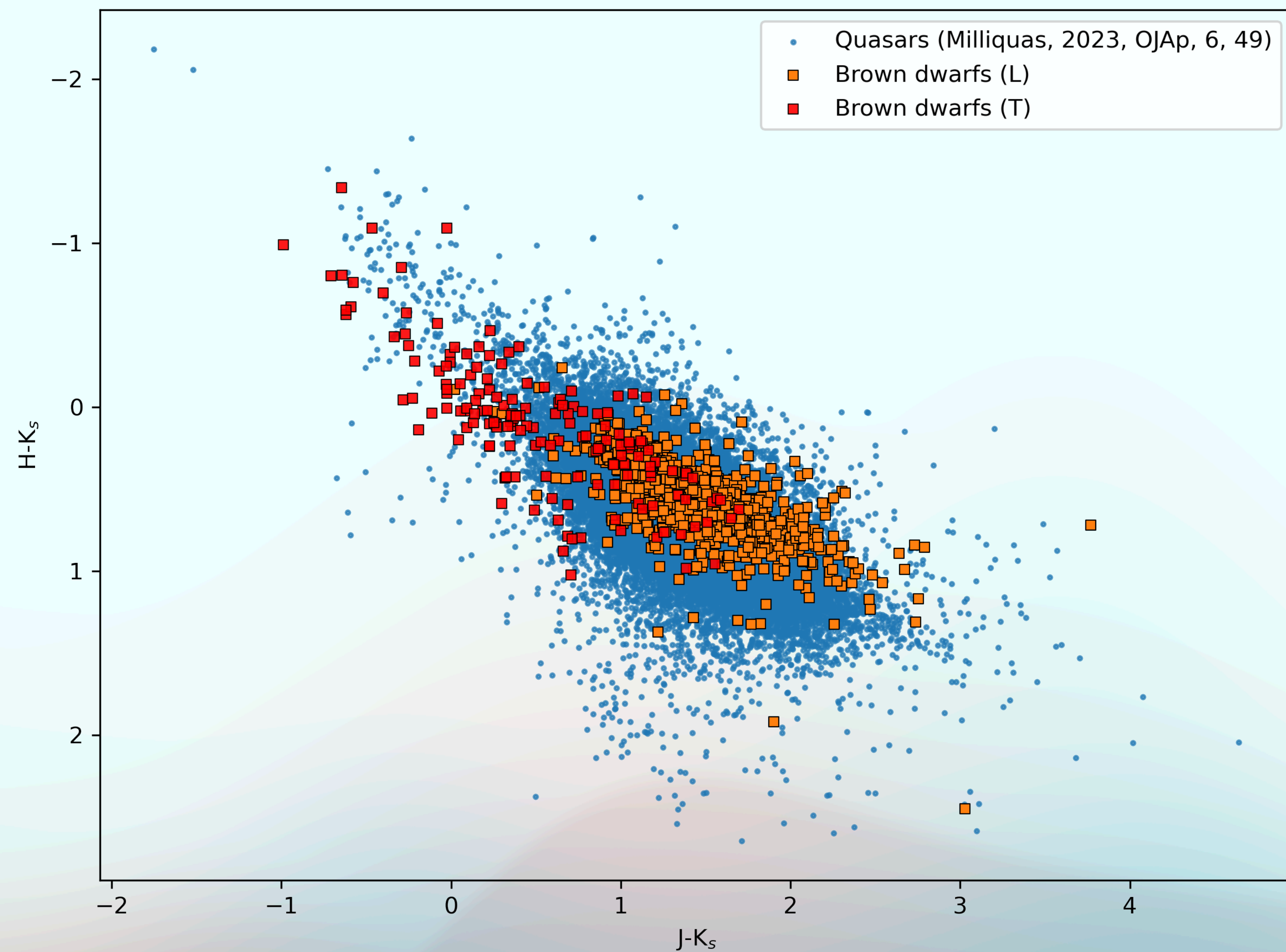
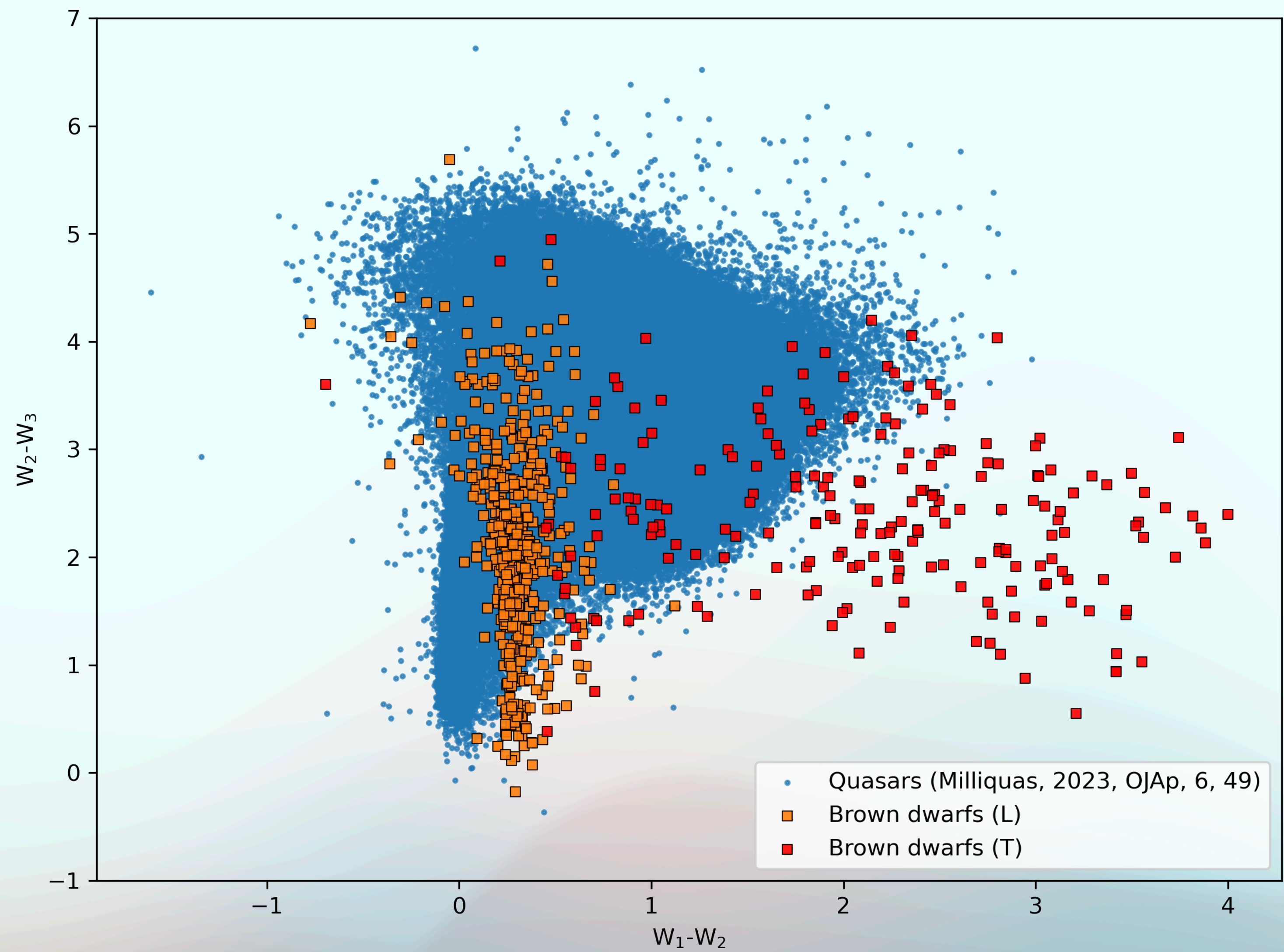
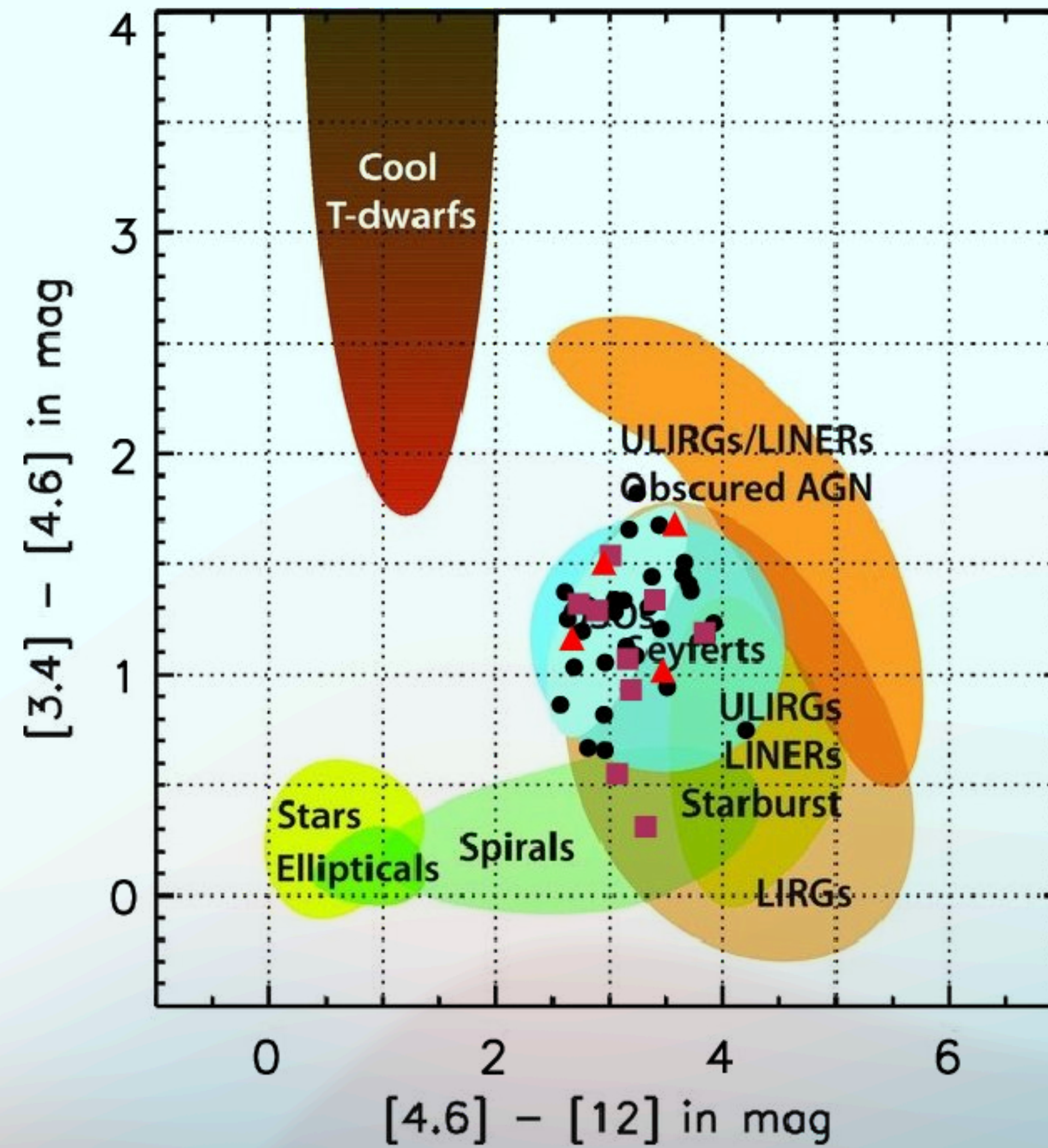
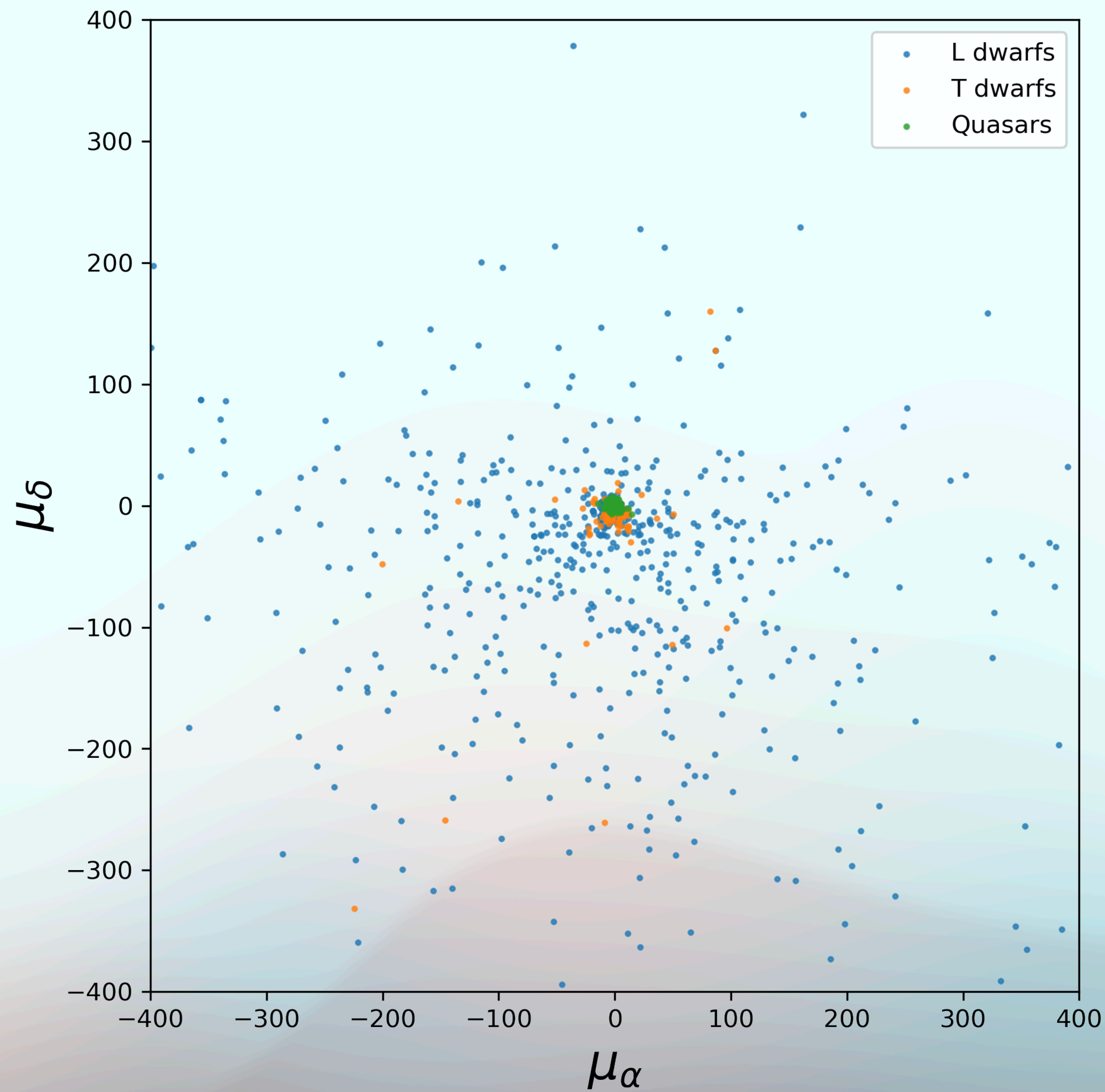


