Resubmission of 12B-0500

NOAO Observing Proposal *Standard proposal* **Panel:** *For office use.*
Date: September 22, 2016 **Category:** Cosmology

Final Two Host Galaxy Observations for "SweetSpot"

Abstract of Scientific Justification *(will be made publicly available for accepted proposals)***:**

The SweetSpot program (2012B-0500) and host galaxy template follow ups (2012B-0500 and 2015B-0347) ...

Summary of observing runs requested for this project

Run	Telescope	Instrument	No. Nights	Moon	Optimal months	Accept. months
1	WIYN	WHIRC	1	bright	April - May	Mar - May
2						
3						
4						
5						
6						

Scheduling constraints and non-usable dates *(up to six lines).*

We have two targets at very different locations on the sky, so these observations could be done on one well placed night in April or May. However, they could also be done on separate nights. We would also be fine with partial nights or being back up on T&E nights.

Investigators *List the name, status, and current affiliation for all investigators. The status code of "P" should be used for all investigators with a Ph.D. or equivalent degree. For graduate students, use "T" if this proposal is a significant part of their thesis project, otherwise use "G".*

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CoI: Peter Garnavich **Status:** P **Affil.:** University of Notre Dame
CoI: Lori Allen **Status:** P **Affil.:** NOAO

Scientific Justification *Be sure to include overall significance to astronomy. For standard proposals limit text to one page with figures, captions and references on no more than two additional pages.*

How Standard are Type Ia Supernovae Standard Candles in the Near-Infrared? In our quest toward precision measurements of dark energy with Type Ia supernovae (SNeIa) [1, 26, 16, 9, 15, 6, 3] we have became limited by systematic errors due to our incomplete understanding of SNIa colors, dust, and their host environments. SNeIa are superior distance indicators in the NIR, with more standard peak H magnitudes and relative insensitivity to reddening [20, 18, 17] As a result, unlike optical Type Ia SNe, which are *standardizable* candles, NIR SNe Ia appear to be truly *standard* candles at the $\sim$ 0.10–0.15 mag level ($\sim$ 5–7% in distance) [18, 19, 27, 8, 25, 2, 10].

Motivated by this opportunity, the "SweetSpot" (PI Wood-Vasey; [25]) and the "CSP-II" (PI M. Phillips) programs were undertaken to build a comprehensive sample of SNeIa observed in the NIR in the nearby Hubble flow. The scientific goals of SweetSpot are: **(1)** Testing if SNeIa are better standard candles in the NIR. **(2)** Breaking the color-dust degeneracy with NIR observations. **(3)** Investigating the nature of SNIa host galaxies using NIR and optical observations **(4)** Connecting local flows and motions with SNIa NIR to galaxies and convergence

Throughout the SweetSpot program, we have been obtaining host galaxies templates for SNeIa from the previous year with significant underlying host galaxy flux. We here request time in an additional semester to observe the host galaxies from the final year of SweetSpot (2014B–2015A) that we were unable to gather in the previous two semeseters. Without the final host galaxy template references, $\sim$ 2 supernovae from the final year of 2012B-0500 will not be usable. Obtaining final host galaxy images free from the contamination of the SN light will be critical in obtaining accurate apparent brightness measurements for the SN lightcurve, and will also help provide measurements of the host galaxy stellar mass along with detailed morphology.

We only need a single filter in each field, so we do have some usable data of the supernova, but we will not be able to examine colors. One target is at redshift of 0.05 and only have JH observations. So we will not be able to calibrate our flux well with no color information.

ASASSN-15fs possibly has pre-B Max observations in Ks. (only half of the LC point have Ks)

Improved Calibration:
MICHAEL: IS THERE ANOTHER SHORT OBSERVATION WE CAN ADD TO IMPROVE THIS?S A dual-band GPS system was installed at KPNO in 2015 March to measure the variable amount of precipitable water vapor (PWV) in the atmosphere. This system is a key part of determining the full effective system transmission function in the NIR (and in general for $\lambda >$ 700 nm), where the edges of the filter bandpasses can be affected by the variable absorption lines from water vapor. Observing the same fields for these 2 supernova and the standard SweetSpot calibration star fields with the dual-band GPS system running for another semester will provide important information to tie down our WIYN+WHIRC magnitudes of the stars in the SN fields we use for calibration. We will use the focus of spending this additional time with the system to provide to all KPNO the water absorption spectral response function based on the observations of the GPS PWV system.

References

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[27] Wood-Vasey, W. M., et al. (2008) *ApJ*, 689, 377.

Experimental Design *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. (limit text to one page)*

We request a total of 1 night to use WHIRC observations of host galaxies of SNeIa.

We will observe the 2 host galaxies from SweetSpot that will require template observations due to significant inferred host galaxy light contributions at the location of the SNeIa. An overview of these targets can be found in Table 1. We are only requiring one filter per object, because we have previously gather the other 1 or 2 filters in previous semesters but was unable to fit these two in due to time constraints from weather or maintenance.

We will also observe $\sim$ 2-3 standard stars, but those will be in all 3 filters.

