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To the NESSF Program Managers:

I am writing to recommend renewal for Sharon (Xuesong) Wang's NASA Earth and Space Science Fellowship. Sharon has made very good progress on her project, I would say ahead of her proposed plan and schedule.

Ms. Wang is improving the radial velocity precision of the High Resolution Spectrograph at the Hobby-Eberly Telescope (HET/HRS) and the HIRES spectrograph at Keck Observatory for the purpose of detecting planets orbiting the nearest Sun-like stars. Of particular utility is using these telescopes to study the planetary systems the *Kepler* spacecraft is discovering with rocky planets in the "Habitable Zone"[1]. HET and Keck are the only two large (8–10 meter class) Northern Hemisphere telescopes capable of precise radial velocity measurements, which we use to discover and characterize the orbits of planets orbiting other stars. Sharon has also begun applying this expertise to the MINERVA project at Mount Hopkins, which employs small (0.7-meter) telescopes to find planets orbiting the nearest stars, and will perform important *TESS* followup observations.

Ms. Wang has successfully determined the power spectrum of the Keck/HIRES and HET/HRS instrumental responses, which has become a key tool for diagnosing their abilities (and limitations) in measureing precise Doppler velocities. This power spectrum reveals to us the nature of the missing components of our models of the HET/HRS instrumental response.

Ms. Wang also managed a successful visit to McDonald Observatory to use the Tull spectrograph, which is the highest-resolution astronomical optical echelle spectrograph we are aware of. This 4-day run resulted in the highest signal-to-noise ratio and resolution spectrum of our iodine calibration cells ever made with an echelle. Ms. Wang is comparing these spectra to our spectra from Fourier transform spectrographs to diagnose any inadequacies in them as references for our work.

Ms. Wang is developing a new Doppler code "from scratch" to work on the MINERVA array, and also for the new, upgraded HET/HRS. This code will be free of the inadequacies of the existing legacy code we use, with good

[1] The region around a star where an Earth-like planet or moon would have a surface temperature consistent with liquid surface water.

modularity and flexibility, proper documentation, and modern programming practices.

Ms. Wang has also developed a comprehensive model of the effects of the Earth's atmosphere on stellar spectrum, which she uses to produce realistic synthetic stellar spectra with known Doppler shifts, as they would actually be observed at our telescopes. By feeding these spectra to her Doppler code, she can determine the exact effects of these telluric lines, including innumerable "microtellurics" on our Doppler measurements. Her prior work has revealed that these effects are important at the 1-3 m/s level; this new work will make sufficiently precise descriptions of the effect that we will be able to remove them.

As you can see, Sharon has made outstanding use of her first year's NESSF. I am eager to see what advances her next year brings, and the planets we will discover and characterize as a result.

Jason T Wright
Assistant Professor of Astronomy