Proper Motion as a Tool for Identifying Ultracool Objects

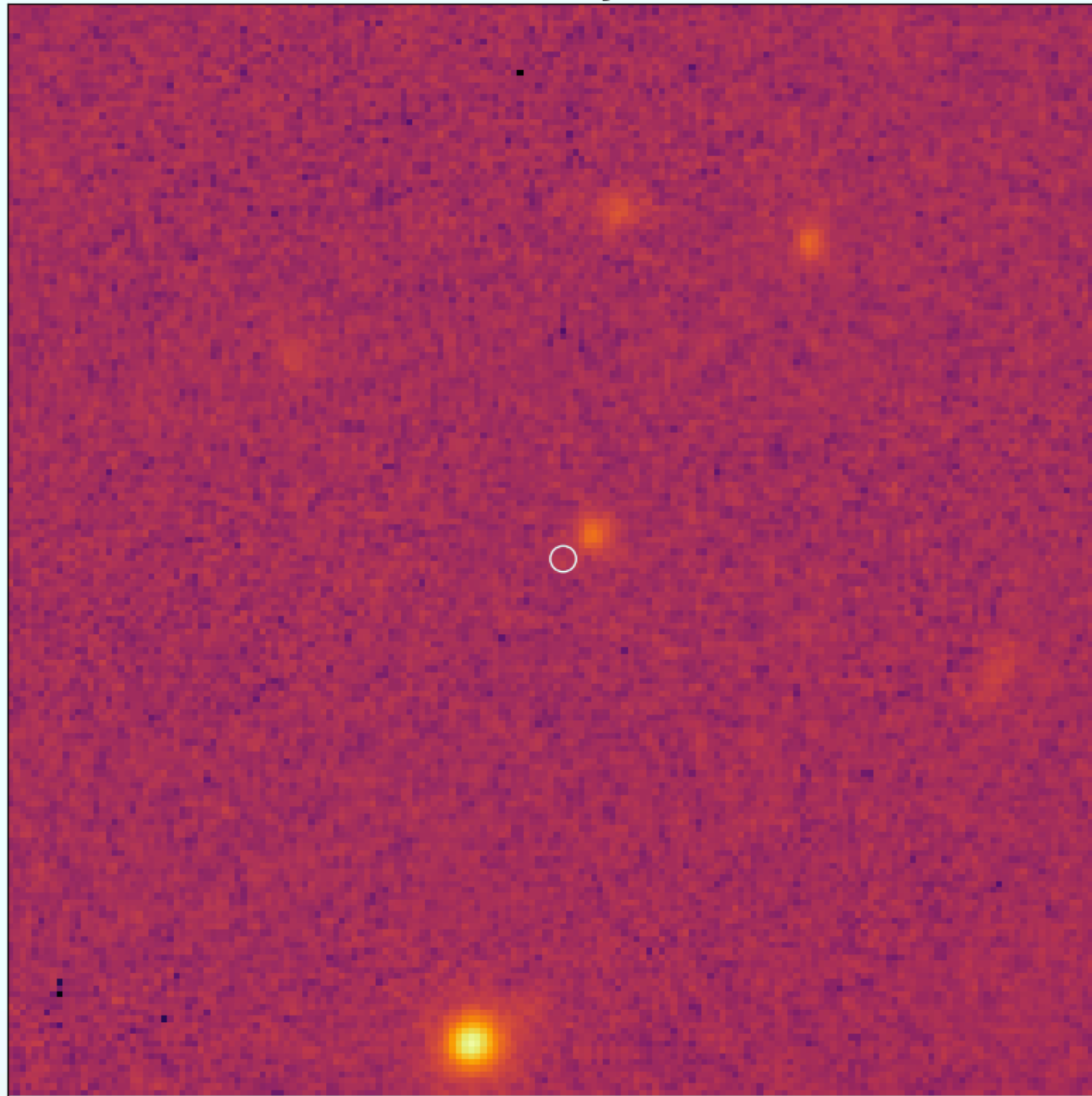




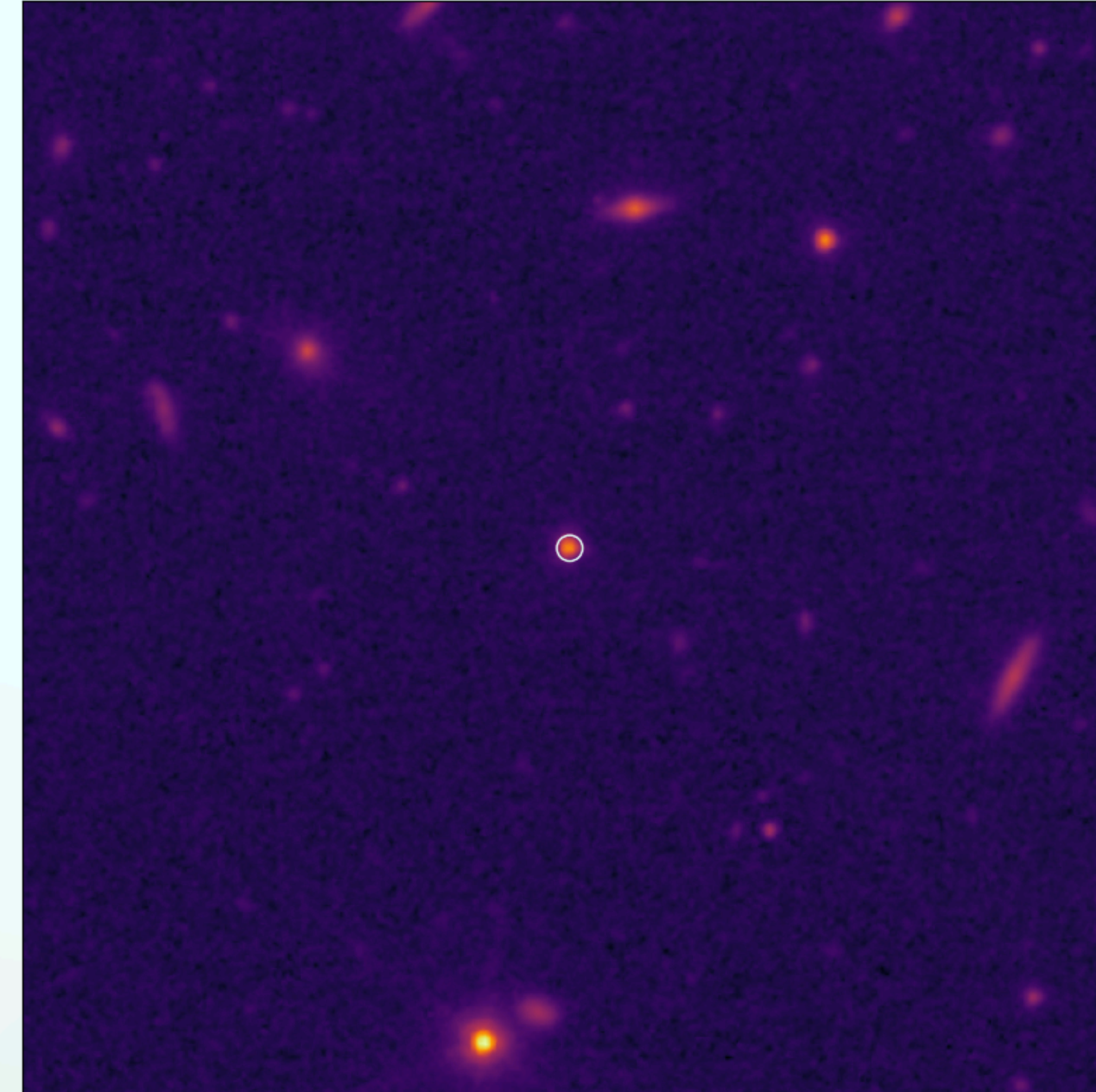




VHS J

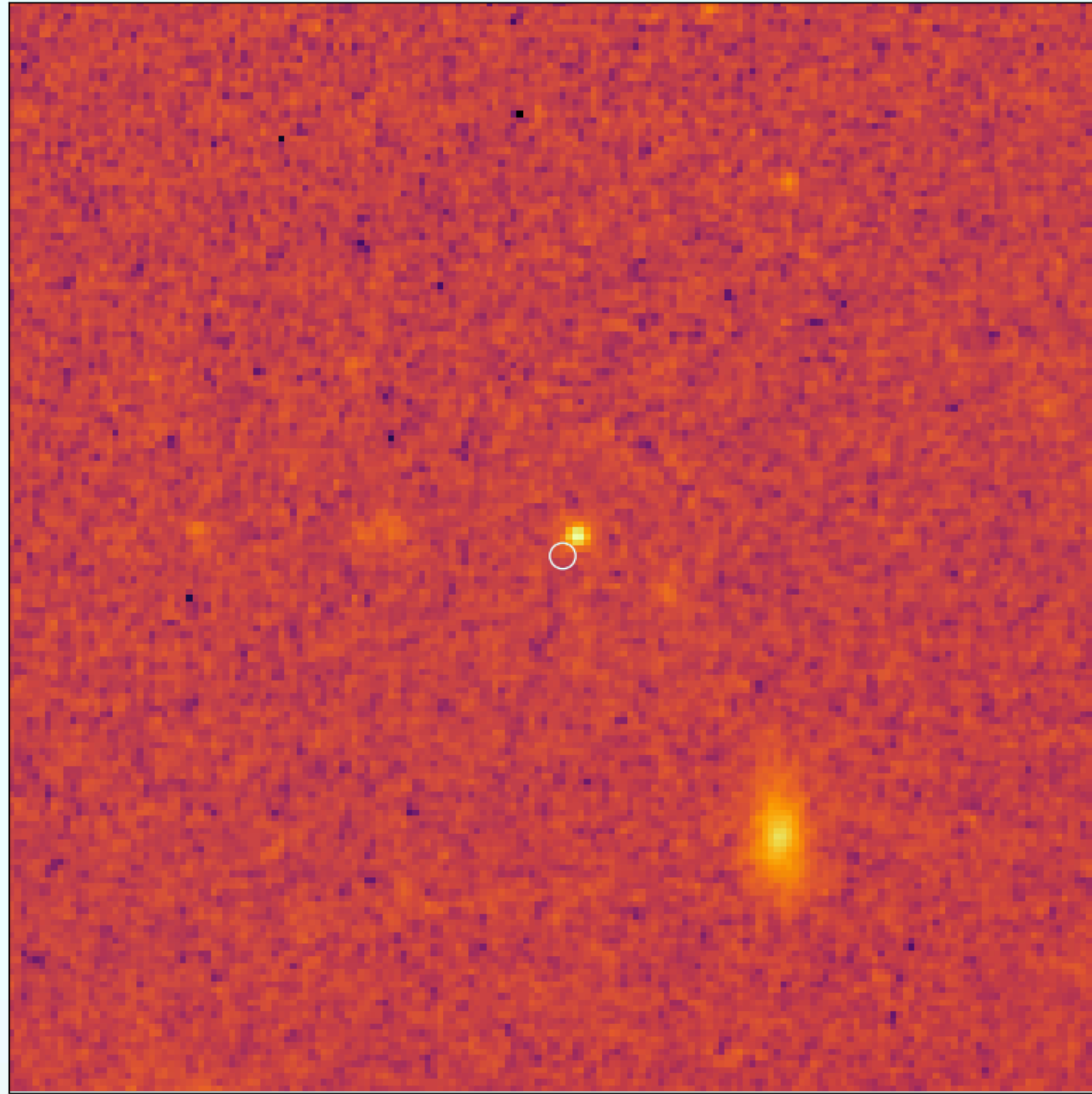


Euclid J

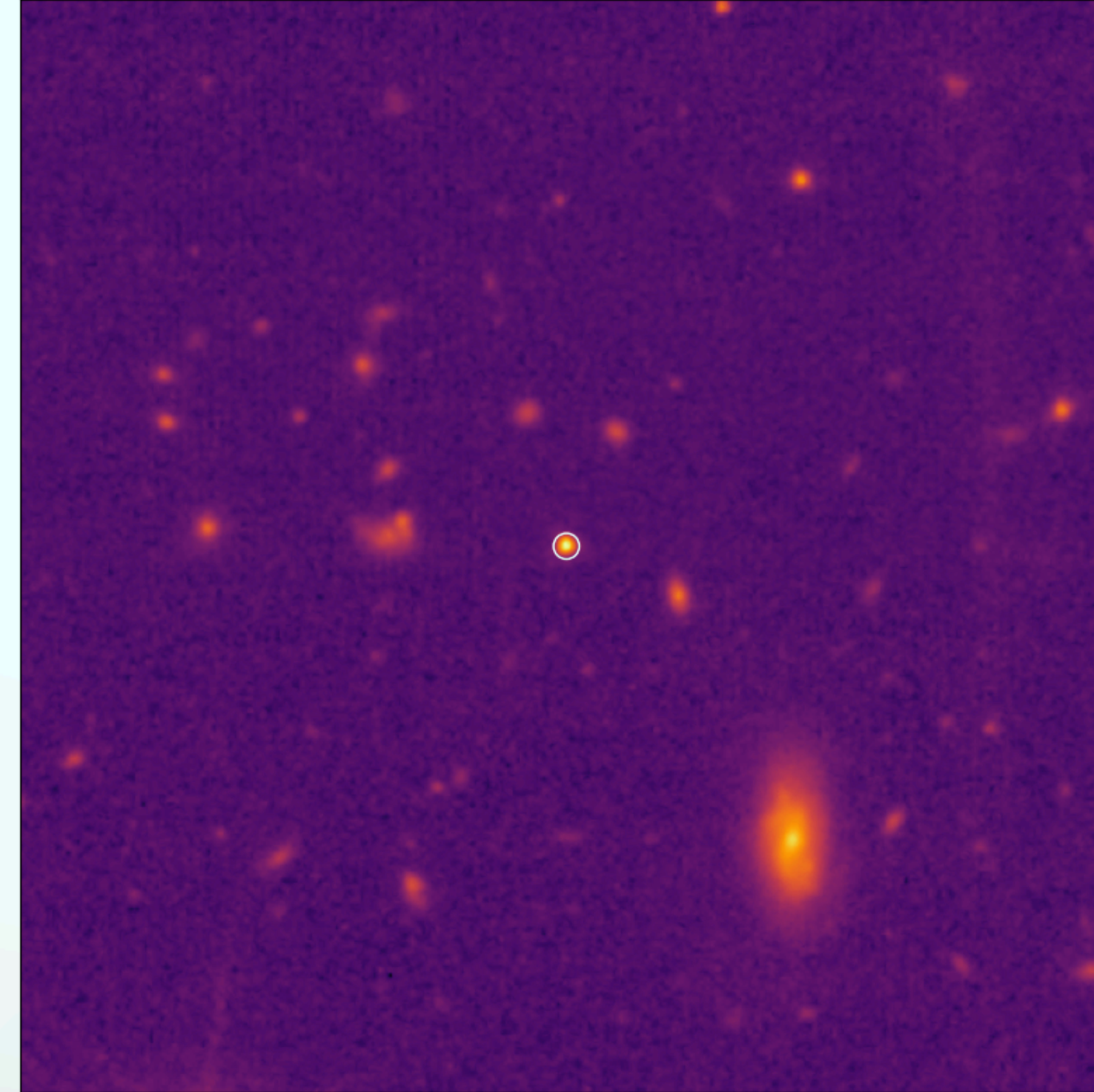


L dwarf. Proper motion (175,-50) mas/yr

VHS J



Euclid J



WISEA J035909.75-474056.8, T8 dwarf. Proper motion (125,-40) mas/yr

Zhang J.Y., Lodieu N. and Martin E.L., A&A **686**, A171 (2024)

