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Professional / Amateur collaborations in exoplanet science

A. Santerne
Centro de Astrofísica, Universidade do Porto, Rua das Estrelas, 4150-762 Porto, Portugal (alexandre.santerne@astro.up.pt)

Abstract

In this presentation, I will present the niches in exoplanet science where amateur astronomers can substantially contribute. These niches require either high-precision photometry or spectroscopy that are now within reach of amateur facilities. I will also discuss the perspective for future professional / amateur collaborations in the context of the upcoming *TESS* and *PLATO* space missions.

1. Introduction

Exoplanet science is a relatively new topic of modern astrophysics. Nearly 20 years ago, the detection of an extrasolar planet required a dedicated instrumentation. With the transfer of knowledge and the great improvement of amateur facilities in the past years, exoplanets can be detected by amateur astronomers with relatively small telescopes. This opens some niches where amateur astronomers can substantially contribute.

2. Transit timing

The study of transiting exoplanets required to have precise ephemeris on the transit epochs. Several years after the first transit detection, the uncertainty on the transit epoch can be larger than the transit duration. In that case, the transit ephemeris are lost (e.g. see Fig. 1 which clearly shows a trend in the transit times). It might require a lot of telescope time to recover those ephemeris, which might limit the characterisation of those exoplanets [9]. The observation of a few transits per year for each transiting exoplanet can avoid loosing transit ephemeris and allow future characterisation of the transiting planet (e.g. transit spectroscopy, Rossiter-McLaughlin effect, . . .). More than 200 transiting giant planets are known so far, which represent a lot of observations for a dedicated professional telescope, while a large community of amateur astronomers can substantially contribute.

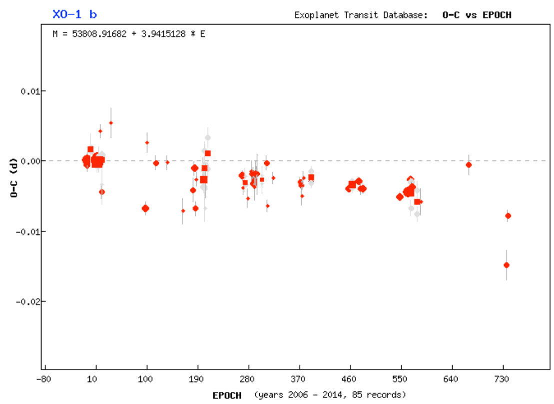

Figure 1: Transit times of XO-1 b [8] from the Exoplanet Transit Database [2].

Photometric follow-up observation of transits can also be used to better characterise transiting planets in multiple-systems that present large transit-timing variation (TTVs). For example, the *Kepler* space telescope detected a few long-period giant transiting planets that present large and not-well-understood TTVs. The follow-up of those systems after the end of the *Kepler* mission will allow a better characterisation of the planets' mass and the systems' architecture [9].

3. Radial velocity search of brown dwarfs

A team of amateur astronomers led by C. Buil[1] were able to detect the radial velocity variation of four exoplanets with a 60-cm telescope and a commercial echelle, fiber-fed spectrograph (spectral resolution of 10000 - see Fig 2). Those exoplanets were discovered only 15 years before with professional telescopes of aperture up to 10m.

This pioneer amateur detection by radial velocity of a sub-jupiter mass object (51 Peg b) opened a new niche for amateur facilities (see also [6]). Transit

[1] see http://www.astrosurf.com/buil/extrasolar/obs.htm

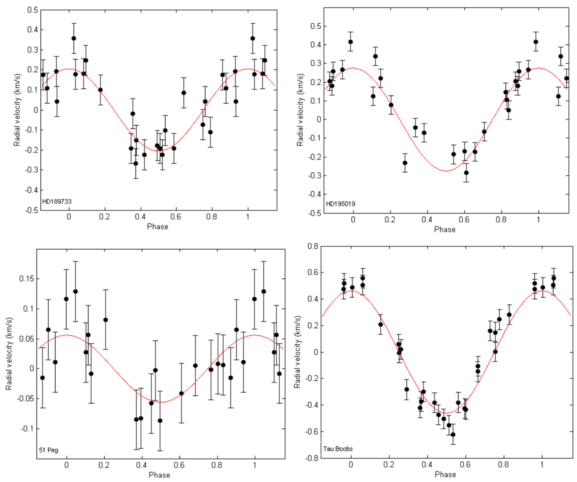

Figure 2: Amateur radial velocity detection of the planets HD189733 b [1], HD195019 b [5], 51 Peg b [7] and τ Bootis b [3] with the eShel spectrograph (Shelyak Instruments): see http://www.astrosurf.com/buil/extrasolar/obs.htm

surveys discovered a few brown dwarfs orbiting fast-rotating, relatively metal-poor early-type stars within a few days of period (e.g. [4]). Those brown dwarfs have not been found in radial velocity surveys, most likely because those brown-dwarf host were rejected from the survey selections based on their fast rotation which limits the detection of low-mass planets. An amateur radial velocity survey of fast-rotating bright early-type stars might allow the discovery of new objects in the brown-dwarf desert.

4. Perspective of future professional / amateur collaboration on exoplanets

The future *TESS* [11] and *PLATO* [10] space missions will target bright stars to search for new transiting planets. These missions have relatively large pixel size (nearly 15”) and photometric mask in which a lot of astrophysical false positive might reside [12]. An efficient collaboration between professional and amateur astronomers will be also extremely useful for the ground-based photometric follow-up of these two missions in order to rule out background eclipsing binaries, decrease the exclusion radius for planet validation [12] and refine transit candidates ephemeris. Since these missions will target bright stars, amateur astronomers might also participate in the radial velocity follow-up to exclude obvious eclipsing binaries or even to characterise the mass of giant planets.

Acknowledgements

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