EPSC Abstracts
Vol. 8, EPSC2013-820-2, 2013
European Planetary Science Congress 2013

Transiting planets around cool stars: results of the first year of the APACHE survey

P. Giacobbe(1,2), M. Damasso(2,3,4), A. Bernagozzi(4), E. Bertolini(4), P. Calcidese(4), A. Carbognani(4), D. Cenadelli(4), J.M. Christille(4,5), L. Lanteri(2), M.G. Lattanzi(2), L.R. Smart(2) and A. Sozzetti(2)
(1) University of Trieste, Italy (giacobbe@oats.inaf.it)
(2) INAF-Osservatorio Astrofisico di Torino, Italy
(3) University of Padova, Italy (mario.damasso@studenti.unipd.it)
(4) Observatory of the Autonomous Region of the Aosta Valley, Italy
(5) University of Perugia, Italy

Abstract

The APACHE survey is a long-term program aimed at discovering small-size planets orbiting selected relatively bright M dwarfs in the solar neighbourhood, using the photometric transit method. By using an array of five 40-cm telescopes, located at the Astronomical Observatory of the Autonomous Region of Aosta Valley (Italy), APACHE is the only project in Europe devoted to the continuous monitoring of cool stars. Here we report about the status and the first results of the campaign after the first year of observations, in particular outlining statistical achievements for the ~300 stars observed so far.

1. Introduction

The search for low-mass, small-size extrasolar planets is among the most exciting and challenging topics in modern Astrophysics, with the primary consideration for the discovery of potentially habitable planets in the solar neighbourhood. M dwarf stars, with masses $M^* \leq 0.6$ MSun, make up the vast majority of the nearby stars within ~30 pc. These stars are important to Astrophysics because they help in understanding a variety of problems, from the local star formation history, to the shape of the initial stellar mass function. However, they have not traditionally been included in large numbers in the target lists of radial velocity (RV) searches for planets for two main reasons. First, they are intrinsically faint, and this fact prevented Doppler surveys in the optical from achieving very high radial-velocity precision (<5-10 m/s). Second, they have been considered as providers of very inhospitable environments for potentially habitable planets. These two paradigms are now concretely shifting, making M dwarfs very intriguing targets. In particular, the sample of the nearest (d<25-30 pc), relatively bright (J<9-10) M dwarfs is amenable to combined studies with a wide array of observational techniques, which can be exploited at the best of their potential providing the opportunity to characterize the architecture of planetary systems across orders of magnitude in mass and orbital separations in a way that is not readily achievable for Solar analogues. For example, the possibility to reach detection of short-period transiting rocky planets from the ground with modest-size telescopes (30-50cm class) is guaranteed by the small radii of M dwarfs, leading to deep transits (Δmag~0.005 mag) for the case of planets with $2 \leq Rp \leq 4$REarth. In addition, as we have discussed above, the favourable mass ratios allow for detection of rocky, potentially habitable planets with the RV technique, thanks to the moderately large amplitudes of the RV signals (a few m/s), by using high-precision spectrographs as HARPS-N, operating at the TNG telescope in La Palma. Analogously, at intermediate separations (~1-4 AU) high-precision astrometry becomes sensitive to planets in the mass range between Neptune and Jupiter. Systematic

studies of planetary systems orbiting low-mass stars can thus crucially inform planet formation and evolution, structural and atmospheric models, particularly when seen in connection with the properties of the host stars.

2. Results after the first year of observations

With an official kick-off in July 2012, APACHE (Sozzetti et al 2013, arXiv:1303.1275, Christille et al. 2013, EPJ Web of Conferences Volume 47, 2013) is monitoring a large (~3000 stars) sample of bright, nearby early and mid-M dwarfs with an array of five 40-cm RC telescopes.

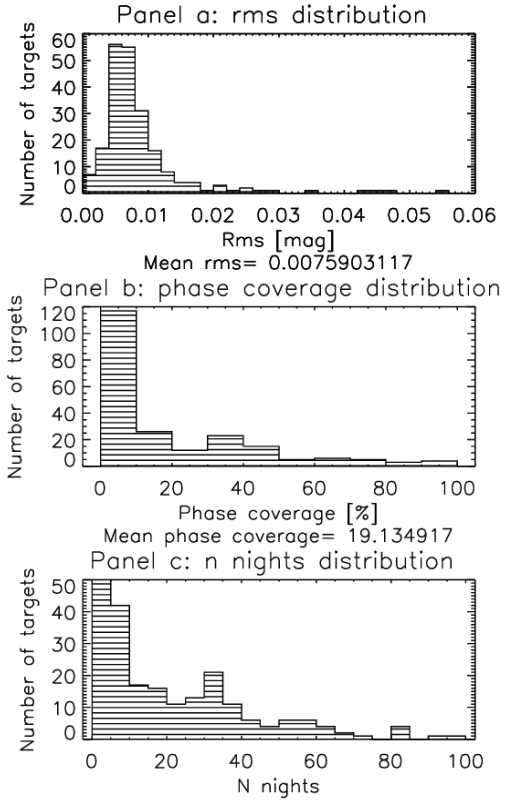

Figure 1: Panel a. Mean rms distribution for the observed sample of targets. Panel b. Phase coverage distribution over the observed sample of targets for orbital period in the range 0.5-5 days. Panel c. Number of night distribution for the observed sample of targets.

After one year of observations, we present the first results concerning a sample of ~300 stars in terms of :

-a careful assessment of the limits to transiting planetary companions for each star in our sample in order to estimate, in a statistical way, the frequency of planets in a specific range of orbital periods, planetary radii and stellar masses;

-the achieved medium-term photometric sensitivity;

-the characterization of the photometric properties of the cool M dwarfs;

-an assessment of the preliminary transit candidates.

Furthermore, the APACHE project has a relevant role inside the Italian National program GAPS (Global Architecture of Planetary Systems), which uses the unrivalled capabilities provided by the HARPS-N spectrograph operating at the TNG. Being a manifold programme, in particular GAPS utilizes HARPS-N for searching for potentially habitable Neptunes and super-Earths around a well-defined sample of early M dwarfs, measuring the variations in their RVs. The majority of these stars have been selected from the APACHE catalogue and thus they are observed both spectroscopically and photometrically. The measurements obtained by APACHE allow the characterization of the photometric micro-variability for the stars in common with GAPS target list (e.g. their rotational period), providing a crucial information for a correct interpretation of the spectroscopic data. The GAPS and APACHE measurements thus make up a unique dataset for a complete study of cool stars in the solar neighbourhood.

Here, we show the preliminary photometric results for a sub-sample of bright targets which have been also observed with the HARPS-N spectrograph in the framework of the large programme GAPS.

3. Final remarks

It is possible to follow the status of the Project at the official scientific blog and Web site (http://apacheproject.altervista.org/).

The results coming from APACHE will be of great relevance for at least two reasons: they will help a) to optimize the target selection criteria for red dwarfs which might be included in next-generation space-based transit survey programs, such as TESS, or which might be selected for spectroscopic characterization of planetary atmospheres of transiting planets orbiting cool, nearby stars with future space-borne infrared observatories such as EchO, and b) to improve the characterization of nearby M dwarf stars, when combined with HARPS-N and Gaia's exquisitely accurate measurements.