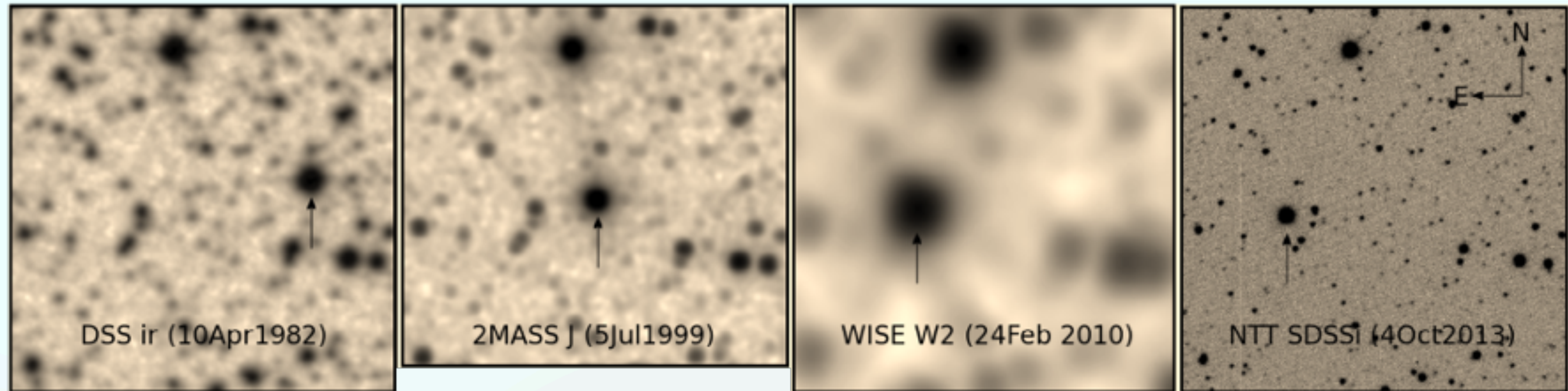
Proper motion surveys

- Crossmatch between different **catalogs at different epochs, (VHS, 2MASS, UKIDSS, WISE etc...)**
- Crossmatch between different **epochs of the same catalog (e.g. NEOWISE)**

Outline of the procedure

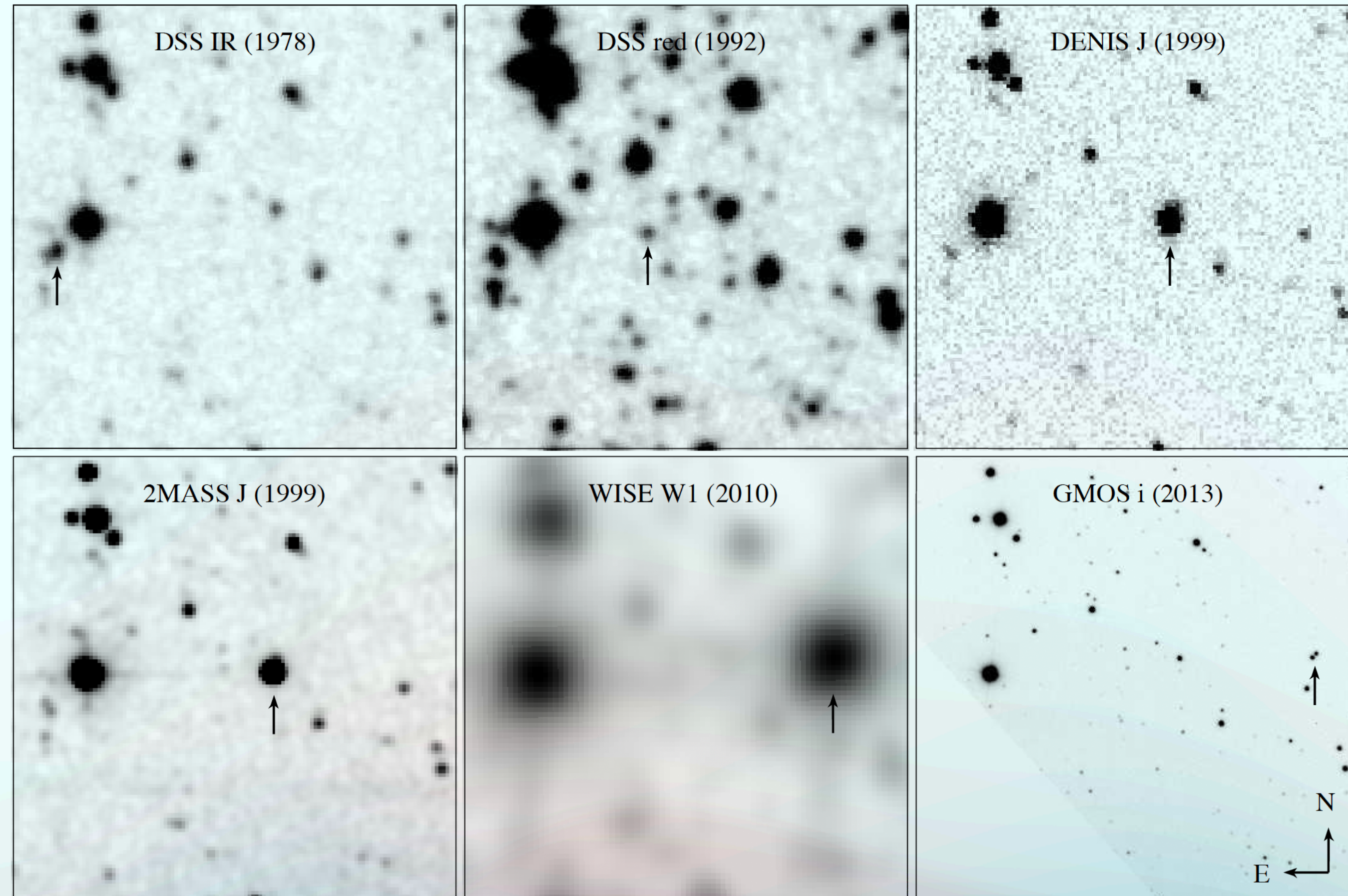
- Clean list of non-moving objects (lower limit)
- Pairing remaining objects (upper limit)
- Cleaning of sample
- Visual inspection

2MASSJ154043.42–510135.7



$$\begin{array}{ll} \mu_{\alpha} \cos \delta & +1.954 \pm 0.002 \text{ arcsec/yr} \\ \mu_{\delta} & -0.330 \pm 0.003 \text{ arcsec/yr} \end{array}$$

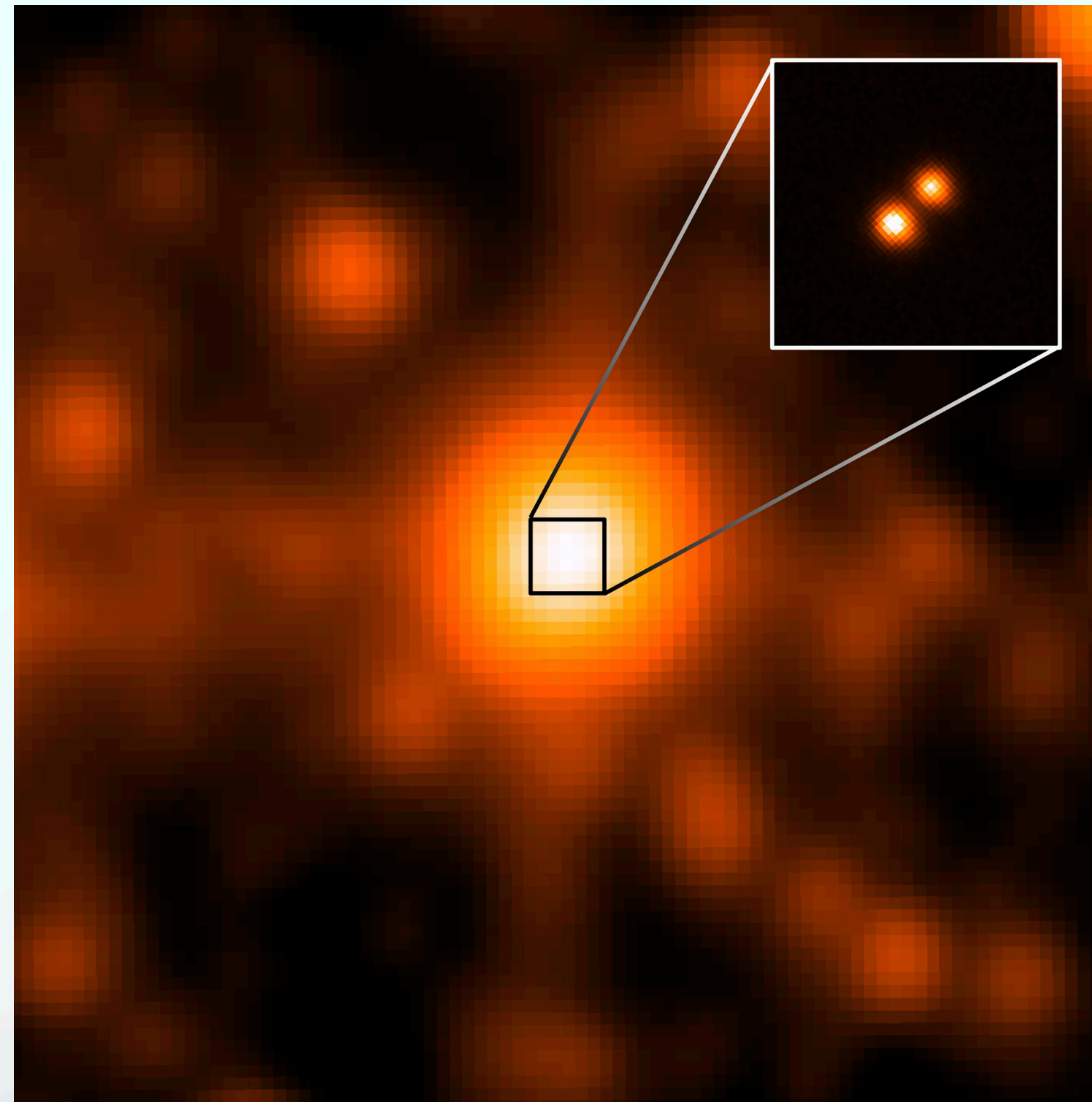
WISE J104915.57–531906.1



Brown dwarf binary at 2 pc

Luhman, ApJL **767** L1 (2013)

