ESA-Gaia Multiplicity Study of Exoplanet Host Stars

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Abstract: We present the latest results of our ongoing survey, which explores the data releases of the ESA-Gaia mission to study the multiplicity of exoplanet host stars, located at distances closer than about 625 pc around the Sun. In total, 375 binaries and 45 hierarchical triple star systems are detected among more than 2200 exoplanet host stars, whose multiplicity is investigated, yielding a multiplicity rate of at least 19 %. The equidistance and the common proper motion of all detected companions and the associated exoplanet host stars are proven with their accurate Gaia astrometry. Companions with masses in the range between about 0.011 and 1.7 $M_\odot$ are detected, which exhibit projected separations to the exoplanet host stars between about 19 and 10000 au. Beside mainly low-mass main sequence stars also 17 brown dwarfs are detected as companions of exoplanet host stars. In addition, also 16 white dwarf companions are identified, whose true nature is revealed by their photometric properties. These degenerated companions and the exoplanet host stars form evolved stellar systems with exoplanets, which have survived (physically but also dynamically) the post main sequence evolution of the former primary stars in these systems. We complement our survey with high-contrast AO and Lucky-Imaging observations, carried out by us with SPHERE at ESO-VLT and AstraLux at CAHA 2.2m to search for very close (sub)stellar companions of all targets, as well as a literature research for companions of exoplanet host stars.
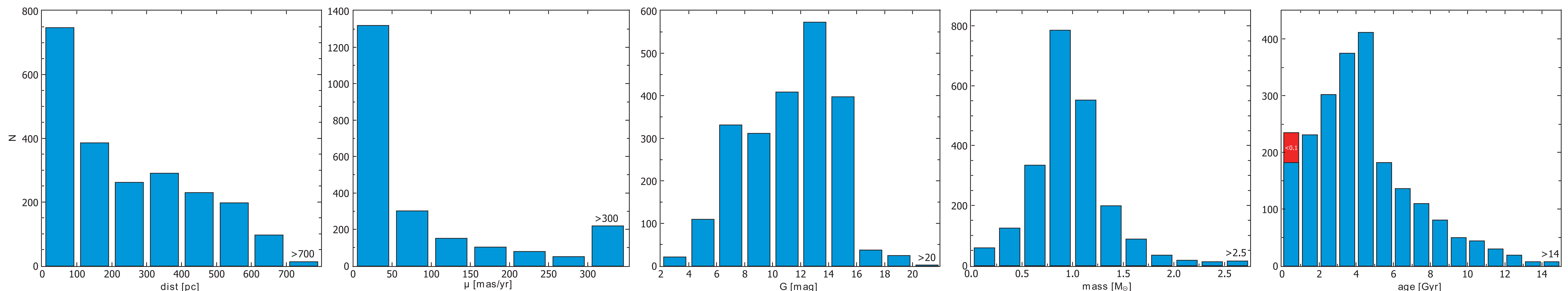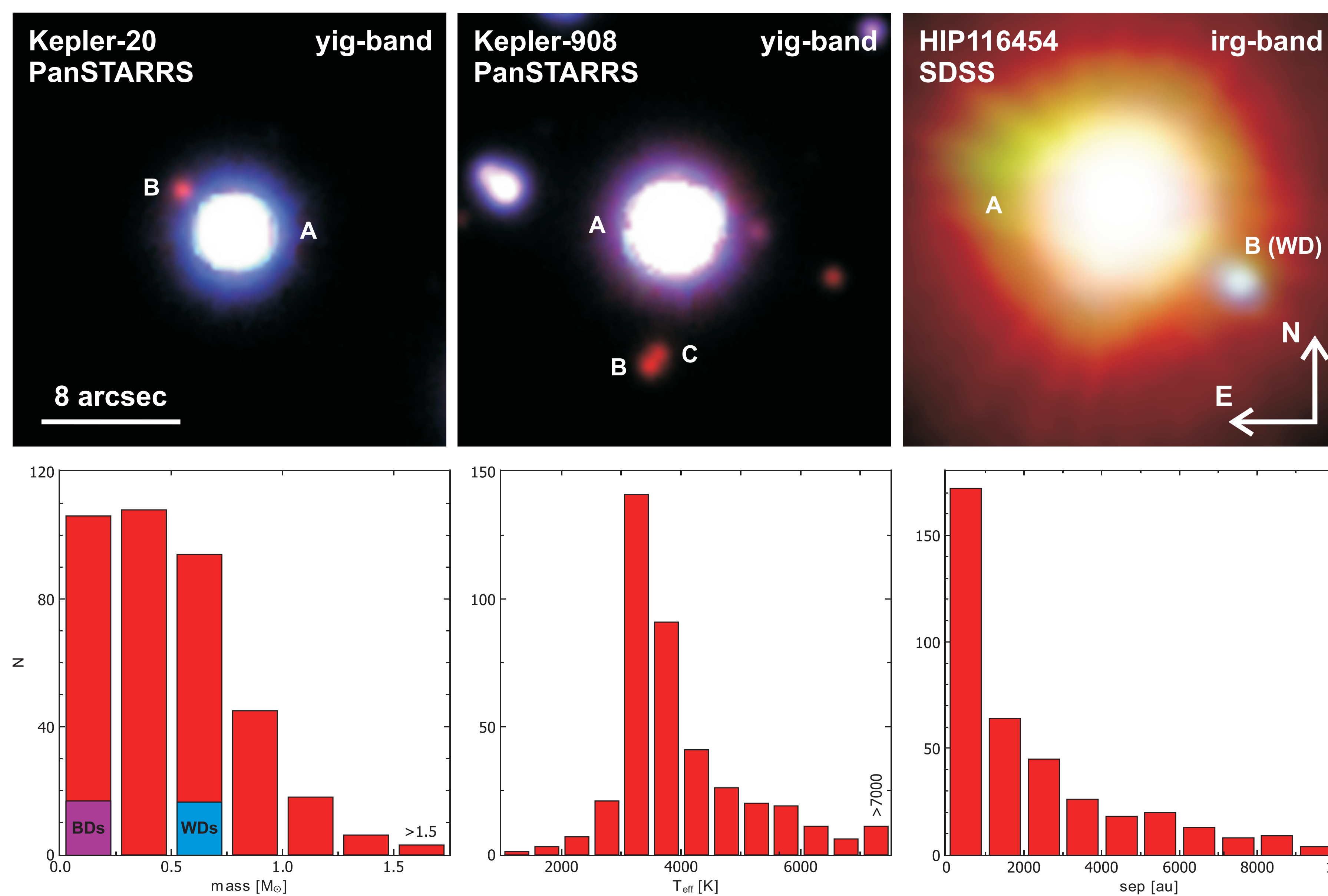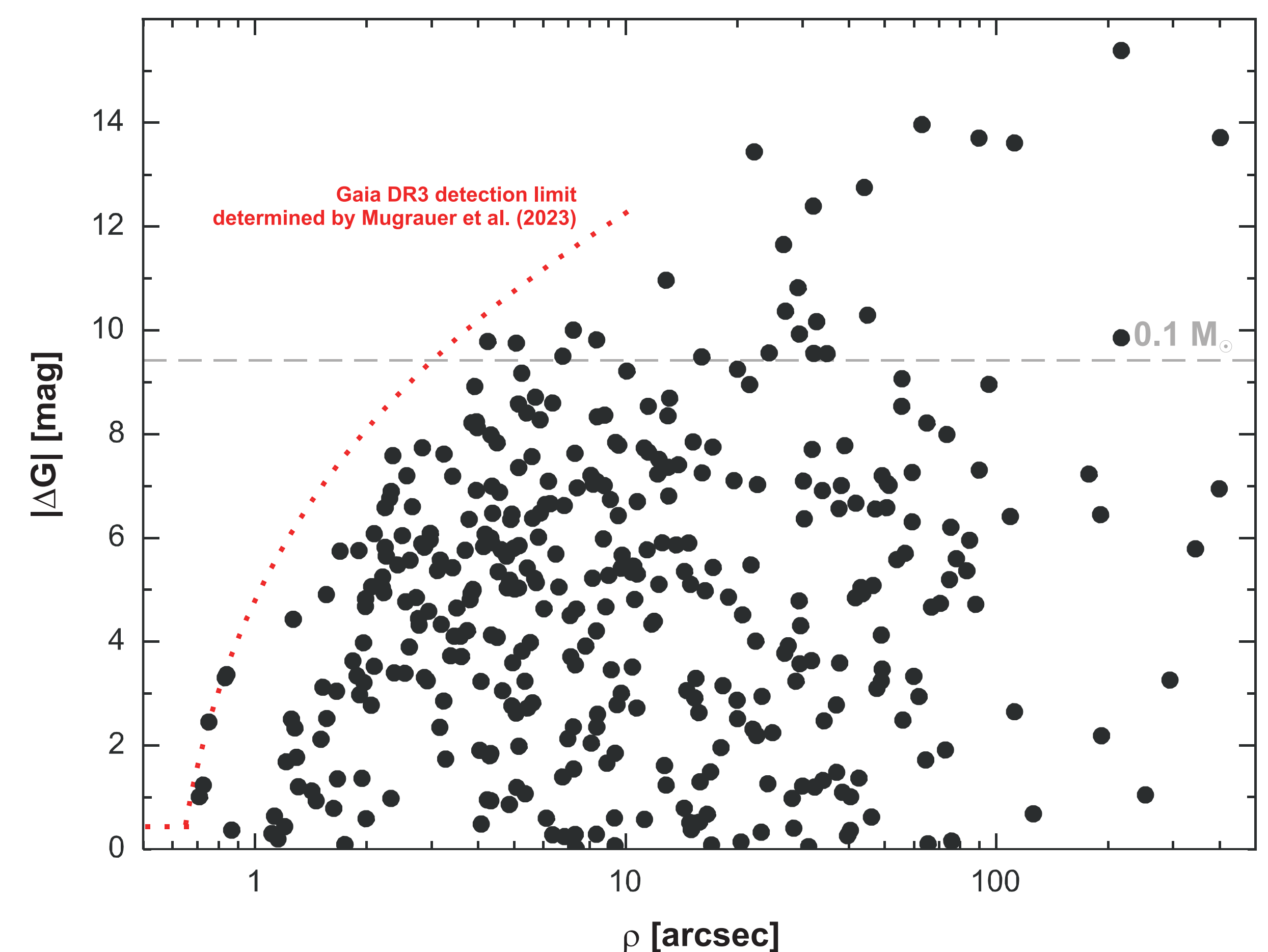
Target Properties

