet transits that are of interest in the wider Steward community. This program was approved for 2014B, and this semester we have only a few modifications to the telescope request and scheduling needs.

Summary of observing runs requested for this project

Run	Telescope	Cage	Instrument	PI	AO	Nights	Moon	Scheduling Optimal	Scheduling Acceptable	Sharing Poss.	Sharing Adv.
1	MMT	f/9	Blue			4	grey	Jan–Jun	Jan–Jul	no	no
2	MMT	f/9	Blue			4	dark	Jan–Jun	Jan–Jul	no	no
3	90in	f/9	B&C			10	grey	Jan–Jun	Jan–Jul	no	no
4	90in	f/9	SPOL			2	grey	Jan–Jun	Jan–Jul	no	no
5	61in	f/9	Mont4k			20	grey	Jan–Jun	Jan–Jul	no	no
6	VATT	f/9	VATT4k			6	grey	Jan–Jun	Jan–Jul	yes	yes
7	MN60	f/9	2MASS			20	any	Jan–Jun	Jan–Jul	yes	yes
8	UKIRT	f/9	WFCAM			8	any	Jan–Jun	Jan–Jul	yes	yes
9	UKIRT	cass	UFTI			4	any	Jan–Jun	Jan–Jul	yes	yes
10	LBT	f/9	MODS			2	dark	Jan–Jun	Jan–Jul	yes	yes

Scheduling constraints and unusable dates *(up to 4 lines)*: We ask nights to be staggered evenly to facilitate transient monitoring: i.e. 1-2 nights per month with MMT/BC, 2 per month on Bok/B&C, 3-5 per month on Kuiper/Mont4k, etc. Please schedule single nights; no more than 2 consecutive nights on Kuiper. PLEASE try to avoid scheduling more than 2 telescopes (especially Kuiper/VATT/Bok) on the same night. We ask that Kuiper nights be preferentially scheduled on weekends to allow undergrad observing; this is a very high priority - many of our Kuiper observers are undergrads. See other items in Exp. Design.

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A ⋆ appended to the proposal type indicates a continuation proposal; a ⋆ appended to the name of a proposer indicates the proposer is a (graduate) student; a proposer whose name is underlined is certified on the proposed telescope/instrument combination; if a ∗ appears within the PI or AO box in the observations summary table, the instrument is a PI instrument and/or Adaptive Optics are requested – signatures are required on the next page.

Target list (attach list if longer than 26 objects)

#	Object	RA	Dec	mag / color / type / redshift / comment / etc.
1	SN 2014abc	00 00 00.00	+30 00 00.00	V <= 20.0, to be discovered

Approval for Instrument Use from PI: N/A

Graduate students *(provide the following information for **each** student named as PI or CoI on the cover page. Have the advisor's signature(s) appear on **all** submitted copies)*

Student's Name	Advisor's Name	Advisor's Signature	2nd-yr	Thesis
Charles Kilpatrick	G. Rieke		no	no
Christopher Bilinski	N. Smith		no	yes

Scientific Justification

There is a wide variety of supernovae (SNe) and other astrophysical explosions, resulting from various stellar initial masses, metallicities, explosion mechanisms, and evolutionary paths. Some are traditional core-collapse SNe, some produce GRBs, some may be failed SNe or weak SNe formed by fallback onto a black hole, some are pre-SN eruptions (a.k.a. luminous blue variables, LBVs), and some are thermonuclear explosions like Type Ia SNe and pair-instability SNe. All of these are of interest in this proposal, where we aim to harness Steward's array of telescopes to obtain followup broad-band photometry (i.e., light curves) and spectroscopy of explosive transient sources. Explosive transients offer unique windows into stellar evolution, allowing us to dissect inner layers of stars as they are peeled away, and to directly measure the mass and energy in their violent death throes. Our aim is to characterize transients that are discovered by other means (including but not limited to publicly announced transients from amateur astronomers, PTF, the Lick Observatory SN search, CRTS, PanSTARRS, Swift, CHASE, etc.). These transient searches find far too many explosive transients to follow all of them systematically, so we will follow a subset in specific categories that align with our primary scientific interests as described below.