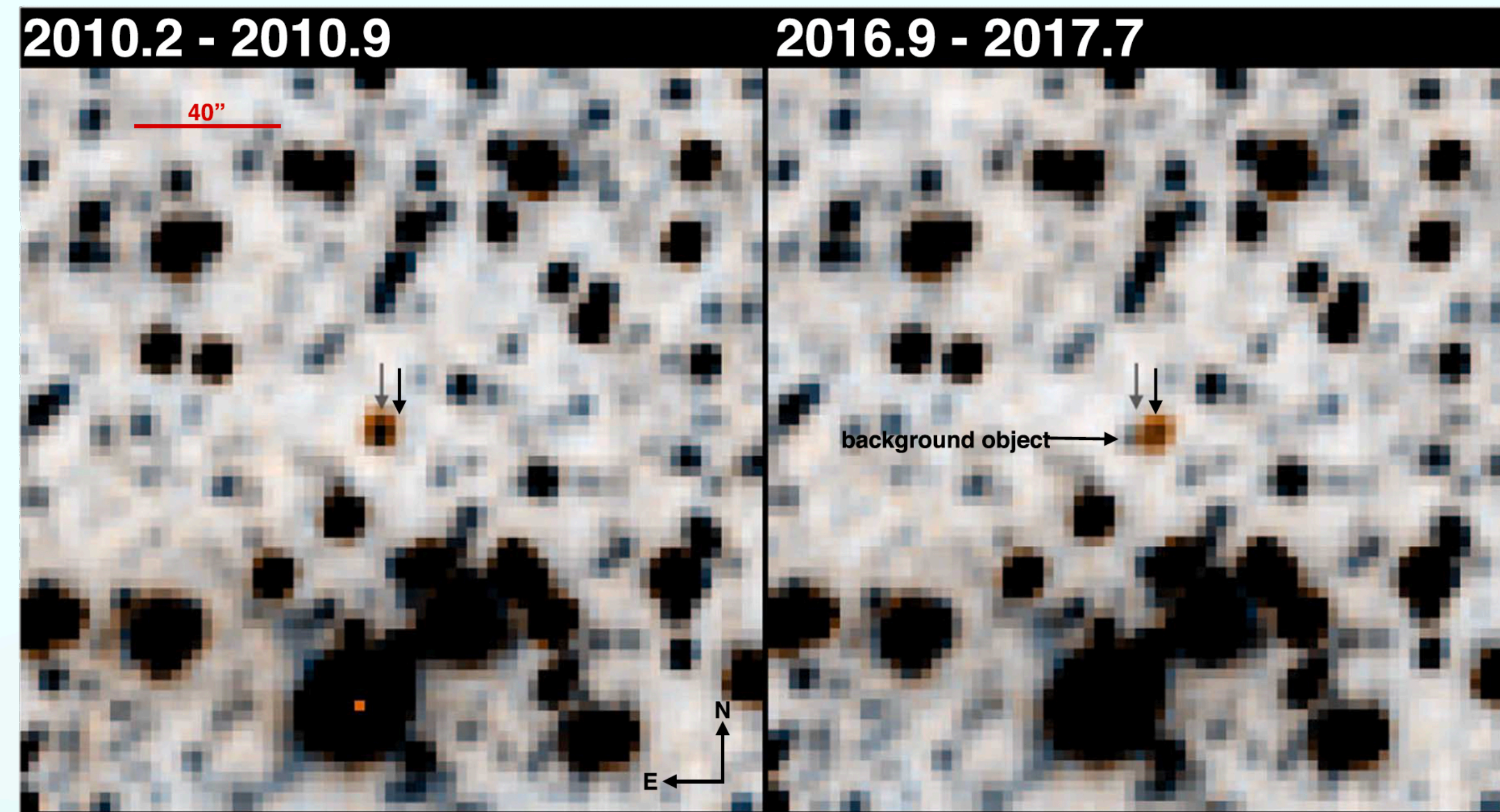
WISE J104915.57–531906.1



Brown dwarf binary at 2 pc

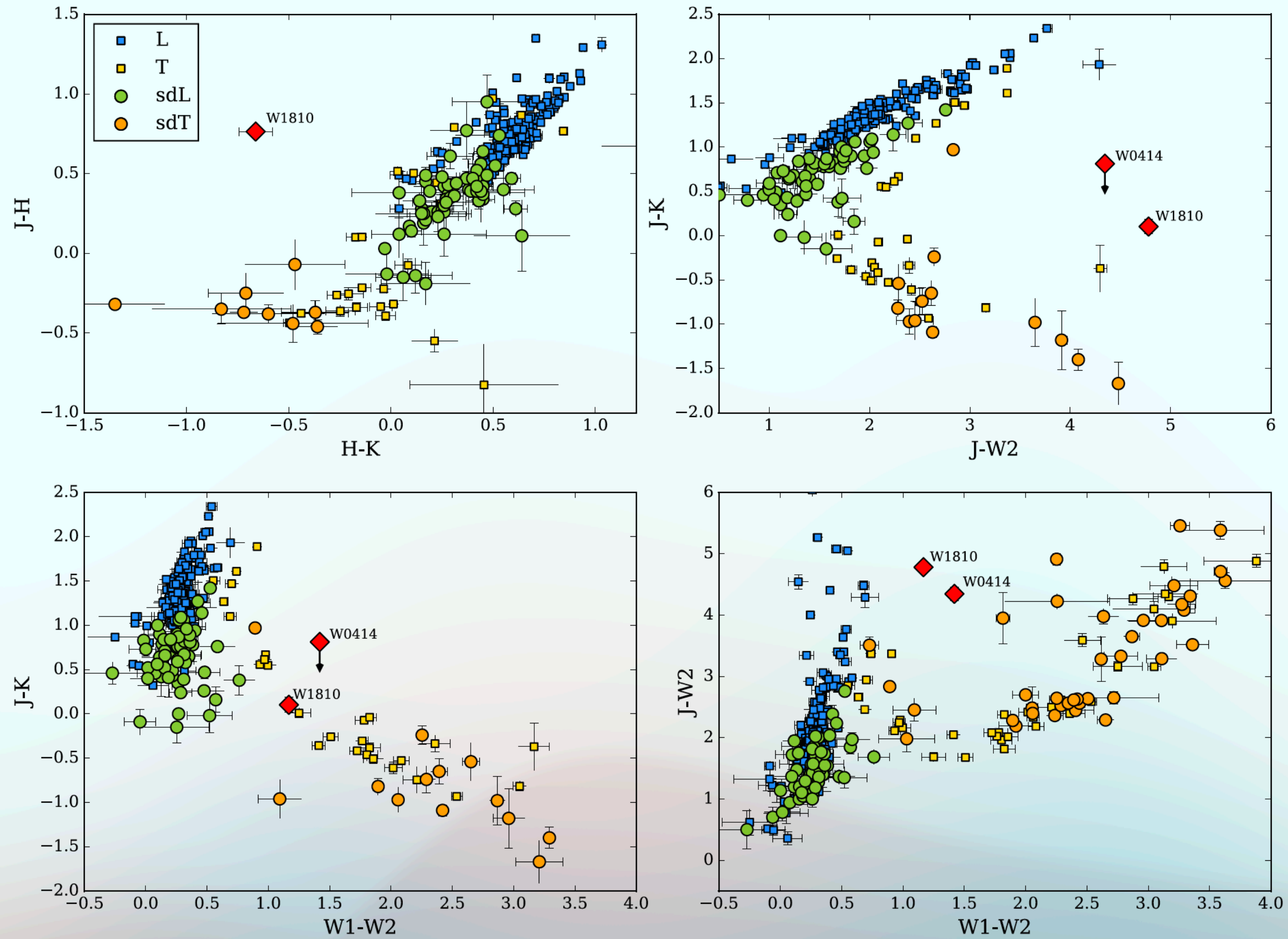
Luhman, ApJL **767** L1 (2013)

