Planetary-mass objects with HAWK-I

María Rosa Zapatero Osorio
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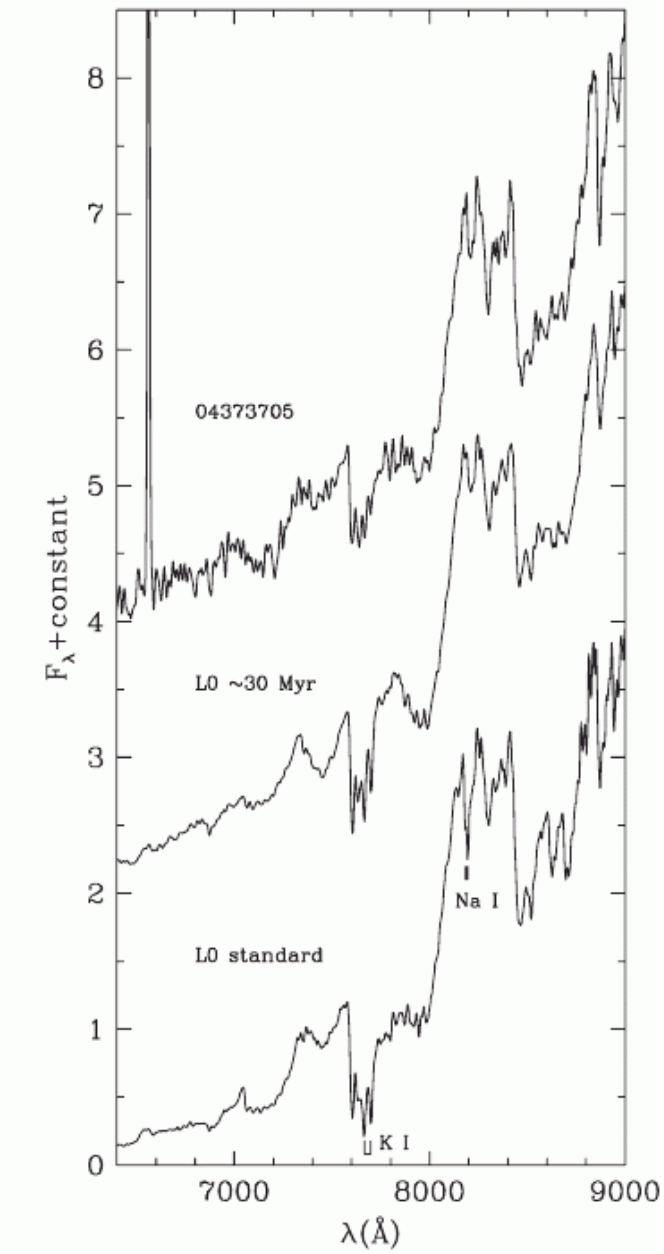
Outline

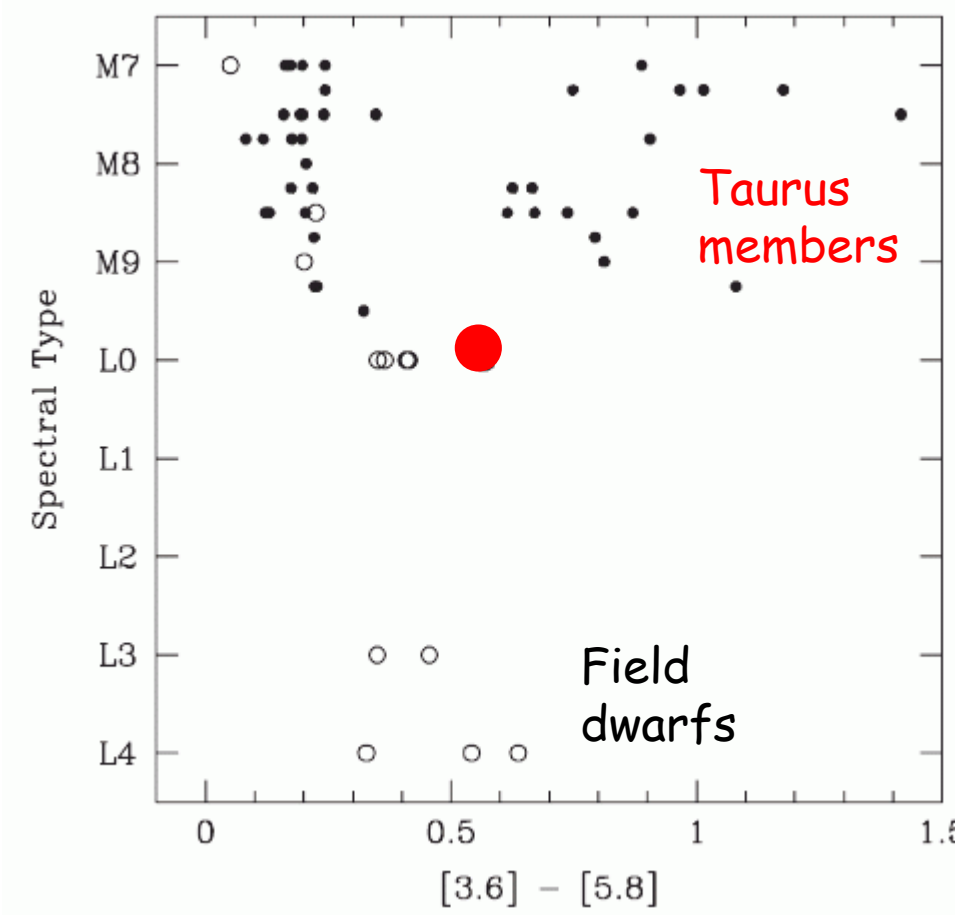
- Mass function in σ Orionis (P82)
- Planets around nearby brown dwarfs in the field (P83).