Here we propose implementation of a "poor man's queue" for Steward's small and moderate-aperture telescopes that we call the Arizona Transient Exploration and Characterization (AZTEC) program. This is an umbrella program with several diverse science goals. The proposal page limits prohibit a detailed justification for each of these, but all are ongoing programs that have regularly been approved in previous semesters by our Steward TAC. In the next subsection, we describe each of these primary science goals and identify the lead investigator. Here we are combining these programs into one larger program, in order to pool our efforts on various telescopes to facilitate more regular monitoring and to maximize the scientific return of our diverse telescope system, as described in the subsequent section. (*AZTEC was approved in 2014B; things are working logistically so far, although we have had terrible Arizona weather in our first month, with ony 1 clear night. We have obtained excellent IR photometry of several transients with UKIRT, including one rapid ToO (Fong et al. 2014).*)

Specific Science Goals

SNe with dense circumstellar material (Type IIn) and super-luminous SNe. PI = N. Smith. About 9% of core-collapse SNe are classified as Type IIn (Smith et al. 2011). The "n" means that they have narrow H lines in their spectrum arising when the SN shock crashes into slow and dense circumstellar material (CSM). These objects are of particular interest because their dense CSM ejected in violent eruptive mass loss events in the few years before the SN, indicating the presence of an instability that is a prelude to core collapse and may affect the core collapse mechanism itself (Smith & Arnett 2014). Spectra of these events can constrain the expansion speed and kinetic energy of the SNe, and can also measure the speed and mass-loss rate of the progenitor star eruptions because the pre-shock gas is illuminated. This allows us to diagnose what the star was doing just before it exploded. The instability causing these pre-SN outbursts is still unidentified, so understanding the diversity in physical parameters is essential to diagnose it. Since SNe IIn have narrow lines, higher spectral resolution is needed, so this component will require nights on MMT with Bluechannel. This program has consistently been awarded MMT time in previous semesters. As with any spectroscopic study of SNe, broad-band light curves are also needed in order to understand the total energetics.

Nearby SNe with a detected progenitor star (PI = N. Smith). Any normal type of core-collapse SN can become extremely valuable in the rare nearby cases when we are lucky enough to have pre-explosion archival detections of a progenitor star, usually found by searching archival HST images taken before the SN. More than a dozen reliable detections of progenitor stars are known (Smartt 2009; with several more added recently). In these cases, precise estimates of the SN ejecta mass, abundances, and kinetic energy derived from spectra and photometry are extremely valuable since they can be compared with the estimated mass and type of star that exploded to test models of explosions and the resulting light curves.

Type Ia SNe. PI = P. Milne. The *Swift* UVOT instrument has discovered that the normal Type Ia SNe used as cosmological distance indicators can be divided into two classes, based on their NUV-optical colors (Milne et al. 2013), and that the ratio between these classes changes with redshift (Milne et al. 2014). Since $B - V$ colors are used to estimate extinction, this potentially impacts the amount of dark energy inferred. The M4K camera has excellent blue sensitivity and is a powerful tool for categorizing the events as NUV-red or

NUV-blue. UKIRT NIR photometry of these SNe Ia will be proposed in a separate proposal (PI Milne) that requests nightly snapshots of UVOT SNe Ia, and will thus be fairly disruptive. Minn60-2MASS observations are requested to support that program as part of our pseudo-queue.

SPOL spectropolarimatry of SNe. PI = G. Williams. This program aims to understand the asymmetry in the SN explosion mechanism for a wide variety of core-collapse SNe and Type Ia SNe using spectropolarimetry obtained with the SPOL instrument mounted on the MMT, Bok, and Kuiper telescopes. SPOL observations will be submitted separately. With the AZTEC program, we will obtain non-polarization spectra and photometry with better time sampling than the relatively sparse SPOL observations. We must know how the times of our SPOL observations correspond to the SN light curve and the time of maximum luminosity. Figure 1 (from our recent paper on the 2012 SN explosion of SN2009ip; Mauerhan et al. 2014) demonstrates the utility of having this complementary and essential information. The study of asymmetric SNe with SPOL and AZTEC data will be the foundation of the PhD thesis for graduate student C. Bilinski.

Eruptive non-SN transients (LBVs and related phenomena). PI = N. Smith. In addition to SNe IIn that result from a SN crashing into CSM created by a pre-SN eruption (above), we also aim to study the eruptions directly. This is a class of transient events that are non-terminal stellar eruptions, such as LBVs like η Car that are sometimes called "SN impostors". Studying the luminosity and spectral evolution provides critical clues about unsteady mass loss in the late evolution of massive stars (see review by Smith 2014).