WISE J181006.18–101000.5

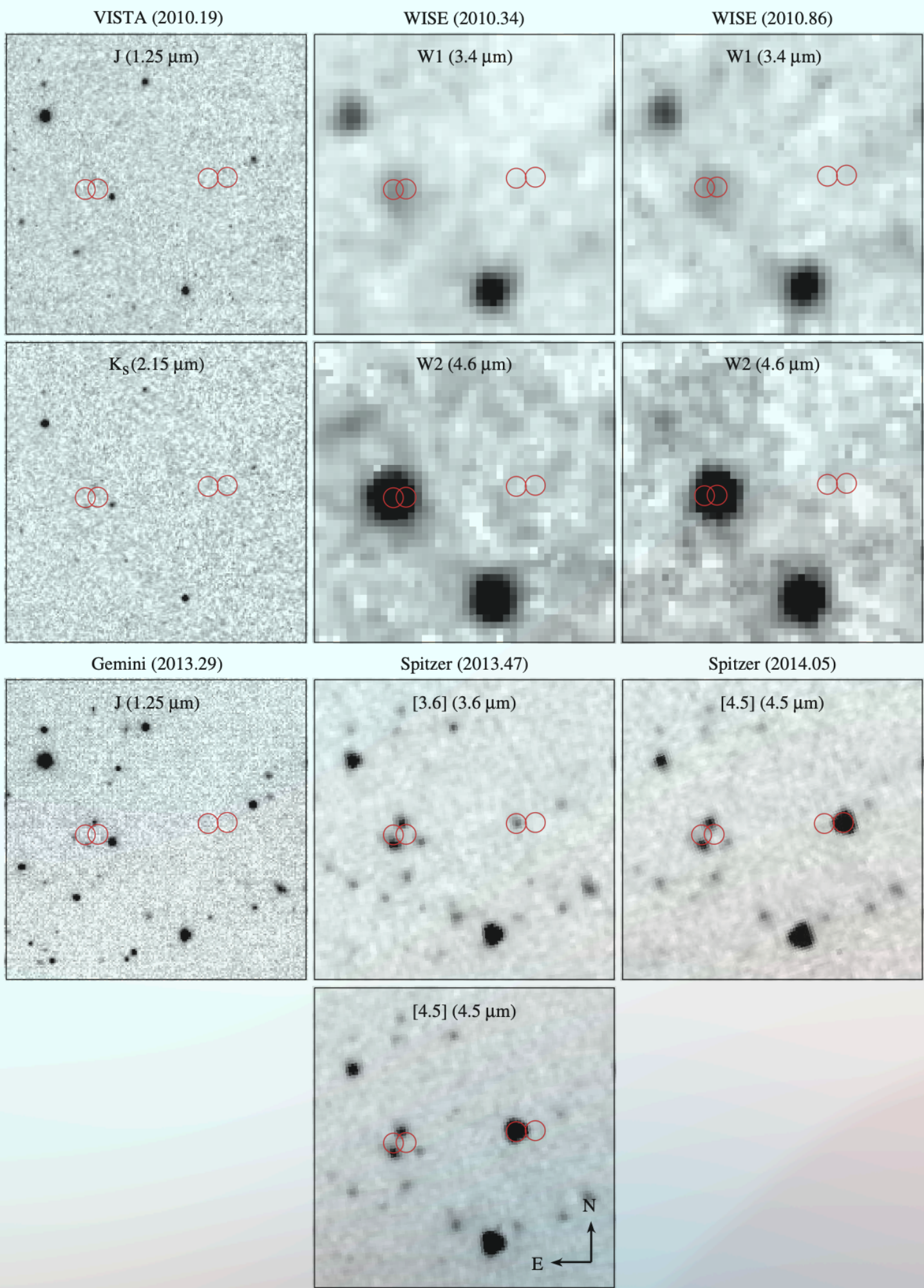


NEOWISE proper motion survey

WISE J181006.18–101000.5



WISE085510.83–071442.5

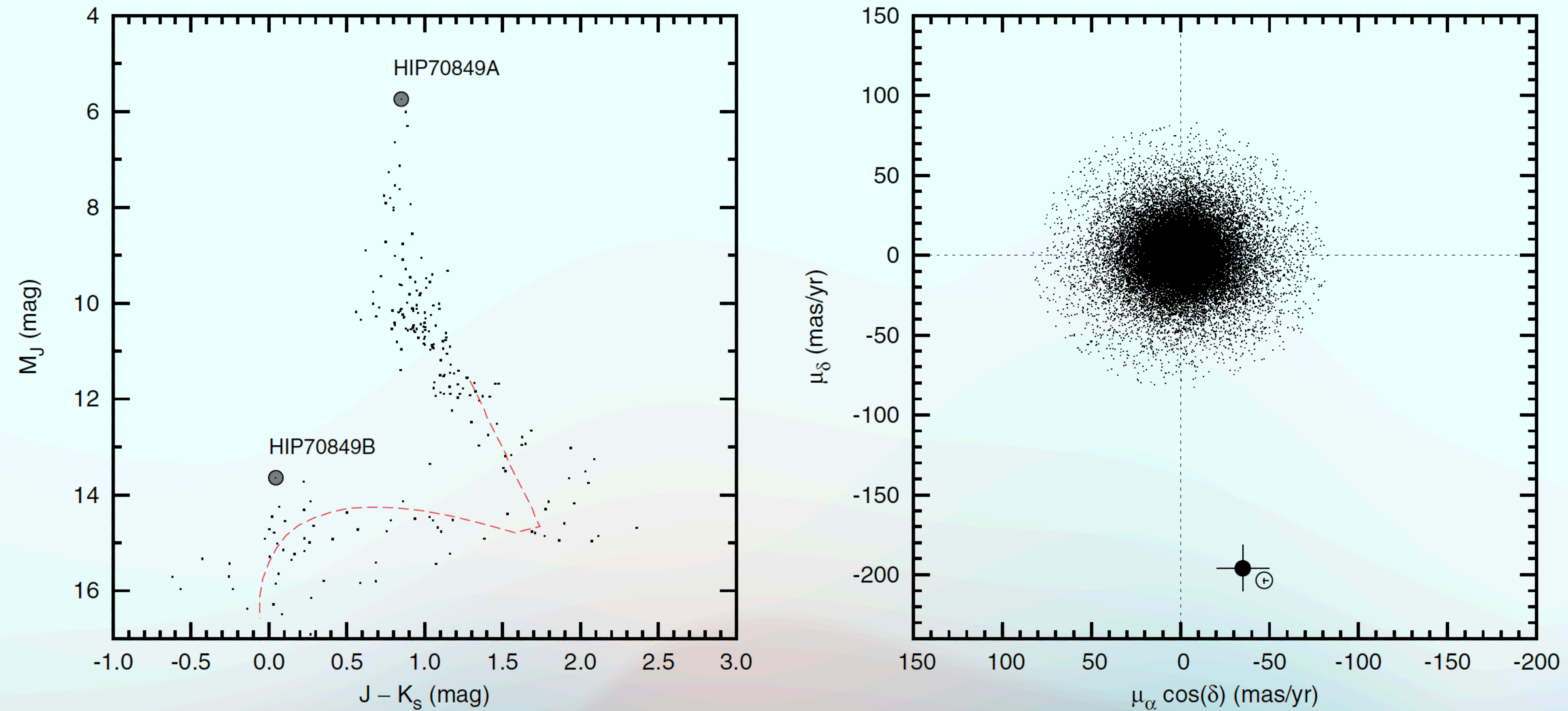


- * Y dwarf (250 K)
- * PM: 8.1 arcsec/yr
- * 2.2 pc

Co-moving objects (CPMs)

- **Common origin:** Same motion + same chemistry $\Rightarrow$ likely **born together**.
- **Reliable ages & benchmarks:** Coeval systems become **natural clocks** for stellar/substellar evolution.
