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Observation of planetary transit in miniobservatories: a proposal for inserting the study of the exoplanets in physics teaching

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Abstract. In this work we are proposal a strategy to insert the study of exoplanets in the training courses of physics teachers and in the master's degree in physics teaching. For this we estimate a magnitude limit (10 mag) from an analysis of the observatory site light pollution and evaluation of the optical set technical features, detector CCD and telescope. We set a range of declination, $-60° < \delta < +15°$, due the urban area near observatory's site and using the Exoplanet Archive database we select 13 stars that can be observed by Unifal Astronomical Observatory. With this informations, we can obtain and analyze the light curve originated by the planetary transit and estimate the radius and orbital parameters of the exoplanet.

Resumo. Neste trabalho estamos propondo uma estratégia para inserir o estudo dos exoplanetas nos cursos de formação de professores de física e no mestrado em ensino de física. Para isso estimamos uma magnitude limite (10 mag) a partir de uma análise da poluição luminosa do sítio do observatório e da avaliação das características do conjunto óptico, detector CCD e telescópio. Definimos um intervalo de declinação, $-60° < \delta < +15°$, devido à zona urbana próxima ao sitio do observatório e utilizando o banco de dados Exoplanet Archive selecionamos 13 estrelas que podem ser observadas pelo Observatório Astronômico da Unifal. Com estas informações, podemos obter e analisar a curva de luz originada pelo trânsito planetário e estimar o raio e os parâmetros orbitais do exoplaneta.

Keywords. miniobservatories – exoplanets – planetary transit

1. Introduction

Since the first discovery in the 90's, Wolszczan et al. (1992), there are already more than 3500 exoplanets detected. Among them, there is a great diversity of characteristics already measured, such as, orbital parameters, the mass and the planet radius. This and other parameters are essential links to test formation models, structure and evolution of exoplanet (Maxted et al. 2010).

Some planet in the Solar System have a strong brightness, due to solar radiation reflected in their atmospheres or surfaces, besides being close to us favoring the obtaining of good images. But, detecting exoplanet is not an easy task, because the distance, the small size and bright contrast of the host star are just a few of the obstacles that must overcome. Facing this challenger, the technological development and the improvement of detection techniques are fundamental to overcome them. And currently the search and characterization of exoplanet have become one of the most attractive areas of modern astronomy.

Among the techniques used to detect them, we highlight the transit planetary (PTT), used in the Kepler Mission and that allowed the detection hundreds of exoplanets and with data still under analysis (Fischer et al. 2015). In 2018, the promising TESS (*Transiting Exoplanet Survey Satellite*) Mission propose to catalog more than 2000 exoplanets and of these, it is expected to detect about 300 with up to twice the Earth size. In this work, we will present a proposal to identify the exoplanets that can be observed in miniobservatories using the planetary transit technique as a strategy to insert the study of exoplanets in the training courses of physics teachers and in the master's degree in physics teaching.

In the section 2 we will highlight PTT. In section 3, we will describe our methodology. In section 4, we will present the preliminary results obtained for the Unifal Astronomical Observatory (UAO) and finally, in section 5 we will present the next step for this work.

2. Planetary Transit Technique

PTT is based on a simple phenomenon, just as it is observed in solar eclipses and occultations of Venus and Mercury. Thus, The PTT consists of the detection of exoplanet by means of the analysis of the light curve of the host star (see 1). Therefore, PTT is preferably employed to detect large mass exoplanets that are close to the host star (Fischer et al. 2015). And even PTT being limited to the exoplanets that are in the line of sight between the observer and star, in last year it has overcoming other techniques regarding number of techniques (Fischer et al. 2015).

From light curve analysis we can extract planetary parameters such as, exoplanet radius (Vanderburg et al. 2011), the orbital semi-major axis (Maxted et al. 2010) and orbital period (Martioli, 2006).

From the stellar structure theories to determine the star radius (R_*) and measure of maximum depth d, we obtain the planet radius (R_p).

$$R_p = R_* \left(\frac{\triangle F}{F}\right)^{1/2} \tag{1}$$

Measuring the time of consecutive transits, we determine the period, P.

$$P = \frac{\pi G M_* t^3}{4 R_*^3} \tag{2}$$

And, finally, by applying Kepler's third law, we can obtain the orbital semi-major axis, a.

$$a = \left(\frac{G M_* P^2}{4\pi^2}\right)^{1/3} \tag{3}$$

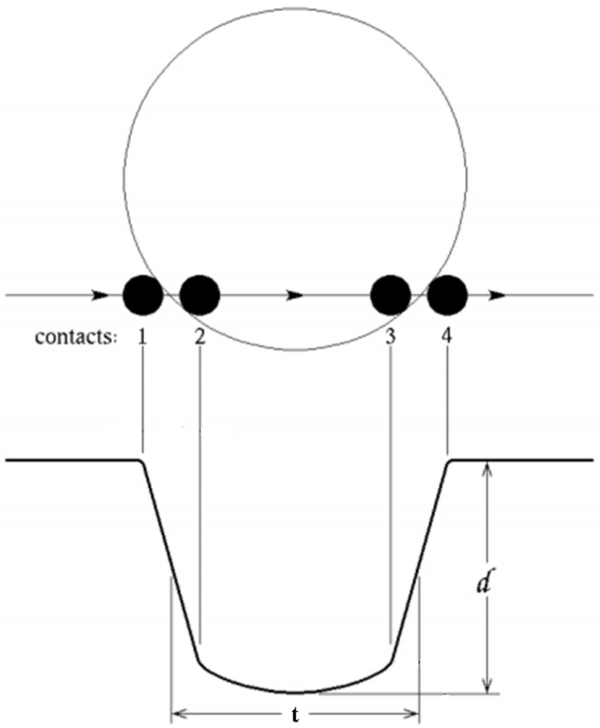

Figure 1. Light curve with observational parameters. (Brown et al. 2001)

3. Metodology

The UAO site is located in the urban area, it was necessary to measure the local light pollution using the technique of recording the limit magnitude with the naked eye. With this technique we have to identify the magnitude of the bright star to identify. From this analysis and evaluation of the optical set technical features, detector CCD and telescope, we estimate that the local limit magnitude as 10 mag.

Due the local light pollution, we have defined that the best objects to be observed should be located to the north. Thus, we defined the declination interval between $-60° < \delta < +15°$.

4. Results

With these parameters, we use the Exoplanets Archive database and select 13 stars that can be observed in the UAO.

Table 1. Stars with observation parameters

	Estrela	α (h m s)	δ (m s)	Mag
1	WASP-18	01 37 23.03	-45 40 40.4	9.30
2	WASP-7	20 44 10.23	-39 13 31.0	9.51
3	WASP-8	23 59 36.07	-35 01 53.0	9.79
4	KELT-11	10 46 49.74	-09 23 56.5	8.03
5	WASP-136	00 01 18.18	-08 55 34.8	9.98
6	WASP-69	21 00 06.19	-05 05 39.9	9.87
7	WASP-74	20 18 09.32	-01 04 32.4	9.70
8	HD106315	12 13 53.39	-00 23 36.5	8.95
9	WASP-76	01 46 31.86	+02 42 01.9	9.50
10	HD3167	00 34 57.52	+04 22 53.3	8.94
11	WASP-38	16 15 50.36	+10 01 57.2	9.44
12	HIP41378	08 26 27.85	+10 04 49.4	8.93
13	KELT-11	08 22 28.21	+13 44 07.1	9.28

5. Conclusion

Our next step to this work, it will be determine the best date to observe each star, and then, using PTT, estimate the radius and orbital parameters of the exoplanet.

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