On-going work!!!

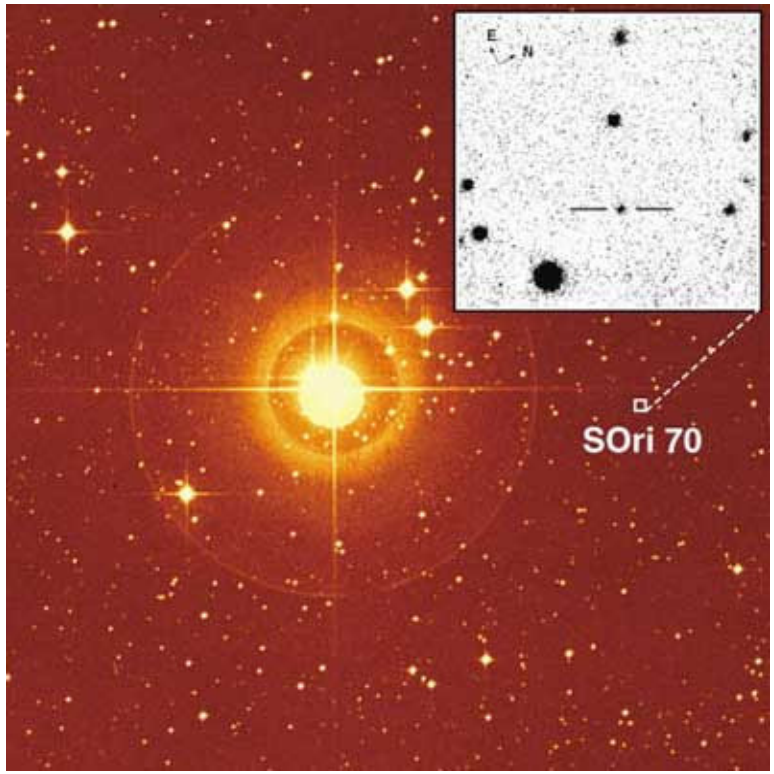
Mass function: star-forming regions



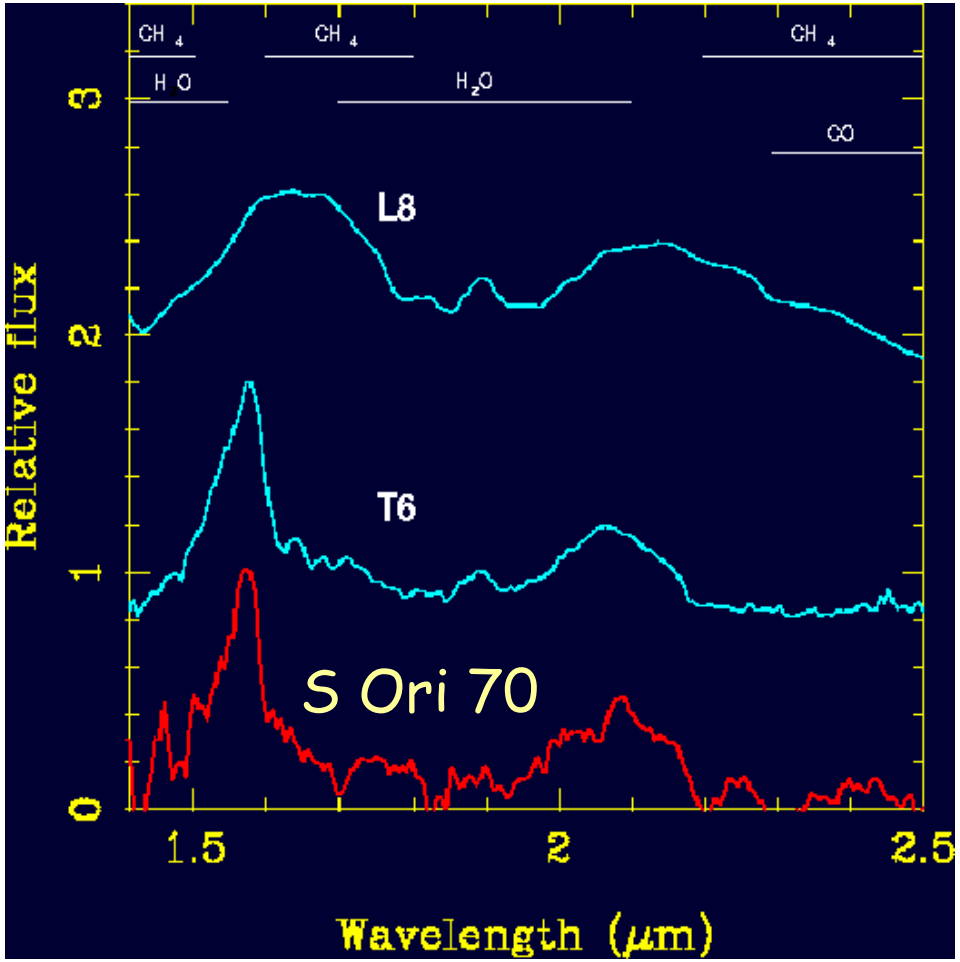
In Taurus (1 Myr, 150 pc), Luhman et al. (2009) have found the first L-type member with a mass estimated at 4-8 M_{jup}.