- **Metal-poor systems:** Act as **fossils of the early Galaxy**—constrain first-star yields, halo assembly, and calibrate models where low metallicity changes stellar evolution.

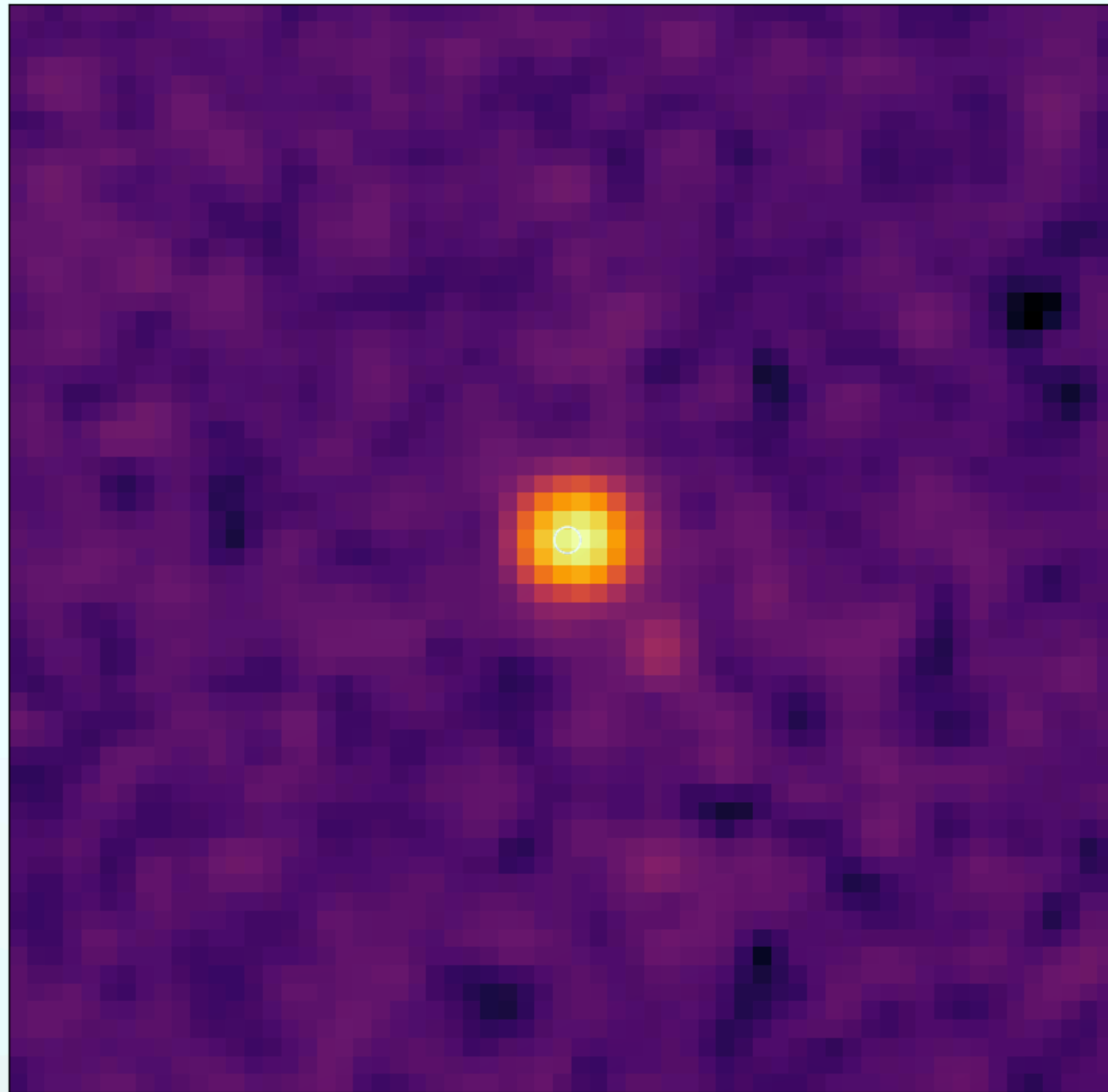
HIP70849 - T4.5 Brown dwarf companion to a planet host star



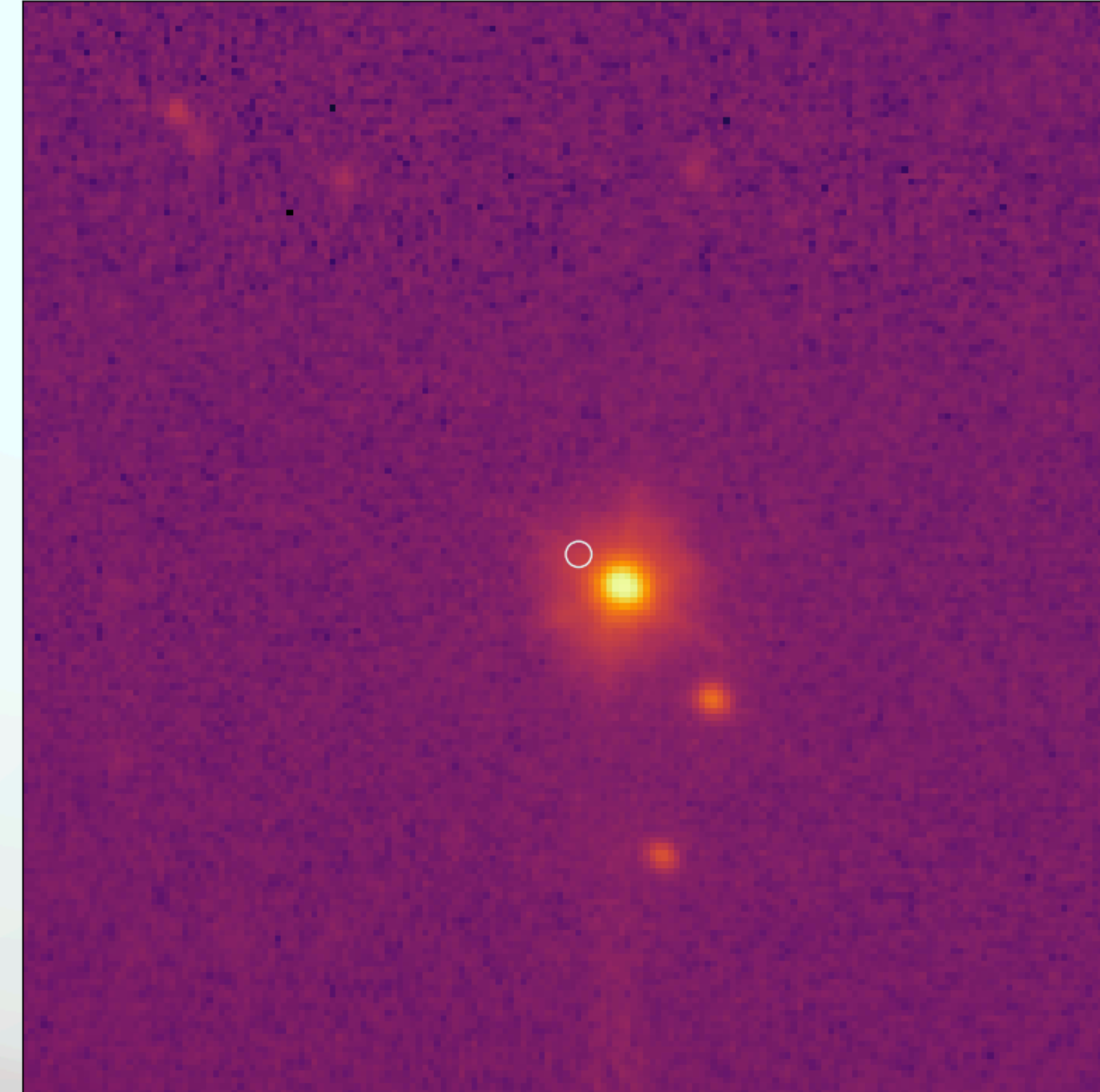
N. Lodieu, A. Pérez-Garrido, V.J.S. Béjar et al., *A&A* **569**, A10 (2014)