Fig. 1: On average, the targets of this survey are 4.2 Gyr old, fast moving stars with a proper motion of about 140 mas/yr, which are located at a distance of ~240 pc, and exhibit a mass of about 1 $M_\odot$.

Detected stellar Companions

## Detection Limit of the Survey

Top left: Examples of exoplanet host stars with stellar companions, detected in the course of this survey.

Top right: The G-band magnitude difference between the detected companions and the exoplanet host stars. The determined Gaia DR3 detection limit for companions is illustrated as dotted red line.

Left: Histograms of the individual properties of all detected companions.

The Impact of stellar Multiplicity on the Properties of Exoplanets and their Host Stars
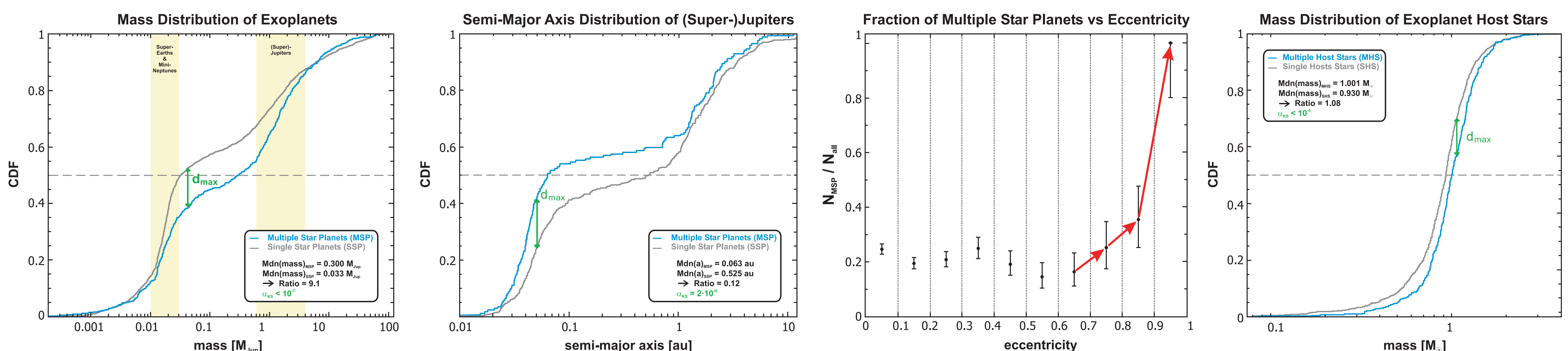
