EPSC Abstracts
Vol. 6, EPSC-DPS2011-40-3, 2011
EPSC-DPS Joint Meeting 2011

Study of TrES-3 Exoplanet

A. Q Vodniza, M. Rojas and K. Reyes

University of Narino Observatory, Nariño, Colombia (aquijanov@gmail.com / Phone: 57-2-7360275)

Abstract

The first amateur observation of an exoplanet was made from the Nyrola Observatory in September 16, 2000. (Marko Moilanen, Jalo Ojanperä, Jouni Sorvari, Aki Id and Arto Oksanen). The jovian-type planet orbits a star that is 153 light years far away, and was called HD209458b in Pegasus [1]. The equipment used by this Observatory was a 16 inches MEADE LX200, a ST7E CCD SBIG camera with a V photometric filter and an f/6.3 focal distance reducer. At the University of Nariño Observatory we have a similar equipment. The equipment we employed is: 14"LX200 GPS MEADE telescope and STL-1001 SBIG. The camera we used in our search is much more sensible than the one used by the Nyrola Observatory [2]. From the Astronomical Observatory at the University of Nariño-COLOMBIA, we begun a systematic search for exoplanets. We have already confirmed the transit of the exoplanet TrES-3. This exoplanet was discovered by O'Donovan and other investigators, and turns around the GSC 03089-00929, with an orbital period of 1.30619 days (31.34856 hours) and inclination of 82.15 deg [3]. The TrES-3 is quite interesting because it has one of the smallest periods found on exoplanets. Jessie L. Christiansen, et.al. observed seven transits and they found that the duration of transit is 81.9+/-1.1 minutes and inclination of 81.99+/-0.30 deg [4], [5]. We have captured a lot of data to elaborate the lightcurves so we can estimate the physical parameters of the exoplanet.

1. Introduction

To develop high precision photometry (thousandths of magnitude) associated with exoplanets' transits, we must take into account the following: The exposure time must not be too small in order to avoid the exposure time being comparable with the download time of the images. Shorter times produce the equivalent effect of an artificial "vignetting". The exposure time of the flat frames must be between 1 and 20 seconds. We must ensure that the stellar image is formed at the same zone of the chip (similar pixels) to reduce defects of the flat frames. In the same way it's better to use the 1X1 option in the binning operation. We should use the right exposure time in order to get a good signal-to-noise relation without the "blooming" effect, because otherwise lineality is lost. Several images must be superimposed to obtain a big quality factor on the image. The flat frames must show a quality factor of 500:1 or better. An appropriate sampling to satisfy the Nyquist sampling rule is obtained if the image of a star takes up at least two pixels,. If the number of pixels is smaller, then there is loss in information. In general, to get an optimum image, the scale should be 2 arc seconds per pixel, though amateur astronomers have achieved excellent photometry with scales from 1 to 6 arc seconds per pixel. On telescopes with small focal distance the stellar images take up a few pixels. To succesfully achieve that the images of the stars take up 2 or 3 pixels, it is necessary to put the image slightly out of focus to make it larger.

1.1 Equations

During the transit, we have the following relation: [6]

$$\Delta L \sim (R_P / R_S)^2 \quad (1)$$

ΔL = reduction of the luminosity star
R_P = radius of the planet disk
R_S = radius of the star disk

Having the photometry data (precision on the order of the thousandth of magnitude) it is possible to calculate the radius and the mass of an exoplanet, if the radius is measured indirectly from the star.

If the distance between the star and planet is much greater than the radius of the star and the radius of the planet, then transit time is much smaller than the orbital period and is calculated using the equation [7]:

$$t_T = \frac{T R_S \sqrt{(1+q)^2 - b^2}}{\pi a \sqrt{1-e^2}} \left(\frac{r}{a}\right) \qquad (2)$$

where:
e = eccentricity of the orbit
r = distance star-planet during the transit
i = orbital inclination
q = R_P / R_S
b = (r cos i) / R_S

If the orbit is circular and the orbital inclination is 90 degrees, we have [8] :

$$t_T = \frac{T R_S}{\pi a}\left(1 + \frac{R_P}{R_S}\right) \qquad (3)$$

With Kepler´s law it is possible to calculate the semi-major axis [9] :

$$a = (T^2 G M_S / 4\pi^2)^{1/3} \qquad (4)$$

2. Summary and Conclusions

We developed high precision photometry on several pictures. Analyses carried out with the best data lead to the following results: length of the transit = (80.8 +/- 3) minutes, depth of the transit = (0.025 +/- 0.001) magnitudes, and orbital period = (31.23 +/- 0.12) hours. Also we estimated the exoplanet radio = 88227.547 km and the semi-major axis of the orbit = 0.0225 UA.

Acknowledgements

The autors would like to thank to University of Narino-Pasto-Colombia

References

[1]http://www.ursa.fi/sirius/HD209458/HD209458_eng.html

[2] http://www.ursa.fi/sirius/nytt/equipments.html

[3] O'Donovan,F., Charbonneau,D., et.al. TrES-3: A Nearby, Massive, Transiting Hot Jupiter in a 31-Hour Orbit. The Astrophysical Journal, 663:L37-L40, 2007 July 1

[4] Jessie L. Christiansen *et al.* The Astrophysical Journal, Volume 726, Issue 2, article id. 94 (2011).

[5]http://adsabs.harvard.edu/abs/2011ApJ...726...94C

[6] Caroline Terquem, Aikel Ajmia. Eccentricity pumping of a planet on an inclined orbit by a disc. Arxiv:1001.0657v1, p. 1 (2010).

[7] Yoshihide Kozai. The Astronomical Journal. Secular Perturbations of Asteroids with High Inclination and Eccentricity. Volume 67, Number 9, p. 591 (1962).

[8] Kasting James F, Whitmire Daniel P, Reynolds Ray T. Habitable Zones aroud Main Sequence Stars. Icarus, Volume 101, Issue 1, p. 108 (1993).

[9] C.D. Murray, S.F. Dermott. Solar System Dynamics. The Disturbing Function. Ed. 1 Cambridge University Press. p. 227, (1999).