Mass function: very young open clusters

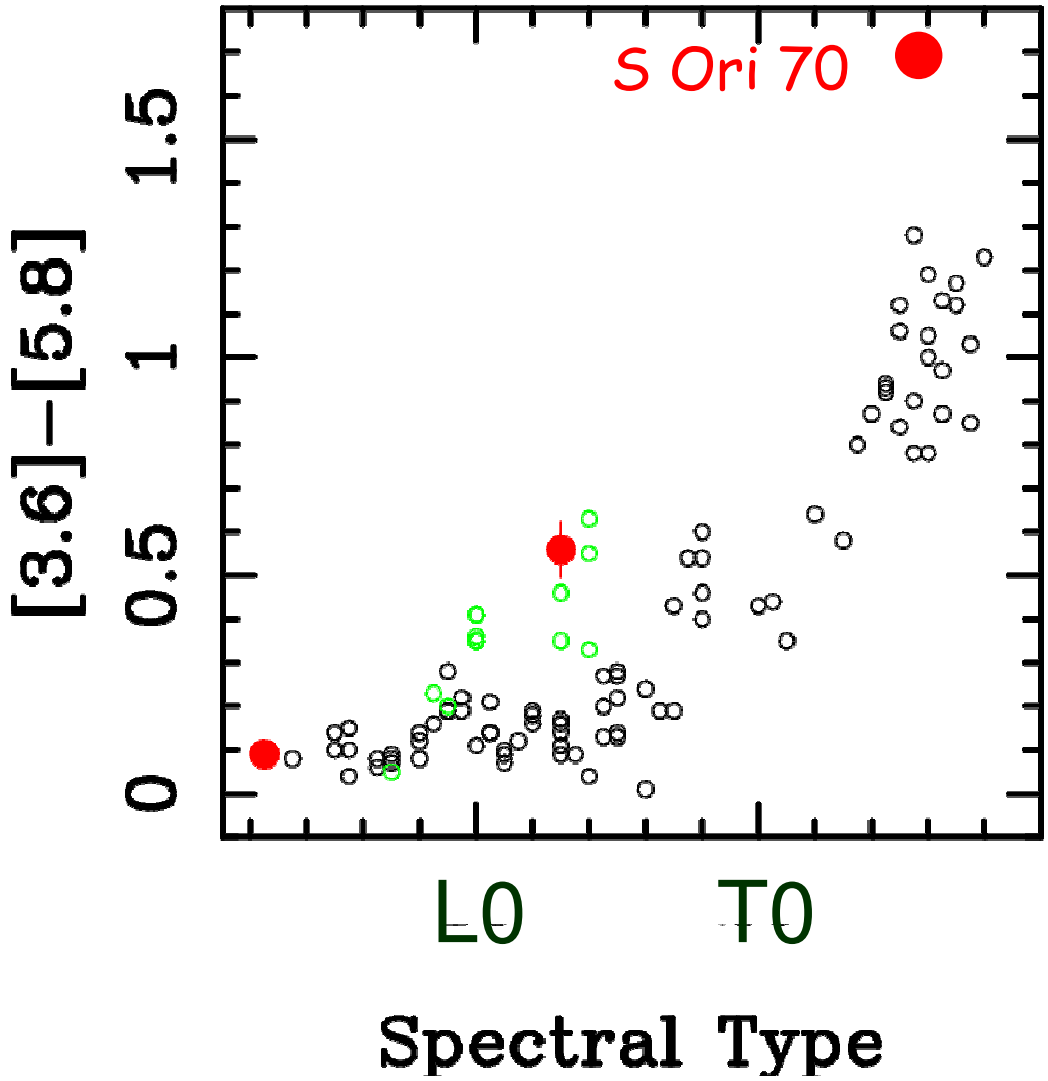


Zapatero Osorio et al. (2002)



S Ori 70 is 3 Myr old; its mass is only 3-7 M_{jup}, and its surface temperature is about 1000 K (spectral type ~L5).