Left: Cumulative distribution function of the mass of single and multiple star planets. **Middle left:** Cumulative distribution function of the semi-major axis of single and multiple (super-)Jupiters. **Middle right:** Fraction of multiple star planets among all exoplanets dependant on the eccentricity (e>0). **Right:** Cumulative distribution function of the mass of single and multiple exoplanet host stars.
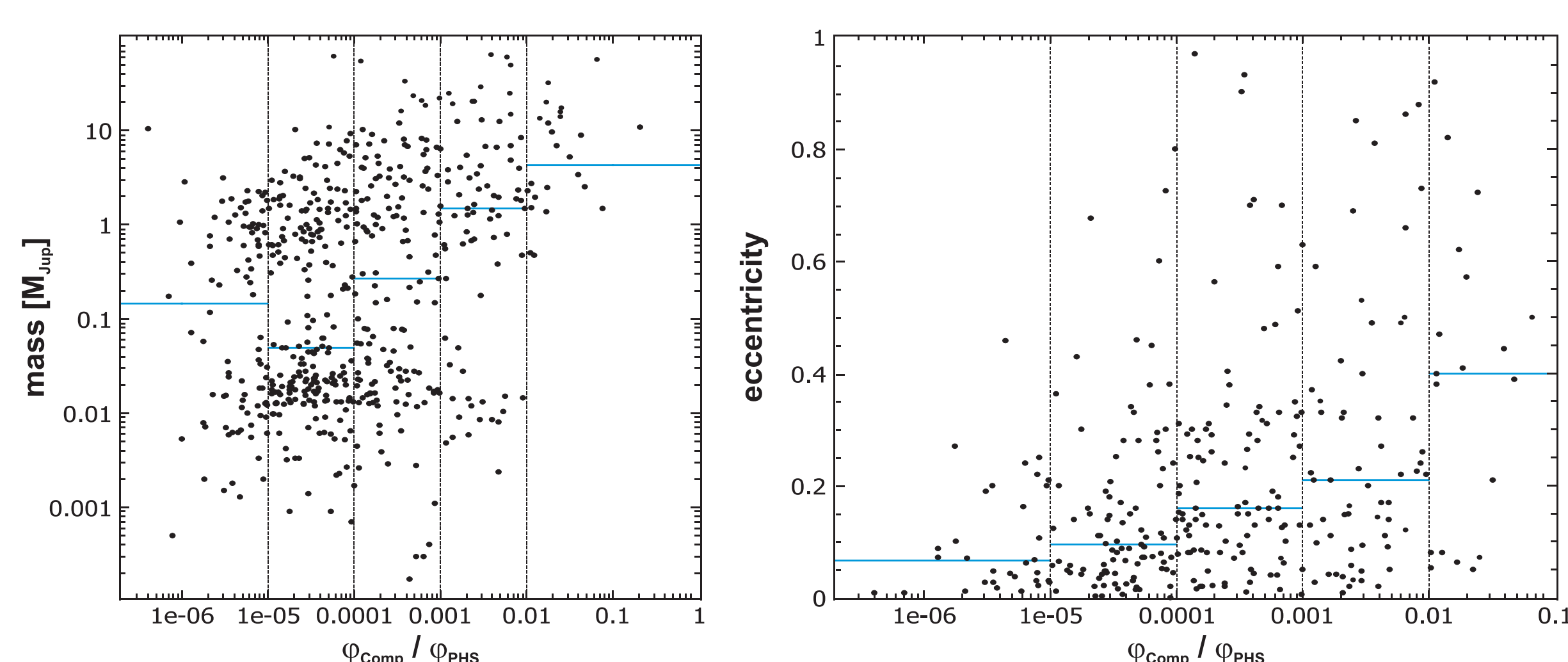
Left: Mass distribution of multiple star planets dependant on the gravitational impact of the companion star(s) in their stellar system. The median mass for all bins of the gravitational potential ratio φ_{Comp} / φ_{PHS} is shown with blue lines.

Right: Eccentricity distribution of multiple star planets (e>0) dependant on the gravitational impact of the companion star(s) in their stellar system. The median eccentricity for all bins of the gravitational potential ratio φ_{Comp} / φ_{PHS} is shown with blue lines.

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