Detection and Characterization of Exoplanets with a Starshade

Abstract

"Are we alone?" This question has been around for thousands of years. Exoplanet Exploration is our attempt to find out the answer. Here, exoplanets are the planets around other stars. There are many ways to find an exoplanet. Methods such as Transit, Radial Velocity, Gravitational Microlensing have been very successful in measuring mass and periods of more than 3000 planets. [1] However, these methods of planet detection observed changes in light from a star--indirect evidence. The only method that gives us direct evidence is called Direct Imaging. Direct imaging measures the light from the planet. The spectrum of an exoplanet tells us about its composition, thermal structure and so on. Furthermore, the chemistry composition can infer the details of its formation. It may also reveal life. Last but not the least, it fulfills humanity's intrinsic cognition need: "Seeing is believing".

The fundamental challenge of Direct Imaging is to block out the extremely bright star close to the small and dim planet. Using a Starshade is a powerful solution. The actual scale is too big to test on the ground. Therefore, we we must rely subscale tests and modeling to predict the on-sky performance of a Starshade. Thus, the first part of my work is to generate simulted images past a Starshade. I will build a model of Starshade imaging considering the effects of various defects of the Starshade and the dynamics of the system. Then, I will adapt the image processing methods such as Locally Optimized Combination of Images (LOCI) and inversion method in Bayesian framework for the Starshade case. In addition, I will carry out some scaled-down experiments to show the feasibility and effectiveness of the formation flying control of a Starshade.

References

[1] "5 ways to find an exoplanet," NASA's Jet Propulsion Laboratory, 8 5 2017. [Online]. Available: https://exoplanets.nasa.gov/interactable/11.