NDSEG Essay 1 (transit)/ Ryan Yamada / Advisor: James P. Lloyd

The search for extrasolar planets has been popular, prolific, and a driver of advanced technology. Nearly all of the 160+ known extrasolar planets were found with optical radial velocity (RV) surveys; however, these surveys select for Jupiter-sized planets in close orbits around sun-like stars. To detect smaller planets around a more complete sample of stars, observations of low-mass stars (M, L, T dwarfs) are necessary. My advisor, Dr. James Lloyd, is an expert in adaptive optics (AO) and interferometry at Cornell. We have the ambitious goal of observing in infrared wavelengths to detect Earth-like extrasolar planets around the untouched realm of dim, low-mass stars.

On an NDSEG Fellowship I will design and execute complementary RV and transit near-infrared searches to discover and characterize planets around low-mass dwarf stars. This project is inspired by my previous experience with differential photometry and the lure of using cutting-edge technology to find other Earths around nearby stars.

In order to maximize efficiency and sensitivity in a transit search, we need to choose the filter that will yield the most precise differential photometry for cool dwarf stars. I am currently researching this question, paying particular attention to the effects of atmospheric absorption and instrument response for a range of facilities. I will then use data from the UKIRT Infrared Deep Sky Survey to identify a few dozen promising candidates among the thousands of late-type dwarfs in the local solar neighborhood. I will then design and execute a survey to monitor these targets for variability. The requirements of time and advantages of a wide field of view suggest using a number of reasonably small robotic telescopes to survey a large portion of the sky. I will develop a robotic telescope system (camera, optics, filters, computer, and software) for targeted photometric observations of transit candidates.

Transits are useful for identifying the planet's radius and orbital orientation, but RV spectra are needed to determine the planet's mass. Follow-up spectral observations of transits will allow us to characterize its mass and atmosphere; to do this I will use an externally dispersed interferometry (EDI) system (Erskine, 2003) for the TripleSpec spectrograph on the Palomar 200-inch. Funded by a NSF/ETI grant, the EDI will vastly improve the resolution of infrared RV surveys. Both TripleSpec and the EDI are being built by Cornell faculty and their collaborators. RV and transit studies will open up an uncharted and rich area of study, and will drive technology in detectors, filters, optics, and space systems.

The search for extrasolar planets is popular, prolific, and a driver of advanced technology, and serves as a way to inspire the STEM professionals of tomorrow. As a professor or researcher in a national laboratory, I hope to play a role in encouraging the development and pursuit of technology and goals that will strengthen United States science.