

Wood-Vasey DOE #SC0011834 Final Report

1. DOE #209072 – University of Pittsburgh

2. “Dark Energy Measurements Using Type Ia Supernovae in the Era of the Large Synoptic Survey Telescope”

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3. Report dated 2017 August

Covers period: 2014 May 1 - 2017 March 31

Focuses on the last period: 2016 April 1 - 2017 March 31

4. Accomplishments

During the past reporting period (Year 3), this grant has provided partial support for graduate students Daniel Perrefort and Kara Ponder. They have been working exploring different aspects of the technical work needed to take full advantage of the potential for cosmological inference using Type Ia supernovae (SNeIa) with LSST.

Daniel Perrefort developed software to model the absorption spectrum due to precipitable water vapor in the atmosphere based on dual-band GPS measurements. This modeling is key for obtaining accurate and well-calibrated broadband imaging observations in the i , z , and y astronomical bandpasses (700-1100 nm). Modeling the spectral energy distribution of the light from a supernova together with the detailed absorption profile from the atmosphere allows is important in successfully comparing flux from different supernovae at different redshifts to determine their relative distances. This determination of relative distances of Type Ia supernovae as a function of redshift is the key measurement enabling us to probe the nature of dark energy using this technique.

Kara Ponder published a paper on using generalized likelihood analyses beyond simple chi-squared analyses to incorporate astrophysical systematics that can affect SN Ia distance measurements (Ponder et al. 2016, ApJ, 825, 35). This framework allows for the addition of functional forms for systematics as they are mapped out over the coming years. Using a specific functional form and distribution allows for the self-consistent fitting for or marginalizing over given classes of systematics for SNeIa.

PI Wood-Vasey and graduate student Ponder have also been significantly involved in the LSST DESC management activities during this grant. Wood-Vasey served as the LSST DESC Supernova Working Group co-convener from 2012–2016 and has served on the LSST DESC Publications Policy Board from 2016-2017. Ponder served on the LSST DESC Collaboration Council from 2014-2016.

5. Papers and Software

We published one paper and one software product, and contributed to a white paper:

- K. A. Ponder, W. M. Wood-Vasey, A. R. Zentner “Incorporating Astrophysical Systematics into a Generalized Likelihood for Cosmology with Type Ia Supernovae” 2016, ApJ, 825, 35
- The Precipitable Water Vapor software developed by Daniel Perrefort is available at https://github.com/mwvgroup/pwv_kpno
- In previous performance years, contributions were also made to a white paper exploring the scientific advantages of joint analyses of LSST together with the space missions Euclid and WFIRST. Bhuv Jain, David Spergel, et al., <https://arxiv.org/abs/1501.07897>

6. Personnel

Graduate students supported by this grant: * Wei Hu: 6 months, 2014-2015. * Eda Gjergo: 6 months, 2014-2015. * Kara Ponder: 12 months, 2015-2016. * Daniel Perrefort: 6 months, 2016-2017.

In the first period (Year 1), this grant supported 2nd-year graduate student Wei Hu in the summer of 2014 and again in the first 3 months of 2015 (total of 4 months during this reporting period); 1st-year graduate student Eda Gjergo (total of 6 months); and 50% support to 3rd-year graduate student Kara Ponder starting in the spring of 2015. In the second period (Year 2), Kara Ponder was partially supported by this grant. In the third period (Year 3), Kara Ponder and Daniel Perrfort were supported by this grant.

Kara Ponder graduated with her PhD effective 2017 August.