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State of the art on the detection of exoplanets by the transit method with small instruments

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Abstract:

In this paper we report all exoplanets that have been discovered to date by the transit method. Also, we present the limit of detection by this method using the small instruments, and the specific information that can be deducted from the transit method. In addition, we present the detection and characterization of HD 189733b, the peculiarity of this exoplanet is that the flow of the target star is decreased significantly (~ 3%) during the transit. We determined the radius of the exoplanet **1.27 ± 0.03** ***R*J**, the impact parameter **0.70 ± 0.02**, and the inclination of the orbit **85.4 ± 0.1**°. The transit of the extrasolar planet HD 189733b is already done using the larger telescope. In this study, we used during the observation a telescope of modest size.

Introduction:

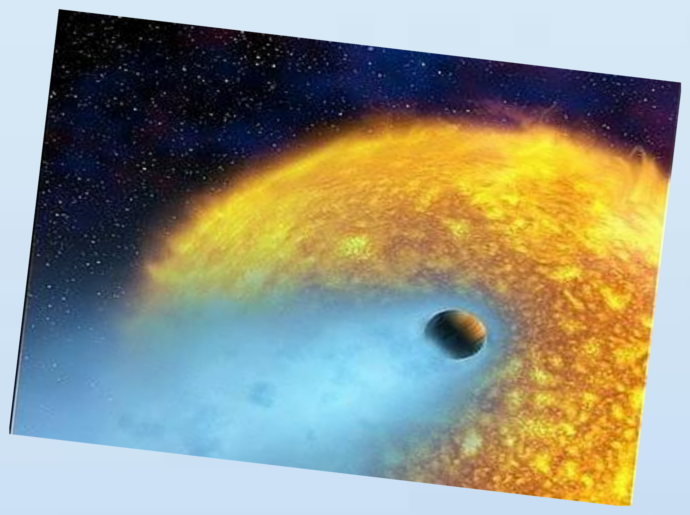
An extrasolar planet or exoplanet is a planet orbiting a star (or remnant of a star) beyond our Solar System. Detecting planets outside the solar system is an extraordinarily difficult with traditional methods of observation. First, because the planets do not emit much light by themselves and therefore are visible by reflection of the brilliance of their stars. Second, because these planets are close to a star, it emits a lot of light and will completely drown the faint of the planet. Finally, because the problem of atmospheric turbulence will as usual make a far more difficult for ground-based telescopes. For all these reasons, the search for extrasolar planets could not really begin until the late twentieth century with new methods and instruments of unprecedented accuracy.

The first definitive detection of an exoplanet orbiting an ordinary main-sequence star came in October 1995 with the announcement, by **Michel Mayor** and **Didier Queloz** of the University of Geneva, of an exoplanet orbiting the star **51 Pegasi**. This result represents the first proof of the non-uniqueness of the Solar System.

About 492 exoplanets had been discovered to date by different methods of detection, the vast majority of these planets have been detected with the radial velocity technique, and 101 exoplanets have been discovered by the transit method.

The limit of detection by the transit method

The transit method is effective for large planets in close orbit around their star (Hot jupiter) - the probability that a planet passes between us and its star is very low- impossible to detect from Earth a decrease of brightness <1% ,a planet of the earth size induces a decrease of 0.1% , so, from ground-based it's impossible to detect this kind of planets by the transit method .



Observations:

To acquire images of the transit, we went to Golf Atlas observatory in Marrakesh during Two nights of observation (nights 27-07-2010,28-07-2010), We have made acquisitions from a Celestron telescope type (**C14**) 3910 mm of focal and 35 cm in diameter which is a small tool for such detection. With a CCD camera **SBIG ST-7** giving a field of view of 12 x 8 arcminutes (Pixel Size of .9 x .9 arcseconds) attached to the end of the telescope (ocular), we have saved on a computer connected to the CCD a lot of images of the transit acquired with exposure time of 7 seconds and using a red filter.