Core-collapse SNe with dust formation and IR Echoes. PI = J. Andrews. Core-collapse supernovae (ccSNe) may be crucial players in the dust budget of galaxies, especially at high-redshift where only higher mass stars have enough time to enrich the ISM. The mechanism and the efficiency of dust condensation is not well understood. When dust forms in SNe, it can be measured using a combination of optical/IR photometry and spectroscopy: (1) a sudden decrease in continuum brightness in the optical, (2) a brightening in the IR as new dust grains re-emit in the IR, and (3) the development of asymmetric, blue-shifted emission-line profiles, caused by new dust preferentially extinguishing redshifted emission. If dusty CSM already exists around the object, there may also be enhanced IR flux due to absorption and re-emission of the initial SN flash, called an "IR echo". Therefore observing IR echoes can be an invaluable tool for reconstructing the evolution and characteristics of the progenitor.

GRBs and their SNe. PI = W-F Fong. Long-duration gamma-ray bursts (GRBs) have two optical counterparts: the afterglow, which is the relativistic jet interacting with the circumburst medium, and a Type Ic SN (lacking both H and He), from the collapse of their massive star progenitors. At present, differences between Type Ic SNe associated with GRBs and Type Ic SNe without GRBs are poorly understood. To date, only ≈ 10 GRB-SNe have been spectroscopically confirmed, due to the paucity of low-redshift ($z \lesssim 0.7$) long GRBs. While the afterglow emission fades below the capabilities of ground-based facilities in $\sim$1 week, the SN emission is often detectable $\gtrsim$3 weeks after the burst. Our program provides a unique opportunity for spectroscopic follow-up of GRB-SN events, thus constraining their expansion velocities and ejecta masses. We note that monitoring GRB afterglows requires observations on a more rapid timescale outside the scope of this proposal, but these will be observed with Super-LOTIS.

AZTEC won't cover everything related to transients, and therefore doesn't negate some other transient programs: For example, ToO interrupts for GRBs will still be needed, and programs that require long exposures for high-redshift SNe and other very faint transients, or studies of host galaxies, will not be covered by AZTEC. We do, however, request a few dark nights on the MMT and LBT to obtain spectroscopy and photometry in the nebular phases of SNe at 80-200 days after explosion (typicaly 20-23 mag); this will only apply to a subset of the transients that are given the highest priority based on their early time observations with the smaller telescopes. During bright phases near peak and a few months after when the transients are still relatively bright (brighter than 20 or 21 mag) they can be observed photometrically with small telescopes. In the next section, we describe some of the logistics of our observing program, including how we plan to involve both graduate and undergraduate students in staffing the many observing runs.

