

September 12, 2016

# NESSF CLOSING REPORT

SHARON XUESONG WANG

PI: JASON T. WRIGHT

## 1. DEGREE AND PROGRAM TIMELINE, AND POSTDOCTORAL EMPLOYMENT

Ph.D., Astronomy & Astrophysics, with Ph.D. minor in Computational Sciences, the Pennsylvania State University

Thesis defense passed on May 31, 2016

Degree officially awarded August 13, 2016

Fellowship terminated on June 26 (as set by immigration status and graduate program timeline)

### **Postdoctoral employment:**

Carnegie Fellow in Astronomy and Planetary Science, starting Sep 1, 2016

Department of Terrestrial Magnetism (DTM), Carnegie Institution for Science, Washington DC

## 2. SYNOPSIS OF RESEARCH

The research plans laid out original proposal are:

1. removing the  $> 1$  m/s radial velocity (RV) systematics caused by telluric lines;
2. validating the calibrator: the iodine atlas for several instruments;
3. improving the wavelength-dependent statistical weighting;
4. improving data reduction and instrument modeling.

We have made significant progress on all fronts, including:

1. We characterized the effects of telluric lines in iodine-calibrated RVs for the first time (20 cm/s in amplitude for induced spurious signals and adding 60 cm/s RMS to RV error budget). Some results are published in Halverson et al. (2016)

and mentioned as brief summary in Fischer et al. (2016). First author manuscript in preparation.

2. We have identified one of the leading RV systematic errors (also likely the largest) in Keck/HIRES - the errors in the deconvolved stellar template. This is recognized and characterized for the first time.
3. We have identified the cause behind the discrepancy between the iodine cell atlases (from FTS scans) of HET/HRS to be temperature variations. We have employed a theoretical code for generating iodine lines at various temperatures, and identified the different temperatures for different iodine atlases. Temperature variation is likely the primary cause of HET/HRS's "under-performance" in RV precision in comparison to Keck/HIRES (3-6 m/s vs. 1-2 m/s). We plan to publish this result in the near future.
4. We have developed the core portion of the next-generation Doppler code, which extracts RV from high-resolution spectra using MCMC with a Gaussian Process capability. The code will be used for RV extraction for MINERVA and NASA WIYN-NEID.

### 3. PUBLICATION LIST

Total publications: 15, with 4 as first or second author, 11 as contributing author.

Total citations: 312 (196 citations as first or second author), h-index: 11, as of Sep. 2016.

#### **Ph.D. Thesis:**

*On Detecting New Words: The Art of Doppler Spectroscopy Using Iodine Cells*,  
available on NASA/ADS.

#### **Publications as a Major Contributor:**

4. The Exoplanet Orbit Database II: Updates to exoplanets.org, Eunhyu Han<sup>+</sup>, Sharon X. Wang, Jason T. Wright, et al. 2014, PASP, 126, 813 (<sup>+</sup> Undergraduate student co-supervised)
3. The X-ray Properties of the Submillimeter Galaxies in the ALMA LABOCA E-CDF-S Submillimeter Survey, Sharon Xuesong Wang, W. Niel Brandt, et al. 2013, ApJ, 778, 179
2. The Discovery of HD 37605c and A Null Detection of Transits of HD 37605b, Sharon Xuesong Wang, Jason T. Wright, et al. 2012, ApJ, 761, 46
1. Tracking Down the Source Population Responsible for the Unresolved Cosmic 6-8 keV Background, Yongquan Xue, S. X. Wang, et al. 2012, ApJ, 758, 129

### Other Publications:

11. A comprehensive radial velocity error budget for next generation Doppler spectrometers, Samuel Halverson, and other 16 coauthors including Sharon Wang, 2016, SPIE, 9908P, 20
10. State of the Field: Extreme Precision Radial Velocities, Debra Fischer et al. including Sharon Xuesong Wang, 2016, PASP, 128, 964, 06601
9. The Distribution of Star Formation and Metals in the Low Surface Brightness Galaxy UGC 628, Young, J. E.; Kuzio de Naray, Rachel; Wang, Sharon X., 2015, MNRAS, 452, 2973
8. Evolution in the Black Hole—Galaxy Scaling Relations and the Duty Cycle of Nuclear Activity in Star-forming Galaxies, Mouyuan Sun, and other 8 coauthors including Sharon X. Wang, 2015, ApJ, 802, 14S
7. The California Planet Survey IV: A Planet Orbiting the Giant Star HD 145934 and Updates to 7 Systems with Long-Period Planets, Katherina Y. Feng, Jason T. Wright, Ben Nelson, Sharon X. Wang, et al. 2014, ApJ, 800, 22F
6. MARVELS-1: A Face-on Double-lined Binary Star Masquerading as a Resonant Planetary System and Consideration of Rare False Positives in Radial Velocity Planet Searches, Jason T. Wright, Arpita Roy, Suvrath Mahadevan, Sharon X. Wang, et al. 2013, ApJ, 770, 119
5. Host Star Properties and Transit Exclusion for the HD 38529 Planetary System, Gregory W. Henry, Stephen R. Kane, Sharon X. Wang, et al. 2013, ApJ, 768, 155
4. The HD 192263 System: Planetary Orbital Period and Stellar Variability Disentangled, Diana Dragomir, and other 13 coauthors including Sharon X. Wang, 2012, ApJ, 754, 37
3. A Search for the Transit of HD 168443b: Improved Orbital Parameters and Photometry, Genady Pilyavsky, and other 15 coauthors including Sharon X. Wang, 2011, ApJ, 743, 162
2. Stellar Variability of the Exoplanet Hosting Star HD 63454, Stephen R. Kane, and other 12 coauthors including Sharon X. Wang, 2011, ApJ, 737, 58
1. Revised Orbit and Transit Exclusion for HD 114762b, Stephen R. Kane, and other 6 coauthors including Sharon X. Wang, 2011, ApJ, 735, L41

## 4. NOTABLE ACCOMPLISHMENTS, TALKS, CONFERENCES

Only the ones relevant to the proposed work are listed.

*Selected Participants, Aspen Summer Workshop on Approaching the Stellar Astrophysical Limits to Exoplanet Detection: Getting to 10cm/s*

*Paths, Roadblocks, and Byways in Detecting Habitable Rocky Planets in Radial Velocity Data*

Invited Talk, Carnegie DTM Exoplanet Seminar, Nov 2015

Invited Talk, Berkeley Center for Integrative Planetary Science Seminar, Sep 2015

NExSci Exoplanet Seminar, Sep 2015

Contributed Talk, Bay Area Exoplanet Science Meeting, Sep 2015

*Co-Chair, Breakout Discussion Session on Telluric Contamination*

The 2nd Extremely Precise Radial Velocity Workshop, Yale, Jul 2015

Co-author for the review paper for the workshop, Fischer et al. (2016).

*Improve RV Precision through Better Modeling and Better Reference Spectra*

Contributing Talk, The 1st Emerging Researchers in Exoplanet Symposium, Penn State, May 2015

*Pushing the Radial Velocity Precision to 1 m/s*

Stellar, Solar and Planet Seminar, Harvard/CfA, Oct 2014