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How many suns are in the sky? Multiplicity surveys of exoplanet host stars

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Abstract. In order to determine the true impact of stellar multiplicity on the formation and evolution of planets, we initiated direct imaging surveys to search for (sub)stellar companions of exoplanet host stars on close orbits, as their gravitational impact on the planet bearing disk at first and on formed planets afterwards is expected to be maximal. According to theory these are the most challenging environments for planet formation and evolution but might occur quite frequently in the milky way, due to the large number of multiple stars within our galaxy. On this poster we showed results, obtained so far in the course of our AO and Lucky-imaging campaigns of exoplanet host stars, conducted with NACO/ESO-VLT for southern and with AstraLux/CAHA2.2m for northern targets, respectively. In addition, we introduced our new high contrast imaging survey with SPHERE/ESO-VLT to search for close companions of southern exoplanet host stars, and presented some first results.

Keywords. binaries (including multiple): close, visual, stars: imaging, planetary systems, techniques: high angular resolution

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Theoretical studies predict that a stellar companion of a star alters the formation process of its planets and the evolution of their orbits. As observations can test these theoretical predictions, we have already searched for wide stellar companions of exoplanet host stars using Seeing-limited IR imagers with large fields of view e.g. MAGIC/CAHA 2.2 m, SofI/ESO-NTT, and UFTI/UKIRT. In the course of these surveys, beside several stellar companions, HD 3651 B the first directly imaged brown dwarf companion of an exoplanet host star was detect (Mugrauer *et al.* 2006). Furthermore, these studies revealed several differences between the properties of exoplanets in star systems and of those orbiting single stars (Mugrauer *et al.* 2007a). With AO and speckle imaging we could also detect close companions of our targets, e.g. γ Cep B (about 0.4 $M_{\odot}$, a$\sim$20 au), which was directly imaged by us for the first time using the 8.2 m Subaru, and the CAHA 3.5 m telescope (Neuhäuser *et al.* 2007), or Gl 86 B, a white dwarf companion (about 0.6 $M_{\odot}$, a$\sim$20 au), whose true nature was revealed by us with NACO/ESO-VLT imaging and spectroscopy (Mugrauer & Neuhäuser 2005), proving that planets can survive the post main sequence evolution of a nearby star, as predicted by theory. Beside close binaries also several triple stars with exoplanets were detected (see e.g. Mugrauer *et al.* 2007b). Today more than 100 multiple stars with exoplanets are known and 35 (27 doubles, 8 triples) of them were

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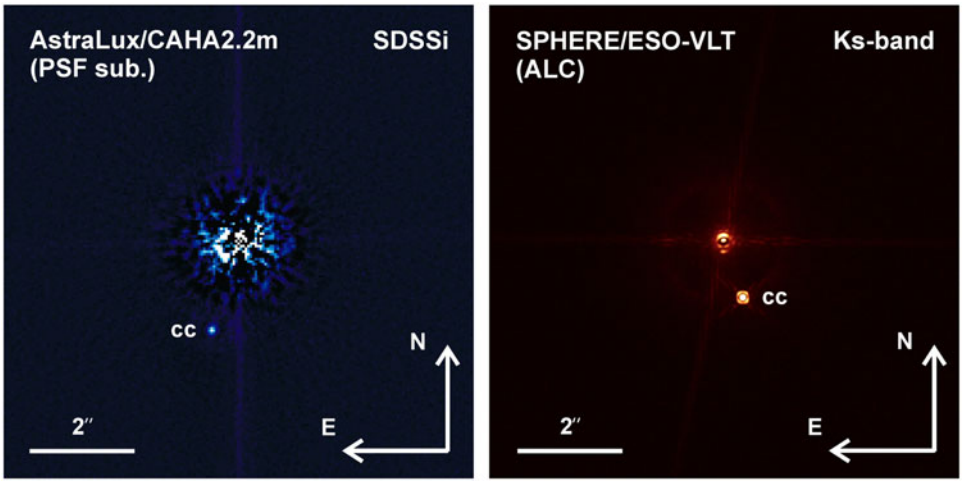

Figure 1. Two examples of close companion-candidates (cc) of exoplanet host stars, recently detected by us in our imaging surveys, carried out with AstraLux/CAHA 2.2 m, and SPHERE/ESO-VLT. The PSF of the bright exoplanet host star (centered in each image) is subtracted in the AstraLux image, while the SPHERE data is taken in coronagraphic mode to suppress the flux of the bright primary star. The companionship of the detected candidates is checked with follow-up imaging observations, which are currently ongoing.

detected in our surveys. This demonstrates the efficiency of these projects and shows that the multiplicity of the exoplanet host stars is significantly underestimated (see also Mugrauer & Dinçel 2016, and Mugrauer *et al.* 2014).

Regarding the impact of stellar multiplicity on the planet formation and evolution, the closest star systems with exoplanets are most intriguing, as the gravitational perturbation of a close stellar companion on the planet bearing disk at first and on formed planets later on is expected to be maximal. However, surveys for such close stellar companions of exoplanet host stars were conducted so far only with small samples sizes. In order to perform a homogeneous multiplicity study of exoplanet host stars with a large enough sample size to draw statistically significant conclusions for the whole exoplanet population, we use AstraLux/CAHA 2.2 m for northern, and NACO as well as SPHERE at the ESO-VLT for southern targets, to discover and characterize close stellar companions (proj. separation > 13 au) of exoplanet host stars and to clarify their multiplicity status (see Fig. 1, Mugrauer & Ginski 2015, Ginski *et al.* 2016, and Ginski *et al.* 2019).

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