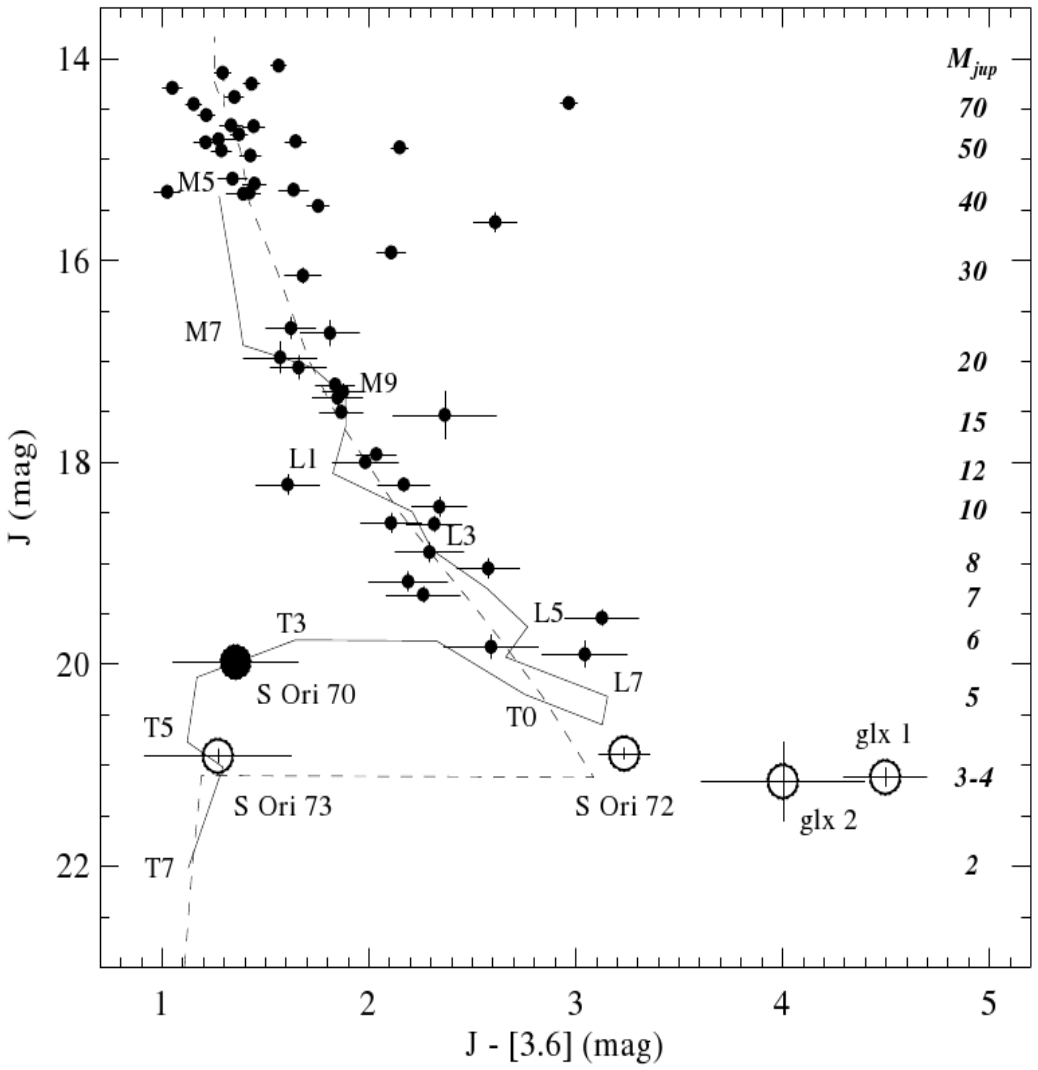
Mass function: very young open clusters



S Ori 70 presents near- and mid-infrared colors redder than expected for its spectral type. This is consistent with low-gravity atmospheres, providing support