These observations will be undertaken with WHIRC in J, H, and K_s and provide reference flux values critical to obtaining SN lightcurves. These observations will also generate maps of the host galaxy at the high resolutions offered by the WIYN+WHIRC system for general study of detailed NIR morphology and host galaxy mass.

Proprietary Period: 18 months

Use of Other Facilities or Resources *(1) Describe how the proposed observations complement data from non-NOAO facilities. For each of these other facilities, indicate the nature of the observations (yours or those of others), and describe the importance of the observations proposed here in the context of the entire program. (2) Do you currently have a grant that would provide resources to support the data processing, analysis, and publication of the observations proposed here?"*

1) These observations will complement the data from other nearby supernova groups such as KAIT, the CfA Supernova group, and the Carnegie Supernova Project to produce the most complementary data sets to enable explorations of optical vs. NIR distance estimation, color, and host galaxy properties. The first steps toward higher redshift are currently being undertaken on *HST* through the RAISIN project (PI R. Kirshner). Farther in the future and going farther in the past, the nearby NIR SNIa set will provide a reference anchor for future higher-redshift restframe NIR work with *JWST* and *WFIRST*.

2) MICHAEL: DO WE STILL HAVE THIS GRANT? The PI is are currently funded by NSF AST-1028162 to carry out the SweetSpot program and related nearby SNIa work. This grant will continue to support graduate students to do the observations, analysis and publications for these proposed observations.

Previous Use of NOAO Facilities *List allocations of telescope time on facilities available through NOAO to the PI during the last 2 years for regular proposals, and at any time in the past for survey proposals (including participation of the PI as a Co-I on previous NOAO surveys), together with the current status of the data (cite publications where appropriate). Mark with an asterisk those allocations of time related to the current proposal. Please include original proposal semesters and ID numbers when available.*

This proposal is to provide final capstone data for our NOAO Survey program "Type Ia Supernovae in the Near-Infrared: A Three-Year Survey toward a One Percent Distance Measurement with WIYN+WHIRC" ⋆ 2012B-0500. and a final installment of WHIRC host galaxy templates that went uncompleted in the follow up program " Final Host Galaxy Observations for "SweetSpot": Calibrating the Supernova Host Galaxy Light and Environment" ⋆ 2015B-0347. We have observed over 100 SNeIa to date. This Survey program has resulted in one publication to date, [25]. A first data release paper and data set is currently in preparation.

PI Wood-Vasey was involved in the 6-year ESSENCE Supernova Survey (PI Suntzeff) that used the CTIO 4.0-m Blanco telescope to discover and study 200 Type Ia Supernovae to measure the dark energy equation-of-state during the past 8 billion years. This survey has so far led to 9 refereed publications with several more either submitted or in preparation for the coming year.

R. J. Foley et al. (2009), AJ, 137, pp. 3731-3742.
R. J. Foley et al. (2008), ApJ, 684, pp. 68-87.
S. Blondin et al. (2008), ApJ, 682, pp. 724-736.
A. C. Becker et al. (2008), ApJL, 682, pp. 53-56.
T. Davis et al. (2007), ApJ, Vol. 666, pp. 716-725.
W. M. Wood-Vasey et al. (2007), ApJ, Vol 666, pp. 694-715.
G. Miknaitis et al. (2007), ApJ, Vol 666, pp. 674-693.
S. Blondin et al. (2006), AJ, Vol 131, pp. 1648-1666.
K. Krisciunas et al. (2005), AJ, Vol. 130, pp. 2453-2472.

Observing Run Details for Run 1: WIYN/WHIRC

Technical Description *Describe the observations to be made during this observing run. Justify the specific telescope, the number of nights, the instrument, and the lunar phase. List objects, coordinates, and magnitudes (or surface brightness, if appropriate) in the Target Tables section below (required for queue and Gemini runs).*

We need to obtain 2 host galaxy references after both 2012B-0500 and 2015B-0347 programs. Observations need to be at least 3 times as long as the longest exposure of the field when the supernova was live. Our template observations need to be better than our supernova observations for accurate template subtractions. LSQ14xi was observed in J for 41 minutes. So its host galaxy needs 123 minutes which equals five 5x5x15" scripts yielding 125 minutes. ASASSN-15fs was observed in Ks for 16 minutes. So its host galaxy needs at least 48 minutes which equals 2 5x5x15" scripts yielding 50 minutes.

Instrument Configuration

Filters: J, H, Ks	Slit:	Fiber cable:
Grating/grism:	Multislit:	Corrector:
Order:	λ_{start}:	Collimator:
Cross disperser:	λ_{end}:	Atmos. disp. corr.:

R.A. range of principal targets (hours): 12 to 19

Dec. range of principal targets (degrees): -14 to +44

Special Instrument Requirements *Describe briefly any special or non-standard usage of instrumentation.*

Target Table for

Obj ID	Object	α	δ	Epoch	Mag.	Filter	Exp. time	# of Lunar exp.	# of Lunar days	Sky	Seeing	Comment
001	LSQ14xi	12:30:41.2	-13:46:22	2000.00		J	60	125	14	phot	1	
002	ASASSN-15fs	18:58:40.8	+43:28:08	2000.00		Ks	60	50	14	phot	1	