Spectral characterization of newly detected young substellar binaries with SINFONI

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Abstract

We employed the Integral Field Spectrograph SINFONI at the Very Large Telescope to observe 7 young substellar systems with Laser Guide Star assisted Adaptive Optics in the *H+K* band, identifying 3 of them as prominent binary candidates.

Through astrometric measurements we obtain resolved photometry for each binary component, which we compare with isochrones from evolutionary models to infer individual masses. We further compare the resolved observed spectra to empirical templates in order to constrain their spectral types.

The combination of constrained ages and relatively short periods make these systems into excellent benchmarks once orbital fitting can constrain their dynamical masses, and thus be used to calibrate more precise substellar evoluationary models.

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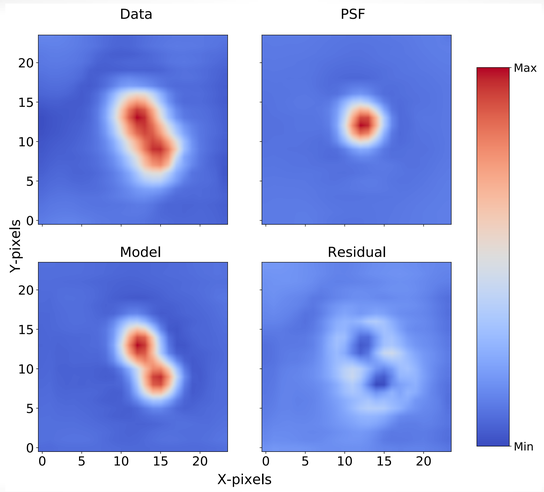
Background

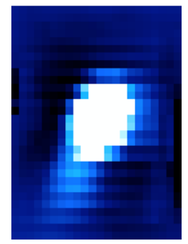
- Multiplicity frequency decreases with later spectral types and lower primary mass (e. g. Duchêne & Kraus 2013)
- Young Moving Group membership probabilities allow easier brown dwarf (BD) age-assessments (Gagné et al. 2018)
- Formation scenarios predict tight BD binaries on small separations (e.g. Reipurth & Clarke 2001; Goodwin & Withworth 2007)

Astrometry & Photometry

- We construct model-binaries from the Point Spread Function (PSF) of observed reference standard stars
- We compare the PSF-model with the observed data and employ a grid-search in *x*-position, *y*-position and brightness to find the optimal fit and smallest residual
- Resolved brightness compared to isochrones to assess individual masses
- Smallest binary separation detected at ≈ 60 mas

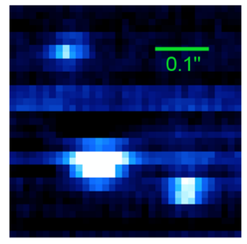


2MASS J15104786-2818174



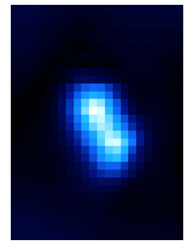
H_{prim}: 12.28 ± 0.04 mag
H_{sec}: 14.22 ± 0.06 mag
YMG: Argus
Age: 30 - 50 Myr
Mass: 42 & 18 M_{Jup}
SpT: M9γ & L1β

2MASS J15474719-2423493



H_{prim}: 13.67 ± 0.07 mag
H_{sec}: 14.55 ± 0.07 mag
YMG: Young Field
Age: 30 - 50 Myr
Mass: 20 & 16 M_{Jup}

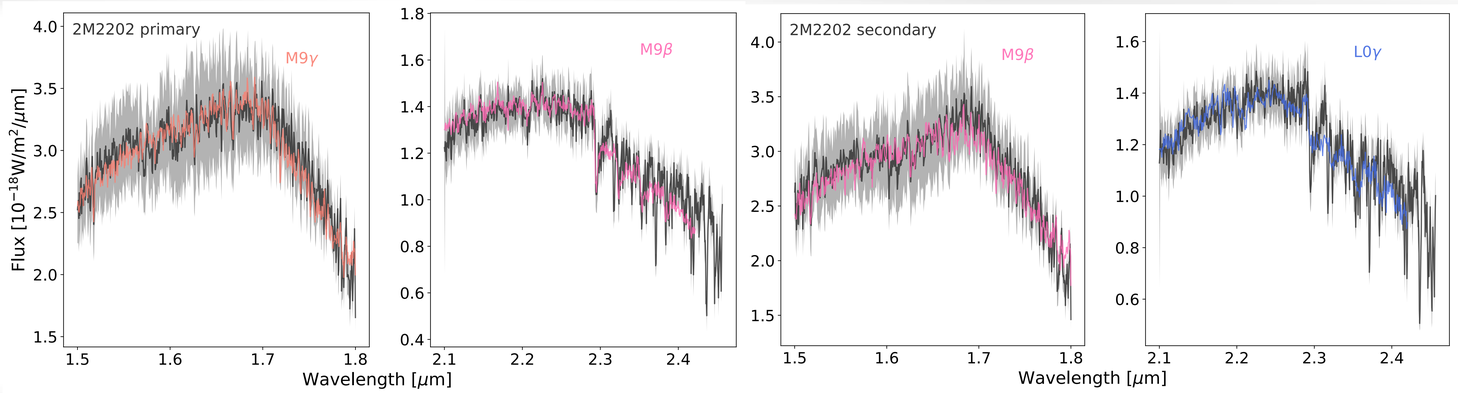
2MASS J22025794-5605087



H_{prim}: 14.34 ± 0.07 mag
H_{sec}: 14.41 ± 0.08 mag
YMG: ABDMG
Age:120 - 200 Myr
Mass: 57 & 56 M_{Jup}
SpT: M9γ/β & M9β/L0γ

Spectral analysis

- Resolved spectra for our binaries are compared to spectral types from Montreal spectral library (Gagné et al. 2015)
- We constrain the spectral types for the resolved binaries J1510 and J2202
- Data for J1547 too poor quality for spectral analysis



Main conclusions

- We observed 7 young BD systems, identifying 3 systems as substellar binary candidates
- Higher multiplicity frequency compared to old field population (≈ 5%, Fontanive et al. 2018) implying dynamical interactions at later stages
- The binary candidates have physical separations of ≈ 4 - 7 AU, corresponding to orbital periods of a few decades for these masses
- Continued astrometric monitoring of these systems would provide highly sought-after benchmarks to compare with evolutionary models

References: Duchêne, G., & Kraus, A. 2013, ARA&A, 51, 269; Fontanive, C., Biller, B., Bonavita, M., & Allers, K. 2018, MNRAS, 479, 2702; Gagné, J., Faherty, J. K., Cruz, K. L., et al. 2015, ApJS, 219, 33; Gagné, J., Mamajek, E. E., Malo, L., et al. 2018, ApJ, 856, 23; Goodwin, S. P., & Whitworth, A. 2007, A&A, 466, 943; Reipurth, B., & Clarke, C. 2001, AJ, 122, 432