for its cluster membership and planetary-mass nature.

Zapatero Osorio et al. (2008); Scholz & Jayawardhana (2008); Luhman et al. (2009)

Mass function: very young open clusters



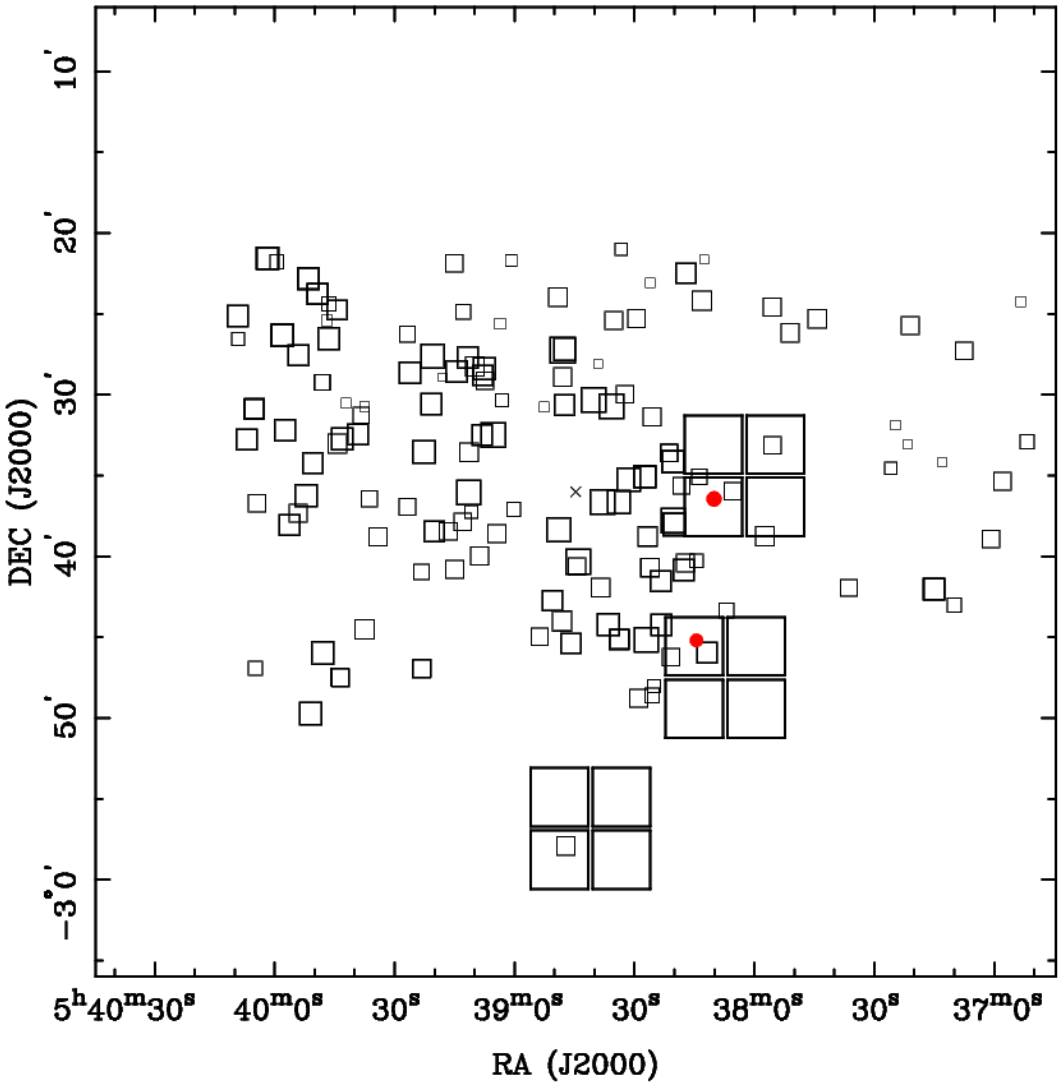
Bihain et al (2009)