Oukaimeden Observatory

The physical parameters specific to the planet inferred from the light curve:

The radius of the exoplanet:

$$R_{planete} = R_* \sqrt{\frac{\Delta F}{F}}$$

The impact parameter:

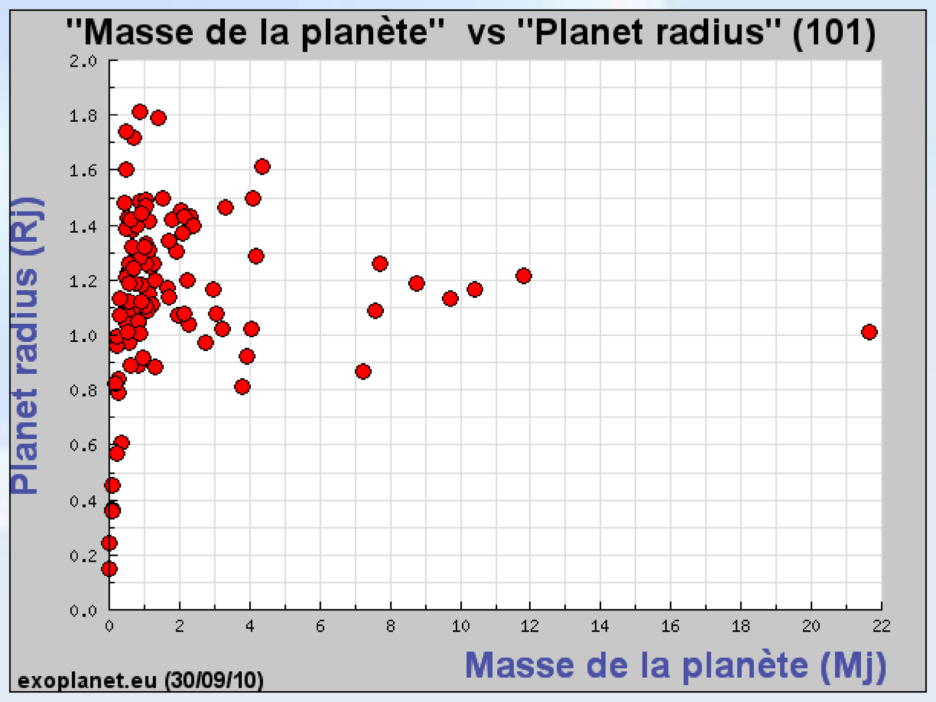
$$b = \left[\frac{(1-\sqrt{\Delta F})^2 - \frac{\sin^2\left(\frac{t_F \pi}{P}\right)}{\sin^2\left(\frac{t_T \pi}{P}\right)}(1+\sqrt{\Delta F})^2}{1-\frac{\sin^2\left(\frac{t_F \pi}{P}\right)}{\sin^2\left(\frac{t_T \pi}{P}\right)}}\right]^{1/2}$$

The inclination i :

$$i = \cos^{-1}\left(b\frac{R_*}{a}\right)$$

Conclusions and prospects::

In this paper we report the detection and characterization of HD 189733b, the peculiarity of this exoplanet is that the flow of the target star is decreased significantly (~ 3%) during the transit. And from the light curve obtained (Fig 2), we determined the radius of the exoplanet **1.27 ± 0.03** ***R*J**, the impact parameter **0.70 ± 0.02**, and the inclination of the orbit **85.4 ± 0.1**°. The transit of the extrasolar planet HD 189733b is already done by F. Bouchy and al (2005) with a 1.93-m telescope, but the main aim of our project is to make this observation with a modest size telescope. The result obtained has encouraged us to target other stars trying to detect an exoplanet not yet discovered.



The curve above represents the radii of all exoplanets (101 exoplanets) detected by the transit method according to their masses. from this curve we can notice that the radius of the vast majority of exoplanets is between 0.9 - 1.5 Mj

Where could we find the exoplanets?

