The Astrophysics of Planetary Systems: Formation, Structure, and Dynamical Evolution
Proceedings IAU Symposium No. 276, 2010
A. Sozzetti, M. G. Lattanzi & A. P. Boss, eds.

doi:10.1017/S1743921311020503

Stellar companions to exoplanet host stars with Astralux

Carolina Bergfors[1], Wolfgang Brandner[1], Thomas Henning[1] and Sebastian Daemgen[2]

[1]Max-Planck-Institute for Astronomy
Königstuhl 17, 69117 Heidelberg, Germany
email: bergfors@mpia.de

[2]European Southern Observatory
Karl-Schwarzschild Strasse 2, 85748 Garching, Germany

Abstract. A close stellar companion influences the formation of planets in the system. The occurrence of stellar companions and characteristics of the stars and planets in the system provide constraints on the formation processes. We present results from our high-resolution Lucky Imaging survey for binary exoplanet host stars, including the discovery of stellar companion candidates to the transiting planet hosts WASP-12 and HAT-P-8.

Keywords. techniques: high angular resolution, planetary systems, binaries: visual

1. Introduction

Today we know of more than 40 planets that belong to a star in a binary or multiple system. While widely separated stellar companions are not expected to affect the formation of planets, the observed binary separation is less than ~ 100 AU for around 20% of the known systems. The presence of a close stellar companion affects planet formation (see, e.g., Nelson 2000; Boss 2006; Kley & Nelson 2008), and the discovery and characterisation of systems like these may provide a way to discriminate between core accretion and disk fragmentation as the dominant formation process.

Transiting exoplanets are in this context especially valuable, since fundamental stellar and planetary properties such as mass, radius and mean density can be derived from the photometric transit in combination with radial velocity measurements.

2. The AstraLux binary exoplanet hosts survey

Resolving close binary systems with separations less than ~ 100 AU in general requires adaptive optics or other high-resolution methods like Lucky Imaging. With the two AstraLux Lucky Imaging instruments at the 2.2 m telescope at Calar Alto (Hormuth *et al.* 2009) and at NTT, La Silla (Hippler *et al.* 2009), we can observe stellar companions to exoplanet host stars at a minimum angular separation of ~ 0.1 arcsec. This corresponds to projected separations of less than 100 AU for $\approx 80\%$ of all exoplanets discovered by radial velocity or transit observations today.

So far, ≈ 180 exoplanet hosts have been observed in our survey, ~ 30 of which host transiting planets (see Bergfors *et al.*, in prep). Among the observed transiting planet hosts, we find close stellar companion candidates to WASP-12 and HAT-P-8 (Fig. 1). The new observations also include the eastern companion candidate to HAT-P-7 (see Narita *et al.* 2010) and second epoch observations of the companions to WASP-2, TrES-2 and TrES-4 from Daemgen *et al.* (2009).

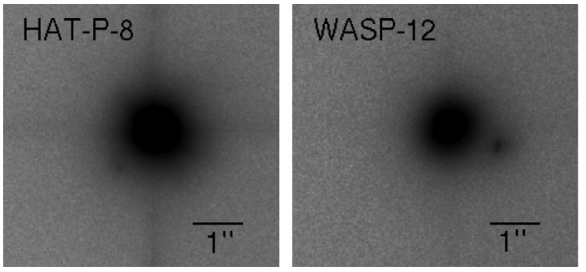

Figure 1. AstraLux Norte z'-band images of the transiting planet hosts HAT-P-8 and WASP-12 and the companion candidates. The images are shown in a logarithmic intensity scale. North is up and east to the left.

Table 1. Properties of planet host star and companion candidate.

Transit host	**SpT(A)**	**SpT(B)**	$\Delta z'$	$\Delta i'$	ρ [$''$]
HAT-P-8	F8 V	M3-M4 V	6.68 ± 0.07	7.34 ± 0.10	1.027 ± 0.011
WASP-12	G0 V	K4-M1 V	3.79 ± 0.10	4.03 ± 0.07	1.047 ± 0.021

3. Binary separation and Safronov number

Hansen & Barman (2007) suggested that hot jupiters could be divided into two classes based on their Safronov number ($\Theta = 0.5 * (v_{esc}/v_{orb})^2$) and equilibrium temperature. Only a small number of transiting planets were known at the time (19), and the significance of the division has been discussed (Fressin, Guillot & Nesta 2009, Southworth 2010). Daemgen *et al.* (2009) found for a somewhat larger sample of 35 transiting exoplanets that the observed gap between groups at $\Theta \sim 0.05$ was still present, and saw a possible correlation between Θ and stellar separation in binary exoplanet hosts where widely separated binaries fell into Class II and closer ones into Class I.

The number of transiting exoplanets is rapidly increasing as a result of new discoveries in large surveys such as e.g. HATNet, SuperWASP, CoRoT and Kepler. There are now more than 100 transiting exoplanets known, and we can investigate the suggested relation for a much larger sample. Not only has the gap between the two classes suggested by Hansen & Barman (2007) become much more narrow, we do no longer see a clear correlation between Θ and binary separation. How stellar companions influence giant planet formation and if it is related to the Safronov number needs to be further investigated.

References

Boss, A. P. 2006, *ApJ*, 641, 1148
Daemgen, S., *et al.* 2009, *A&A*, 498, 567
Fressin, F., Guillot, T., & Nesta, L. 2009, *A&A*, 504, 605
Hansen, B. M. S. & Barman, T. 2007, *ApJ*, 671, 861
Hippler, S., *et al.* 2009, *Msngr*, 137, 14
Hormuth, F., *et al.* 2009, *in AIP Conf. Ser.*, 1094, 935
Kley, W. & Nelson, R. P. 2008, *A&A*, 486, 617
Narita, N., *et al.* 2010, *PASJ*, 62, 779
Nelson, A. F. 2000, *ApJ*, 537, L65
Southworth, J. 2010, *MNRAS*, 408, 1689

https://doi.org/10.1017/S1743921311020503 Published online by Cambridge University Press