Monitoring Extra-Solar Planets at Tarleton State University

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Methods of Detection

Astrometry

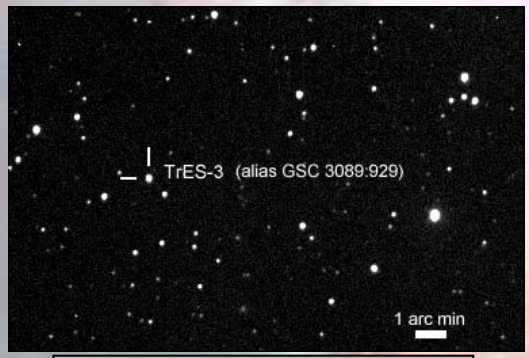
This consists of precisely measuring a star's position in the sky and observing the ways in which that position changes over time. The gravitational influence of an orbiting planet will cause the star itself to move in a circular or elliptical path about the system's center of mass.
One advantage of this method is that it is more sensitive to planets with large orbits. However, for this reason it can take years of observing to confirm the presence of a planet.

Radial Velocity

Variations in the speed with which a star moves towards or away from Earth can be deduced from the displacement in the parent star's spectral lines (a line in a spectrum due to the absorption or emission of light at a discrete frequency) due to the Doppler effect. The goal is to measure variations in the speed with which the star moves toward or away from Earth.
This is by far the most productive technique, but it requires very high accuracy in the methods of detection.

Transit

If a planet crosses in front of its parent star's (from our perspective), then the observed brightness of the star drops by a small amount. The amount by which the star dims depends on the star's size and on the size of the planet.



Future Work

At this stage of our research, we have confirmed that our telescope is indeed capable of detecting extra-solar planets. After sufficiently improving our techniques of detection and analysis, we will proceed to participate in the international collaboration of planet-hunting.

Acknowledgements

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Introduction

An extra-solar planet is a planet which orbits a star other than our Sun. While not confirmed until 1988, the existence of such planets has long been assumed to be plausible; the possibility was noted as early as 1713 by Isaac Newton.
It is estimated that at least 10% of sun-like stars have a planetary system.
To date, 313 extra-solar planets have been detected and confirmed.

Our Project

We measured the transits of known extra-solar planets using Tarleton State University's 32" telescope and analyzed the data using differential photometry. The data presented represents our efforts to improve our detection and data analysis techniques for future efforts of detecting unknown extra-solar planets.

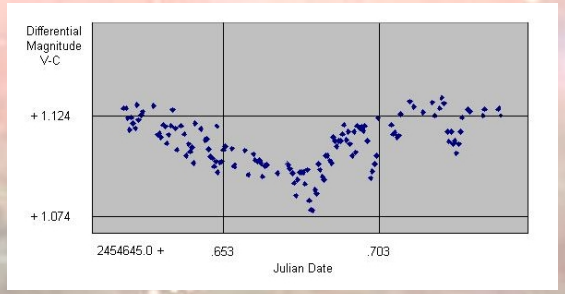
Discussed here is TrES-3, a planet with nearly twice the mass of Jupiter, a semi-major axis of 0.0226 (± 0.0013) AU, and an orbital period of 1.30619 (± 1e-05) days. It orbits a star 1300 ± 600 light-years away in the constellation of Hercules. It was discovered in 2007 by O'Donovan, et al.

TrES-3 is of great interest due to its close proximity to its parent star, and also its degenerative orbit. This means that the planet is gradually getting closer to its sun, and will eventually collide with it.

We used the transit method to measure the star's emitted radiation using a CCD camera during a time interval previously determined to coincide with the planet's transit, then compared the variation of the star's emitted light with that of the average emitted light of several neighboring stars with constant brightness.

The resulting light curve, showing TrES-3's brightness with respect to time, clearly displays a "dip", indicating that we detected the planet crossing its star. We compare our light curve to that of another research group's to confirm the accuracy of our detection.

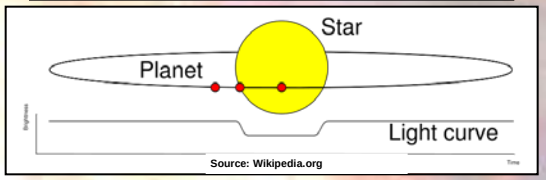
Our Results



The Transit Method

This method consists of taking multiple exposures of a star and comparing its relative brightness with respect to time. When a planet transits over the star from the perspective of an observer, blocking some of the star's light for a short time, a dip appears in the graph.

One major disadvantage of the transit method is that the planet's orbit would need to be aligned in such a way that we are able to detect it; it is estimated that only 10% of small planetary orbits have such an alignment, and that this percentage decreases for planets with larger orbits.



Differential Photometry

Photometry is a technique of measuring the flux, or intensity of an astronomical object's electromagnetic radiation. Photometry is performed by gathering radiation with a telescope, sometimes using specialized optical filters, and recording the light energy with a CCD camera.
Afterward, the relative brightness of the star, compared to the steady brightness of nearby constant stars, can be compared over time.

Results from the Kobdilj Observatory