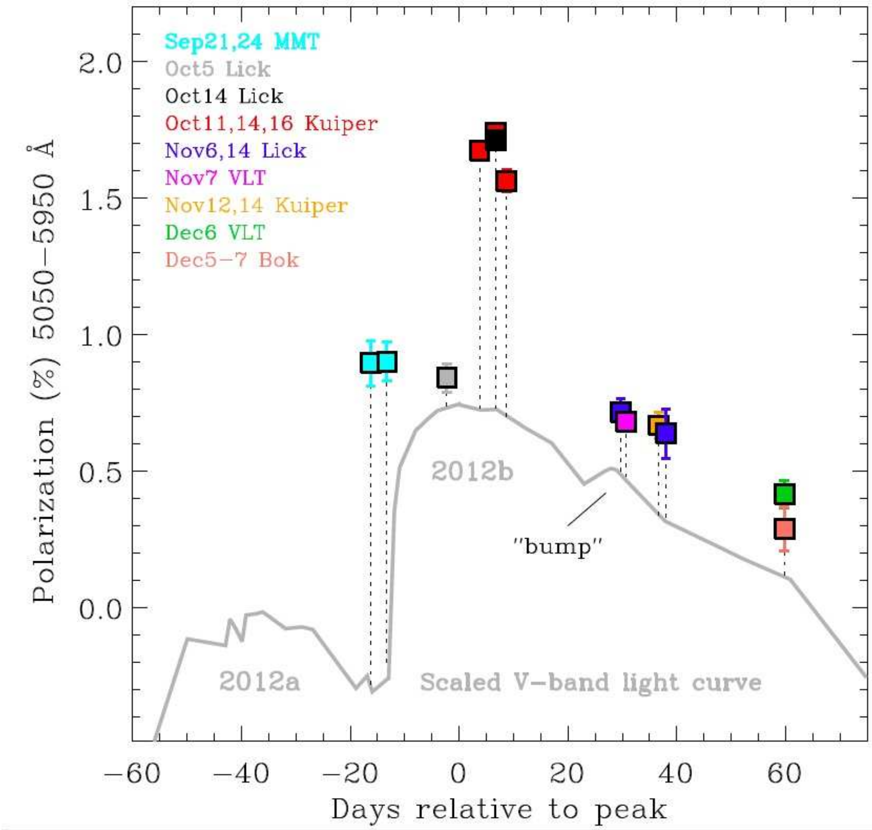

Figure 1: This figure shows how epochs of spectropolarimetry (colored squares) compare to phases in the visible light curve (grey) of the recent Type IIn explosion (in 2012) of the object SN 2009ip (the original transient in 2009 was not a true SN; Smith et al. 2010). This is from our recent paper on the polarization of SN 2009ip by Mauerhan, Williams, Smith, et al. (2014). The combination of a well-sampled light curve with dense coverage of the complex spectral evolution was critical for measuring the time evolution of luminosity and kinetic energy, providing the context in which we were able to interpret our more sparsely sampled epochs of spectropolarimetry. This, in turn, allowed us to construct a coherent model for the geometry that gave rise to the polarization at each phase of the SN colliding with its asymmetric CSM (see Mauerhan et al. 2014 for more details).

REFERENCES

Fong, W., Milne, P., Smith, N., & Andrews, J. 2014, GCN Circular, 16826, 1

Mauerhan, J., Williams, G.G., Smith, N., et al. 2014, MNRAS, 442, 1166

Milne et al. 2013, ApJ, 779, 28

Milne, P., Foley, R., Brown, & Narayan 2014, ApJ, submitted (arXiv:1408.1706)

Smartt, S. 2009, ARAA, 47, 63

Smith, N. 2014, ARAA, 52, 487

Smith, N., & Arnett, W.D. 2014, ApJ, 785, 82

Smith, N., et al. 2011, MNRAS, 412, 1522

Smith, N., et al. 2010, AJ, 139, 1451

Experimental Design & Technical Description *Describe your overall observational program. How will these observations contribute toward the accomplishment of the goals outlined in the science justification? If you've requested long-term status, justify why this is necessary for successful completion of the science. (**up to one page**)*

This proposal aims to observe diverse explosive transient targets that have not yet been discovered, so we cannot provide a traditional estimate of the exposure times needed for a set number of targets of known flux. We anticipate a wide variety of different types of transients, requiring different observing parameters for each. Our time request is guided by two principles: (1) Establishing a cadence for monitoring transients that is frequent enough to provide well-sampled light curves and somewhat more sparsely sampled spectroscopy; these are essential to understand the temporal evolution of an explosion. Most SNe rise and fall on timescales of a month or longer, so weekly sampling of the photometric light curves is usually sufficient. Spectral evolution sampled once every week or few weeks is typically sufficient. (2) Since this is a combination of several proposals that have previously been awarded time, our time request is guided roughly by the time allocated to these programs in previous semesters. Nights requested for each telescope/instrument and the science goals are described below:

Bok/B&C and SPOL: The B&C spectrograph on the Bok will be our main source of critical low-resolution visible-wavelength spectra, required for all transients before and after maximum luminosity. To achieve adequate time sampling of spectra, we request roughly 2 nights per month staggered as evenly as possible. We also request 2 nights with SPOL on the Bok for low-res spectroscopy (not specpol). The reason for the SPOL request is simply to help the cadence of our spectroscopic monitoring when SPOL is mounted in blocks; this is flexible (SPOL can be substituted for B&C - we can iterate with the scheduler on this detail). *Scheduling: We ask to have the equivalent of one night in each of the two longer SPOL runs.*

MMT/Bluechannel: Bluechannel on the MMT will emphasize higher resolution spectra (1200 lpm grating; 4 gray nights), for SNe and transients with narrow lines (Type IIn SNe and LBV eruptions). Higher resolution will also be used to study the Na I D absorption. We will also use Bluechannel to obtain low-res spectra of fainter targets, like SNe after they have faded from their peak (4 dark nights). *Scheduling: Please stagger these MMT nights evenly through the semester as single nights; not more than 3 weeks between MMT/BC runs (unless an LBT night, or perhaps a Hectospec night as an alternative, can be scheduled in that gap).*

LBT/MODS: We request 2 nights for dark-time spectroscopy with MODS; same as the MMT dark time spectroscopy above, but reserved for our faintest targets. These will be single-object long-slit observations, easily be incorporated into Arizona's mini-queue observing runs with MODS. *It would be very helpful to schedule LBT/MODS nights in any large gaps of time when Bluechannel is not mounted on the MMT.*

