Project Proposal:
Confirming Exoplanet Transit Signals Through Ground-based Observational Image Analysis

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(Dated: October 15, 2015)

Search for periodic exoplanet transits through ground based observational image analysis and search for time varying transit signals in select star systems.

I. INTRODUCTION

We propose to confirm the existence of a known exoplanet. There are several methods for determining the existice of an exoplanet; these include direct imaging, the doppler method, gravitational microlensing, and the transit method. We will use the transit method for our observations. The transit method of exoplanet detection takes advantage of the exoplanet's orbital geometry relative to an Earth observer's line of sight. The exoplanet must pass directly between the Earth and the host star. As the exoplanet intersects the line of sight to the star, there is a decrease in the observed flux from the star.

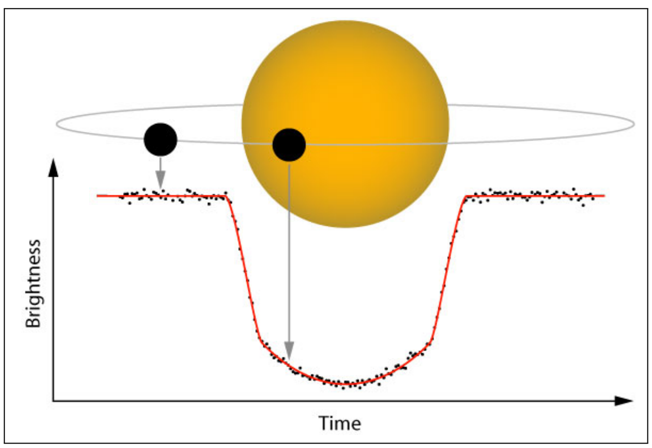

Figure 1. Geometry of exoplanet light curve in the transit method.

The decrease in brightness is directly proportional to the cross-sectional area of the planet compared to the star - assuming a uniformly illuminated disk of the star with no limb darkening and that the $\Delta Flux$ is taken at the centroid, c of the transit signal.

$$\Delta Flux_{t=c} = \frac{A_p}{A_s} = \frac{\pi R_p^2}{\pi R_s^2} = \left(\frac{R_p}{R_s}\right)^2 \tag{1}$$

If the size of the star is known then the radius of the candidate exoplanet can be determined.

Since the first exoplanet was discoveries in 1992, scientists and observers have quickly complied a vast expanse of knowledge in exoplanetology including invaluable catalogs of exoplanet candidates. Such examples include professional endeavors such as the Kepler Space Telescope and the James Webb Telescope, and amateur efforts such as the Exoplanet Transit Database from the Czech Astronomical Society. Using these resources, it is possible to begin making observations of stars that host exoplanet candidates in order to confirm past observations of their existence. It may even be possible to determine if a time varying transit signal is observable for the chosen systems. This time varying signal would likely be indicative of another exoplanet candidate in the observed star systems. It is similar to the precession of Mercury's orbit due to the gravitational influence of Jupiter.

II. SETUP

The data obtained from the images will allow for several of the candidate exoplanet properties to be estimated including: period of oribt, semi-major axis, effective planetary surface temperature, spatial relation to the habitable zone, the planetary radius, the exoplanet's density, and the potentially the exoplanet's mass.

If the radius of the star is known then it is possible to determine the radius of the observed planet using Equation(1). Am important parameter to consider is the period of the planet. There are two possible outcomes from our determination of the period. First, if the period is constant then we may determine the semi-major axis of its orbit if the mass of the star is known. Second, if the periods vareis from orbit to orbit then there is most likely other planets in the system whose gravitational influence is affecting the observed exoplanet's orbit.

III. DESCRIPTION OF OBSERVATIONS

Once a candidate star is chosen for observation, the specific conditions of our observing will slightly change. The nights needed for observation will be in the range of late October to November; with this in mind, a potential exoplanet candidate must be chosen with the proper RA and Dec. The RA coordinates should be between 23h and 3h for optimal observations, allowing for up to four hours of observing during the transit event. Likewise, the declination must be around $40°N$. The field of view of the SBO 24" telescope is **[SOMETHING]** square

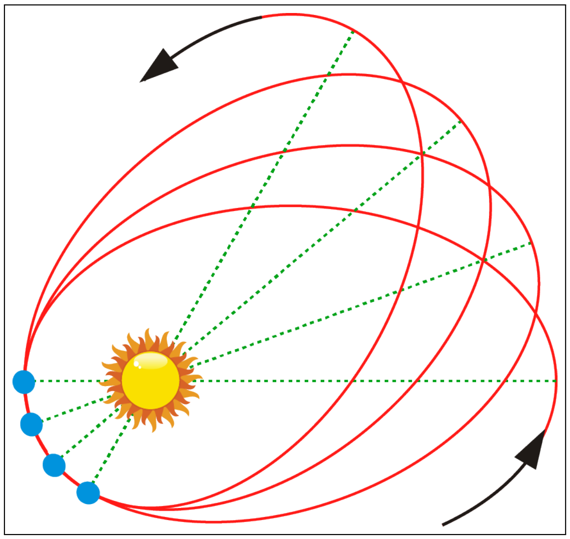

Figure 2. Transit time variations (TTV) can be observed from precessing exoplanet orbits.

arcseconds, which will need to include the host star of the exoplanet candidate and a good comparison star. An online exoplanet database, *Exoplanets Data Explorer* (http://exoplanets.org/table)will be used to determine a list of exoplanet candidates. The criteria for these candidates is (1) that the host star be between magnitude 8 and 15 and (2) that the exoplanet candidate have a transit depth of at least 1% decrease in flux. With these criteria, a well defined light curve with high SNR can be established for the observation.

IV. RESULTS

The image analysis shows that the period of the observed exoplanets is [**SOMETHING**].

The signal to noise ratio is [**SOMETHING**].

The measured properties are [**SOMETHING**].

There [**WAS / WAS NOT**] transit time variation signals observed.

V. CONCLUSION ("KNOCK-DOWN")

Our measurements allow us to constrain the following important properties to [**THIS / THESE**] systems [**SOMETHING**]