Project Title: Discovering Exoplanets

***Just twenty years have passed since the discovery of the first planet beyond the Solar System, and over 5000 exoplanets have been found. The limit on detection has reached Earth-like planets and some are habitable. Studying exoplanets recasts our view of our own Solar System. In no more than 750 words, address the following questions about planets near and far.***

1. ***What are the two main, indirect methods for finding exoplanets?***

The two main, indirect methods for discovering exoplanets are the Doppler method and the Transit method.

The Transit method relies on the orbit of the planet around the star is such that the planet passes directly in front of the star from our perspective. This transit in front of the star allows us to perceive a small dip in the luminosity of the star. With enough, regular transits for a given planet, confidence grows in the discovery of a new exoplanet.

The Doppler method takes advantage of the wobble in a planet caused by reflex motion or gravitational pull on the star from the orbiting planet. This reflexive motion manifests a small Doppler shift in the star’s emission allowing us to ascertain the presence of a planet. Like the Transit method, this method only works for certain geometries, namely the Doppler method relies on the planet not orbiting on the plane of the sky or else no such shift may be perceived from our point of view.

1. ***Why is it so difficult to see exoplanets directly in an image?***

Imaging exoplanets is largely difficult because of two factors. First, so little light from a star is reflected off the planet (e.g. 100 millionth the star’s light is reflected off a Jupiter-sized planet, and 1 billionth for an Earth-sized planet). The light we can then see is attenuated at a proportion inversely related to its distance from us. Secondly, the first fact may not be such an obstacle if these planets weren’t near their star which is orders of magnitude brighter. From our perspective, there is a very small angular difference between the star and the planet and it is very difficult to confidently image and identify a relatively dim planet in such close proximity to its star.

In cases where imaging has been successful, it is often when the planet is much colder and further out in its orbit from the star. This increase in angle and difference in temperature increases our ability to image the planet in the infrared spectrum.

1. ***What are some similarities or differences between our Solar System and new, distant planet systems? Provide at least one similarity and/or difference.In the last few years, thousands of extrasolar planets have been discovered, including some that are Earth-like and possibly habitable.***

One similarity between our Solar System and the newly discovered, distant planet systems is that several of the planets found are of similar size to Earth and the planets within our system (e.g. 700 planets within a factor of three Earths and 300 truly Earth sized). While there is an absence of many large planet in the catalog of discovered exoplanets, the hypothesis is that these planets have such long orbits (on the order of 12 Earth years or longer) that we simply haven’t been collecting data long enough or have been able to detect the periodicity of some planets.

A key difference between these distant, discovered planet systems and our own Solar System is the eccentricity of these exoplanets’ orbits about their stars. In our solar system, planets follow circular orbits about the Sun with eccentricity of less than 10%. In a large fraction of discovered exoplanets, this eccentricity routinely exceeds 10% and in some cases is as high as 50%. This leads astronomers to conclude that these distant planet systems may not be long term stable.