In σ Orionis (3 Myr, 390 pc), the finding of additional T-type cluster member candidates is the result of combining multiwavelength observations using ISAAC/VLT + WFC/INT + IRAC/Spitzer.

Bihain et al. (2009) have identified S Ori 73, with an estimated mass at 3-7 M_{jup}.

Note the very faint brightness of these free-floating planetary-mass objects (J>20 mag).

Mass function: very young open clusters



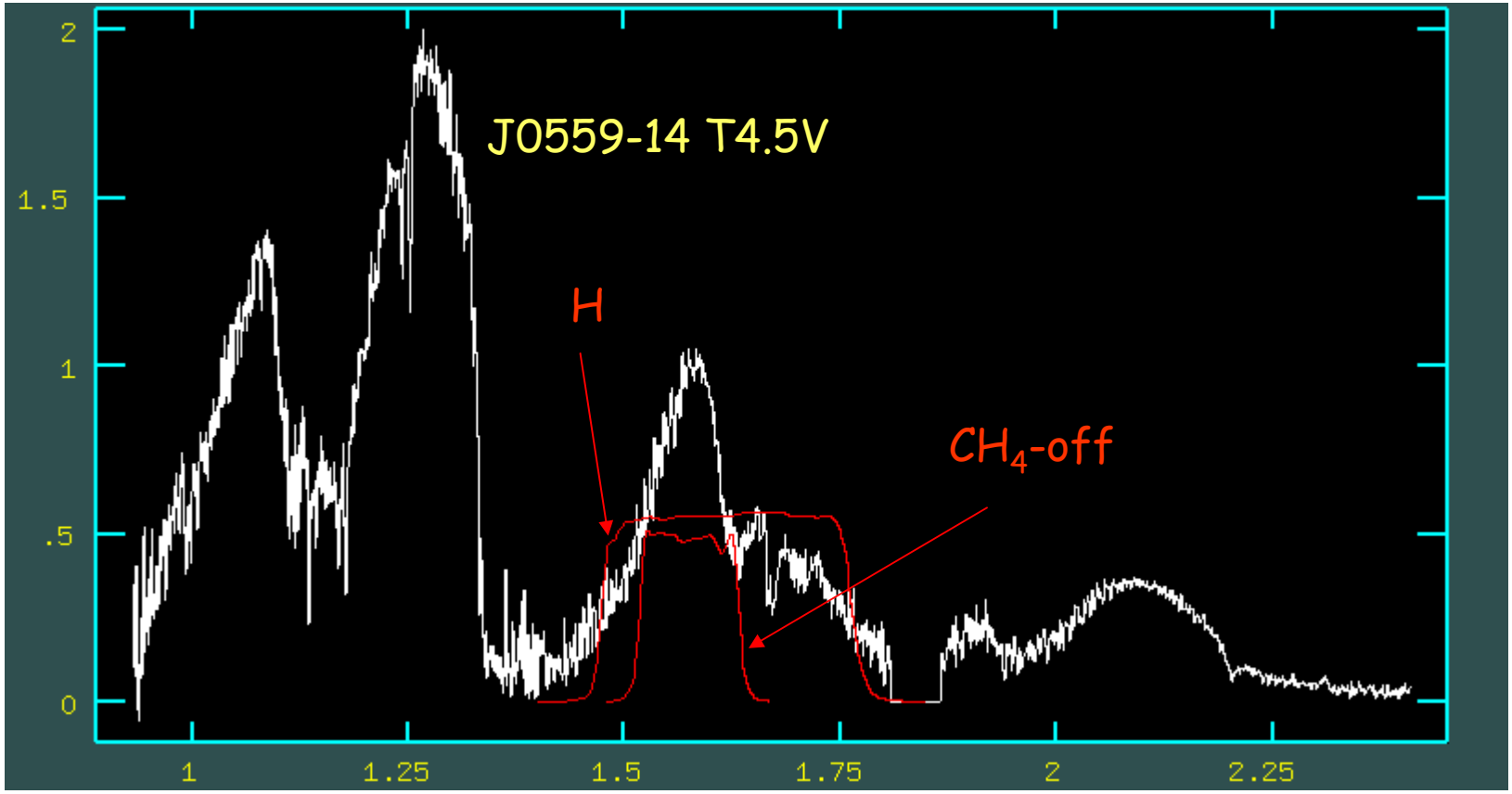
Hawk-I pointings, 2009

J+H+CH_4 Hawk-I images for:

- Going deeper (H~23 mag), and
- Confirming the presence of methane in the atmosphere of S Ori 73.