Since the discovery of a planet orbiting the star 51 Pegasi in 1995 at Haute Provence Observatory, almost 492 planetary systems have been discovered. The only characteristic that seems to singularize out the host stars of these systems is their metallicity, these stars are on average much more 'metalic' than most other stars of field.

A new interpretation (Haywood .2009) suggests that the percentage of stars with giant exoplanets, or "rate of Jupiters," would depend on the density of H2 gas in the galactic disk.

The principle of the used technique:

The principle of our technique is to observe the light variations of the star to infer the presence of an extrasolar planet: is the transit method exoplanetary. A planet passing in front of the star leads inevitably reduced the amount of light (like an eclipse). It is this variation that we observe and study. And what we get as the first result will be called light curve (see **Fig.1**).

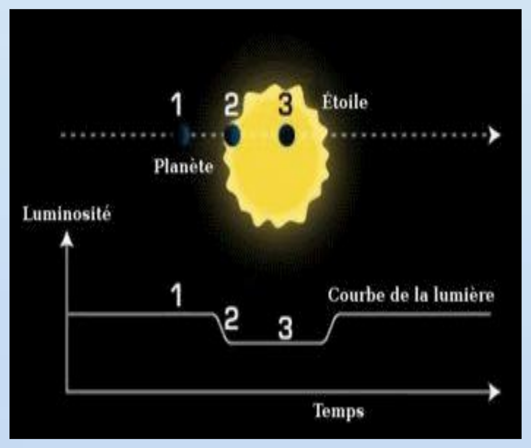


Fig.1 Example of a Light curve

Project presentation:

Our project focuses on the observation of exoplanets by a particular method of detection to draw then the physical parameters specific to planet.

It should be noted that our project in the first time is the observation of a planet already known as HD 189733b, but the main purpose is to verify the possibility of this observation with a telescope of modest size and in the average atmospheric conditions.

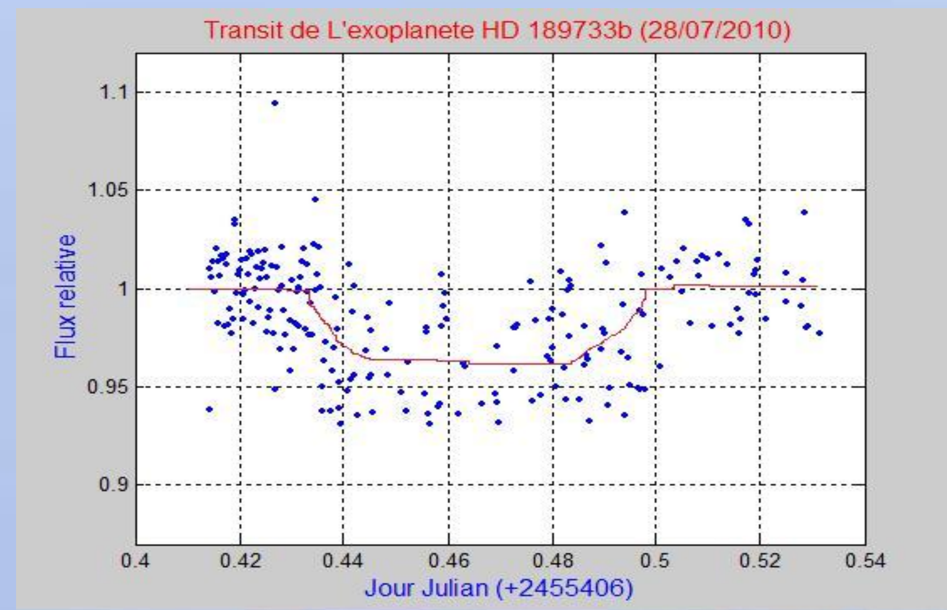


Fig.2
light curve of exoplanet HD 189733b