Kuiper/Mont4k: This will be our main engine for obtaining well-sampled broad-band UBVRI light curves, essential to understand the basic energetics of any transient source. We request 3-4 observing runs per month on the Kuiper (i.e., weekly observations), in order to obtain adequately sampled light curves. The numerous Kuiper runs in particular (but also other telescopes) will have intense observing by UA undergrads; several undergrads are already certified observers. *Scheduling: Please schedule single nights when possible, no more than 2 consecutive nights.* **NOTE TO TAC: It is very important that our Kuiper runs be scheduled on weekends, because undergrad students will do most of the observing. If the science is deemed competitive enough, we request that the TAC give our runs high priority on the Kuiper.**

VATT/VATT4k: The Kuiper telescope cannot point above DEC=+60 deg, but the VATT has no such restriction. Thus, we can use the VATT for the same broad-band light curves of transients at high declination. *Scheduling: We request that VATT nights NOT be scheduled on the same nights as Kuiper.*

MN60/2MASS: The Minnesota will be used for JHK photometry, needed for studies of dust formation and IR echoes, and for evaluating dust extinction. For an adequate cadence, we request $\sim$4 nights/month.

UKIRT: The JHK near-IR photometry obtained with UKIRT has the same science as above for MN60, but we will use UKIRT for our fainter targets. Also, since UKIRT has true queue observing, we will use this facility for triggering rapid ToOs, such as GRBs. To facilitate interrupt ToOs (which will be rare, but important) we request that the TAC prioritize this aspect accordingly. We have requested both WFCAM and UFTI cameras, mainly to assist in scheduling an even cadence.

Summary of Time Requested and Awarded *The TAC needs to understand the scope of this project — (1) tell us how many UAO nights you've already had for this project, how many you request this time, and (a good guess of) how many you need to complete the project; (2) if a substantial amount of observing for this project comes from non-UAO telescopes, tell us about that observing, and how the UAO part fits in; (3) if you are collaborating with people who have telescopes, especially if you are part of a large collaboration, tell us who is leading the project, and how UAO time and your participation fit in. (**up to one page**)*

This program was approved by the TAC in 2014B, and this is a continuation of the same program. The nature of this field is that our targets come and go with time as provided by Nature, and we respond, so study is ongoing. This is a combination of several smaller proposals that have routinely been awarded time in previous semesters. For this proposal, we request a similar number of total nights in the MMT and Bok (for spectroscopy), with an increase in the number of Kuiper and VATT nights compared to previous semesters since we are aiming to have well-sampled photometric light curves, which were not emphasized as strongly in previous proposals.

We are focused mainly on followup of transients discovered by other means (i.e. this is a followup program, not a transient search engine). The different science goals included in this program are part of a much more diverse collaboration within the larger community that is too extensive to list here in detail. We collaborate directly with the Lick Observatory Supernova Search (LOSS) at Berkeley and the Palomar Transient Factory (PTF) at Caltech; these are the main dedicated search engines that discover, obtain early photometry, and initially classify the transients. SNe and other transients are also discovered regularly by amateurs or other professional search programs (like the Catalina Sky Survey, Pan-STARRS, etc.) and announced regularly through IAU circulars and ATels, and our program will draw from these as well. The AZTEC data proposed here will be the main component of most of our followup studies, although we may collaborate with outside investigators with their own data on a case-by-case basis.

While the observations proposed here will be of immediate scientific use in the study of the various classes of transients described above, there is also additional long-term benefit for Steward Observatory. Namely, the Small Telescope Science Steering Committee (chair = D. Zaritsky, with co-Is N. Smith, P. Milne, P. Smith, and G. Williams as members) is working toward the strategic goal of automating and roboticizing Steward's small telescopes to make them more efficient, flexible, cheaper to operate, and more responsive to transient studies. We will use our queue scheduled nights as a testbed for experimenting with various methods of operation and queue scheduling (sometimes implementing automated schedulers and testing remote observing capabilities), and we will streamline the best operation modes, instrument setups, and data reduction techniques.

Similarly, ANTARES (Arizona-NOAO Transient Analysis and Response to Events System) is an NSF-funded joint collaboration between NOAO and the Arizona Computer Science Department to build a transient alert broker that can scale to the rate and volume of LSST. ANTARES will winnow the large alert stream down to a small number of interesting events. The AZTEC system will provide feedback to ANTARES to improve the broker's design and algorithms through testing and training. Once ANTARES is operational, it will filter alerts from available time-domain surveys to select objects for AZTEC followup.