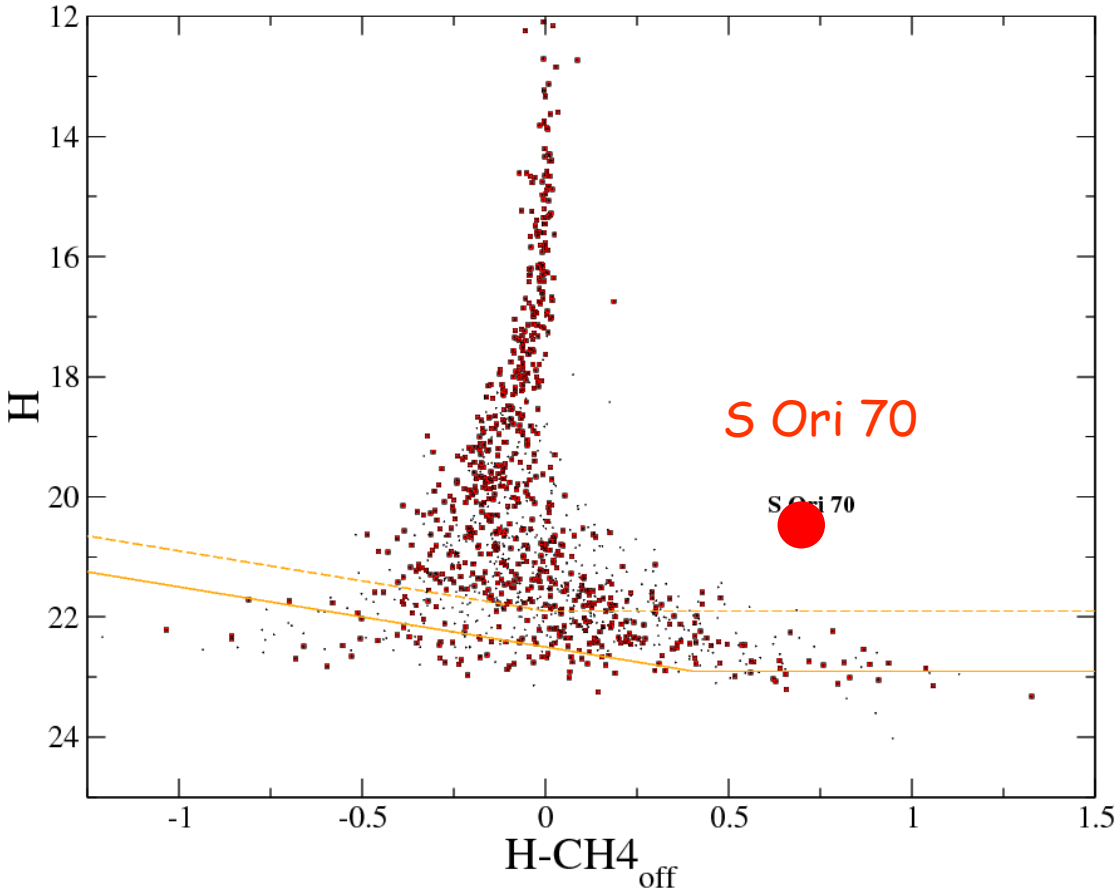
Mass function: very young open clusters

Hawk-I H and CH_4 filter passbands