VHS1256b - Exoplanet companion to an equal mass binary

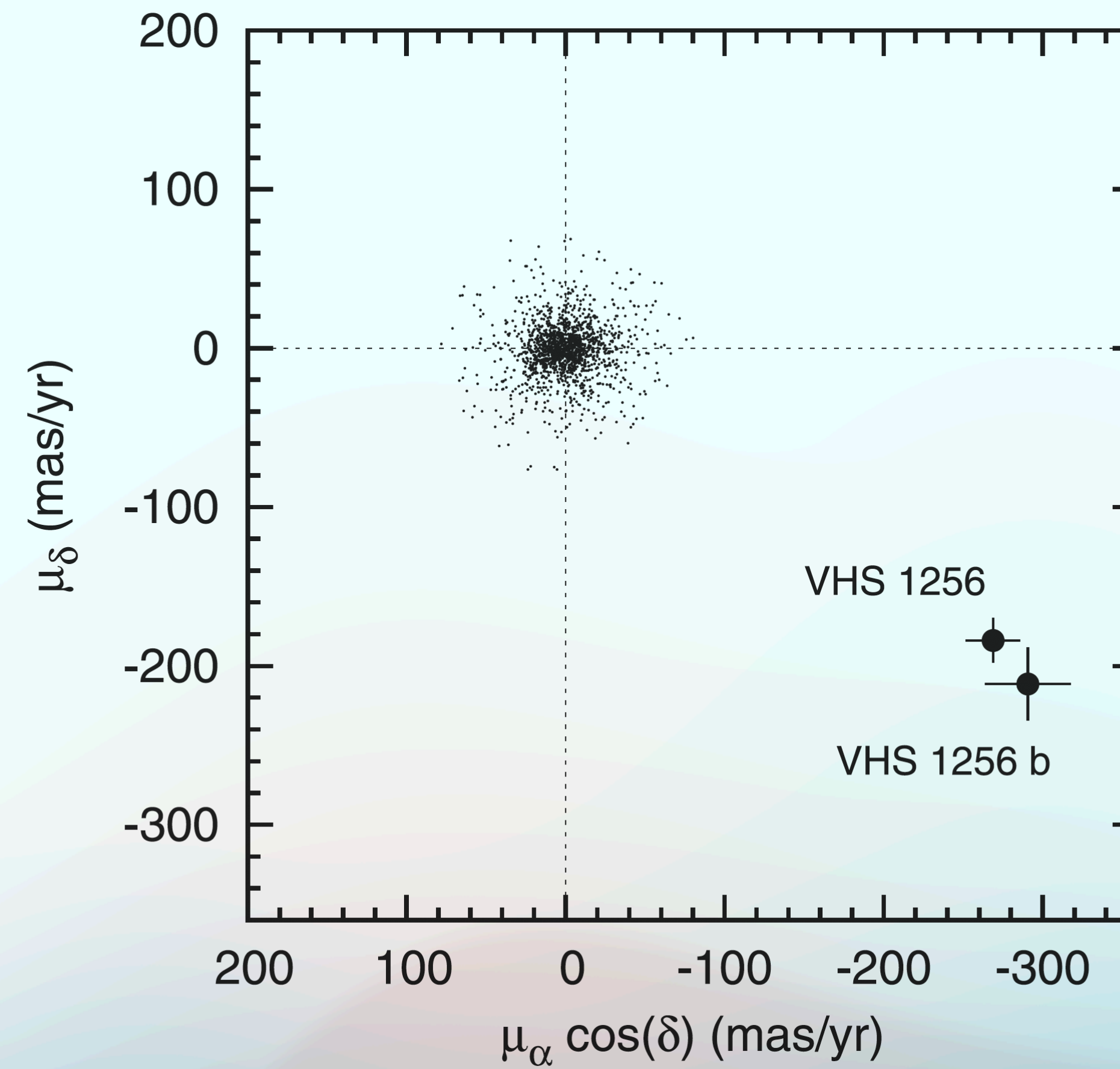
2MASS K



VHS K

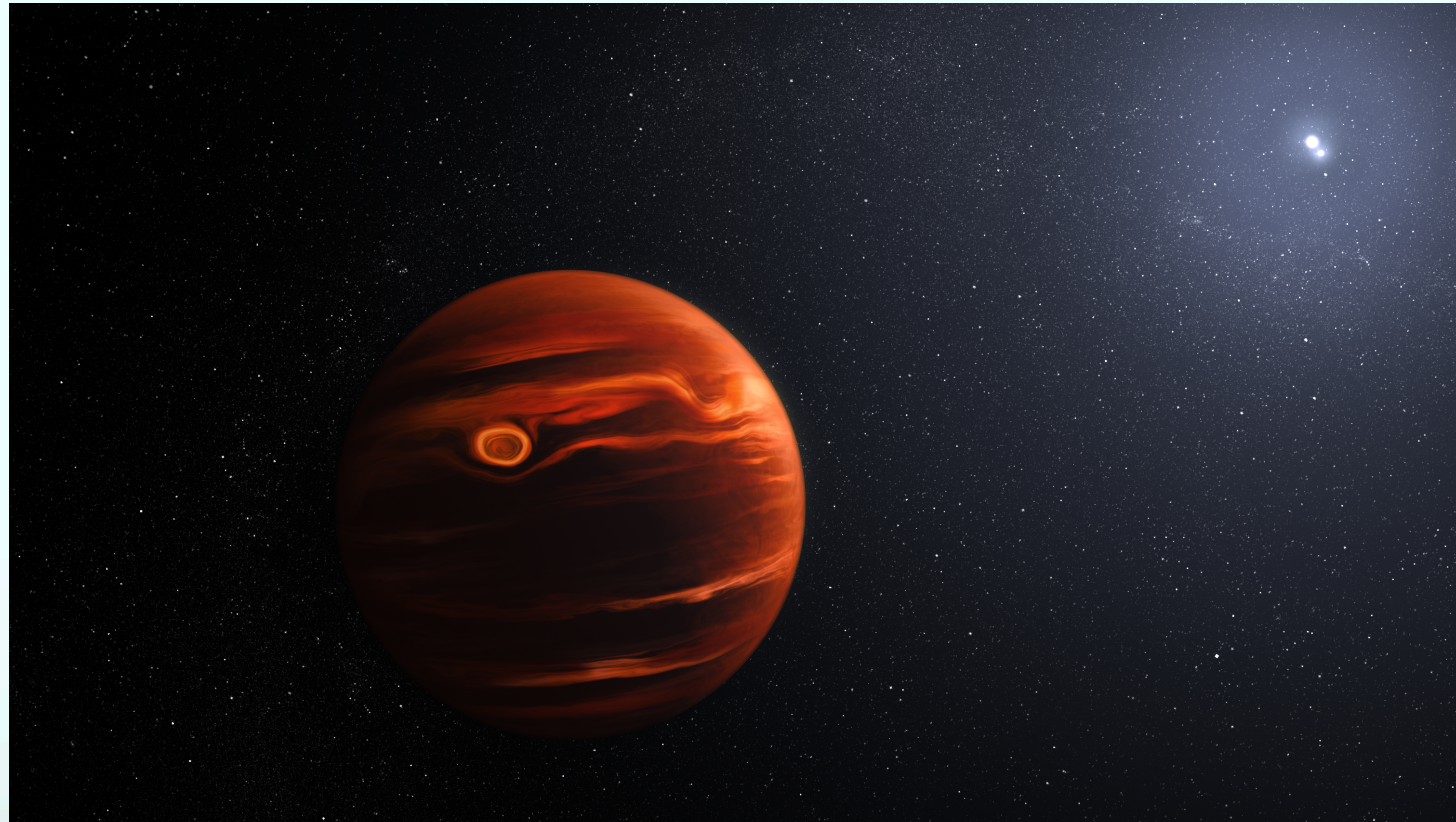


VHS1256b - Exoplanet companion to an equal mass binary



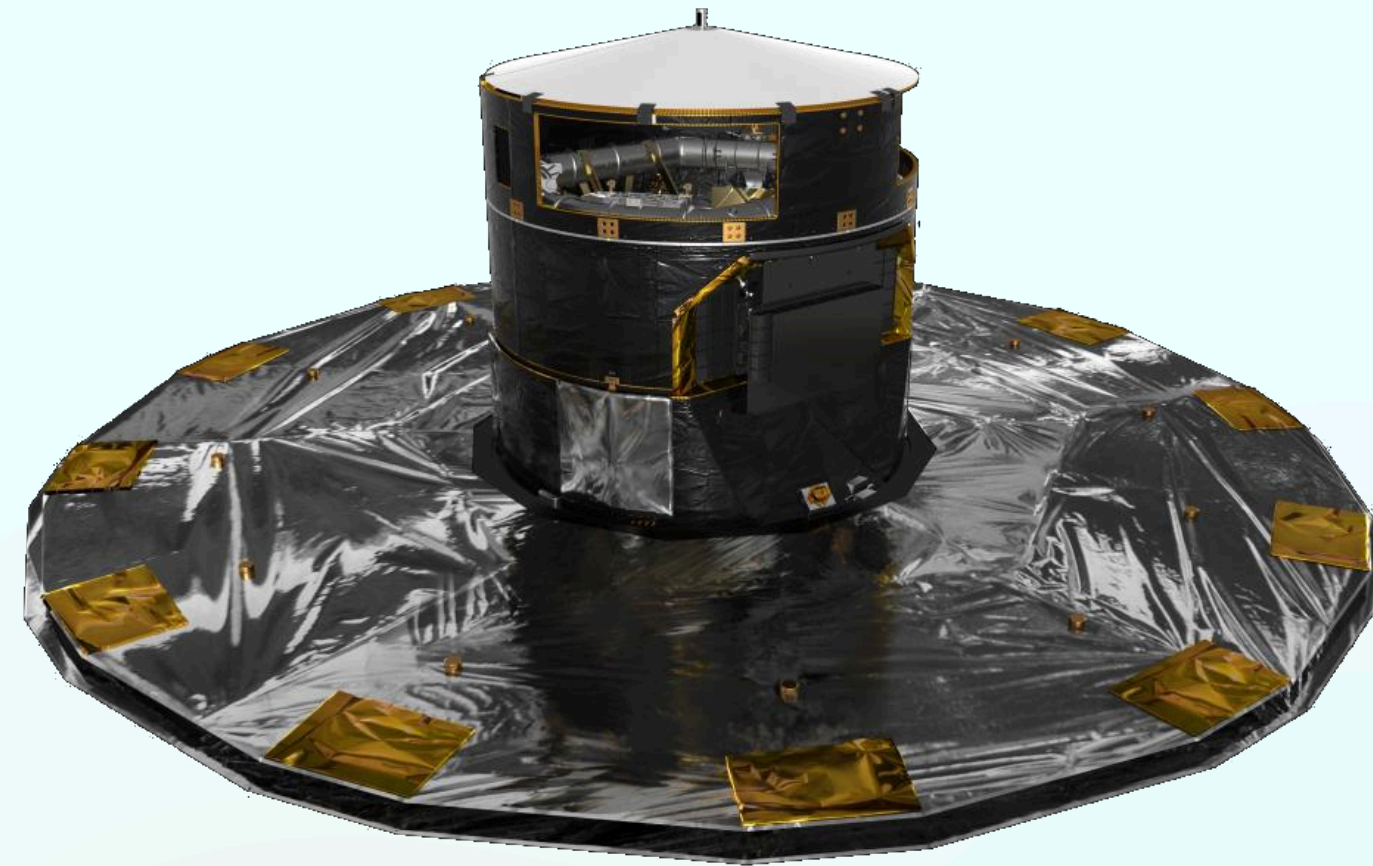
B. Gauza, V. J. S. Béjar, A. Pérez-Garrido et al., ApJ **804**, 96 (2015)

VHS1256b - Exoplanet companion to an equal mass binary



S. Gandhi, S. deRegt, I. Snellen et al., *ApJL* **957**, L36 (2023)

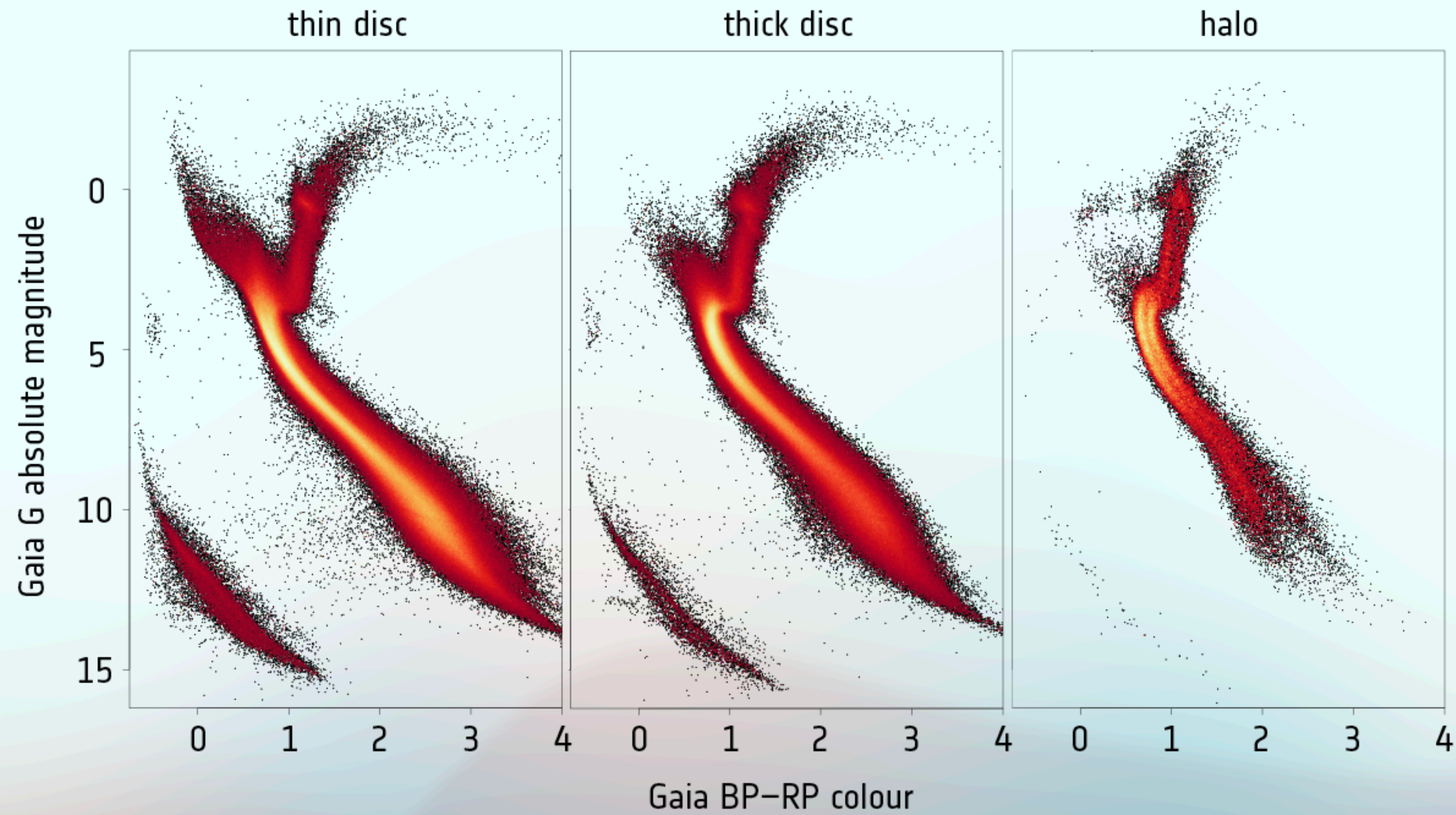
GAIA



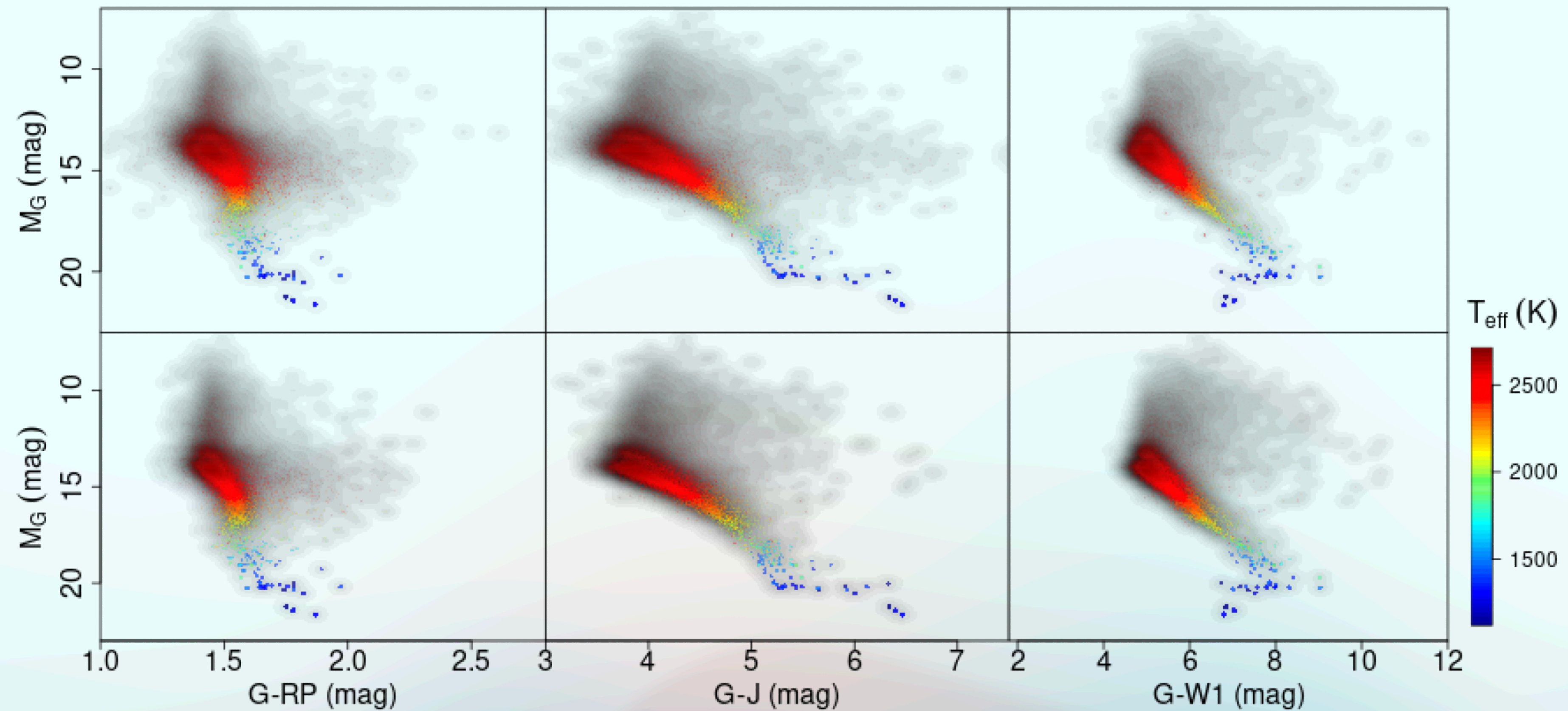
DR3 - Positions on the sky, parallax, and proper motion for around 1.46 billion sources

DR4 - information of about 2.7 billion sources (December 2026)

GAIA



Gaia Ultracool Dwarf Sample



Gaia data as the starting point for identifying co-moving Brown Dwarfs with:

- Solar neighborhood (FGK/M primaries)
- Young moving groups/associations
- Open clusters
- Thick disk/halo (metal-poor)
- White dwarf + BD systems
- Star-forming regions / Galactic plane

Conclusions

- Powerful discriminator against extragalactic contaminants
- Uncovers rare/exotic substellar populations
- Identifies co-moving, co-eval systems (wide binaries, benchmark ages/metallicities)

Thanks!