Our list of investigators is primarily interested in explosive transient phenomena, but an established queue observing system on Steward's smaller telescopes will also be useful for a host of other applications of potential interest to members of the Steward community, including AGNs, tidal disruption flares, studies of binary stars (especially light curves of eclipsing binaries), studies of stellar rotation, transiting exoplanets, novae and cataclysmic variables, etc. When investigators (even those outside AZTEC) wish to obtain small amounts of time across several nights for monitoring these types of sources, we can incorporate them into our scheduled nights. Moreover, since we are requesting many nights staggered throughout the semester, this AZTEC program also provides a potential venue for Steward's community to request observations to fill in observations lost to weather in TAC-approved programs; this could be particularly valuable for graduate student thesis projects, where delays of a year to repeat observations can be detrimental.

Previous Use of Steward Facilities *List* ***all*** *allocations of telescope time for the present project and allocations for other projects on facilities available through UAO during the past 2 years, together with the current status of the data (cite publications where appropriate). Mark those allocations related to the present proposal (i.e, precede text with* `\related` *command).* ***(up to one page)***

⋆ PI N. Smith. AZTEC was approved for 2014B, with a comparable amount of time across many telescopes as in the present request. However, we have just started in the past month after monsoons. For our first month we had terrible Arizona weather, with only one clear Kuiper night, during which we obtained excellent photometry for a long list of targets. These data have been fully reduced. We also obtained several epochs of IR photometry with UKIRT, and these data have also been reduced. We now need additional data to investigate the time variability.

⋆ PI N. Smith has typically been awarded 4-5 MMT nights per semester for spectroscopic followup of supernovae. During 2013B, every single night (!) was lost to poor weather, and in 2014A only 1 night was clear. Based on good data obtained in 2012B and 2013A (during which roughly half the nights were lost to bad weather), and the 1 night in 2014A, several papers have been published (Smith et al. 2014, MNRAS, 438, 1191; Smith et al. 2013, MNRAS, 434, 2721; Mauerhan, Smith, et al. 2013a, MNRAS, 431, 2599; Mauerhan, Smith et al. 2013b, MNRAS, 430, 1801) and several more are currently in prep.

⋆ PI N. Smith was awarded 3 half-nights in 2014A with FIRE on Magellan to study dust formation and circumstellar dust in supernovae, but these observations were lost to weather. Two nights were also awarded for IR spectroscopy of SNe in 2013A and 2013B. Some of these data appeared in Smith et al. 2013, MNRAS, 430, 1801.

⋆ SPOL (PI = G. Williams): Please see the SPOL proposal for 2015A for an update on this program.

⋆ P. Milne has been awarded roughly 5 nights of UAO telescope time per month for the last 10 years. Two PhD theses were based on these observations (J. Lair-2005 and G. Bryngelson-2012, Clemson University) and one collective paper has been published (Lair, Leising, Milne & Williams 2006, AJ, 132, 2024). Observations of individual SNe and GRBs have contributed to the following publications: Kasliwal et al. 2008, ApJ, 683, L29; Soderberg et al. 2008, Nature, 453, 469; Dessart et al. 2008, ApJ, 675, 644; Updike et al. 2008, ApJ, 685, 361; Krisciunas et al. 2009, AJ, 138, 1584; Leloudas et al. 2009, A&A, 505, 265; Melandri et al. 2009, MNRAS, 395, 1941; Ganeshalingam et al. 2012, ApJ, 751, 142 Mauerhan et al. 2013, MNRAS, 431, 2599 McClelland et al. 2013, ApJ, 767, 119.

Over the course of nearly 6 years (October 2008-July 2014) the TAC has allocated a total of nearly 500 nights on the 2.3m and 1.54m telescopes to support the Fermi Gamma-ray Space Telescope by providing the only optical public spectropolarimetric and spectrophotometric data archive on gamma-ray-bright blazars (P.S. Smith, B.T. Jannuzi, and G.D. Schmidt). It is currently funded though November 2015. See the progress report for program L57 for details on time allocation and publications.

PI Smith has been granted 2 nights on Magellan in 2014A and 2 nights in 2013A to obtain IMACS spectra of light echoes from Eta Carinae. The data from these two runs are in various stages of reduction (the 2-D reduction of the very faint light echoes is very complicated). One paper has just been published (Prieto et al. 2014) and several more are in prep (Smith et al. 2014a, 2014b; Rest et al. 2014).