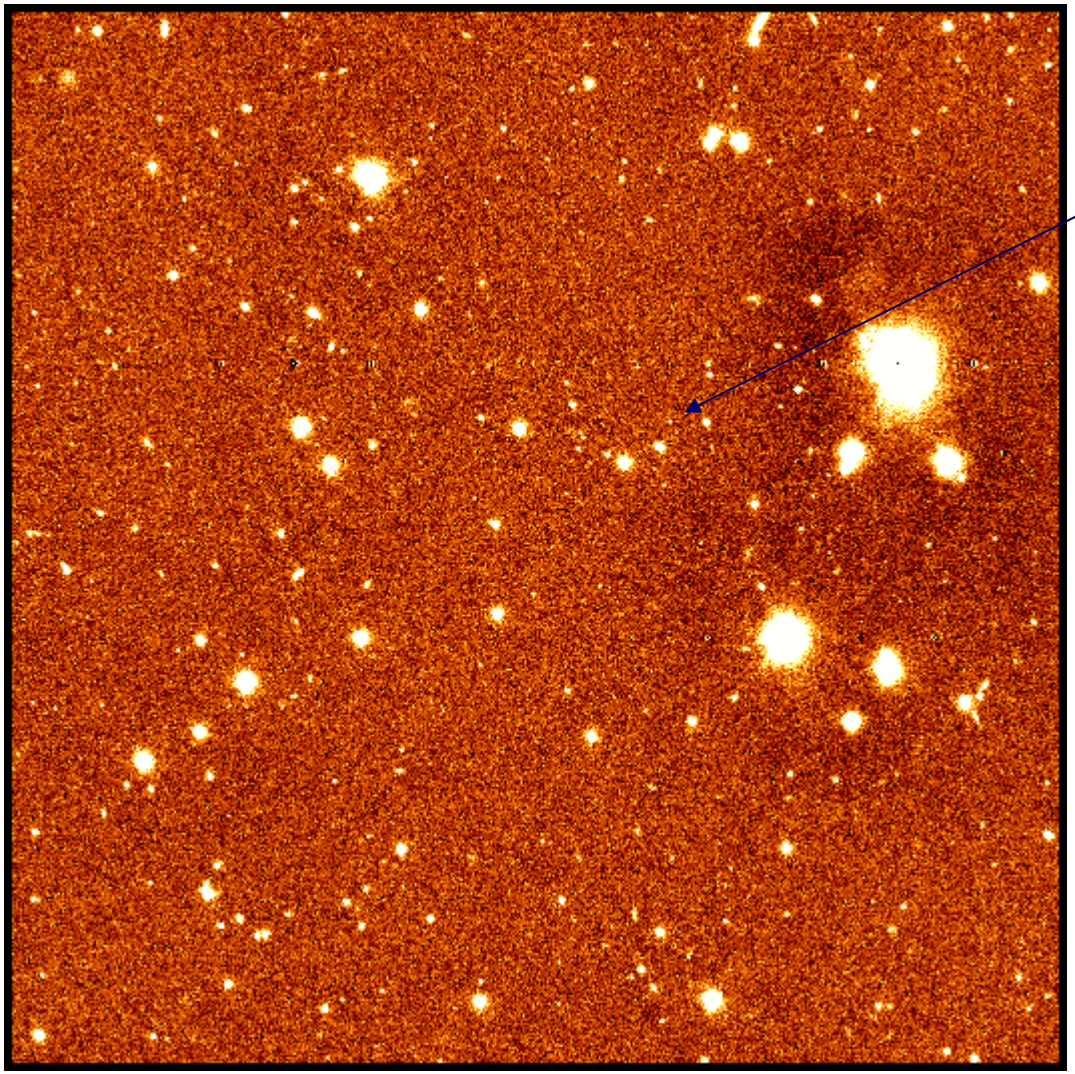
"Methane" objects should show red H – CH_4off colors.

Mass function: very young open clusters



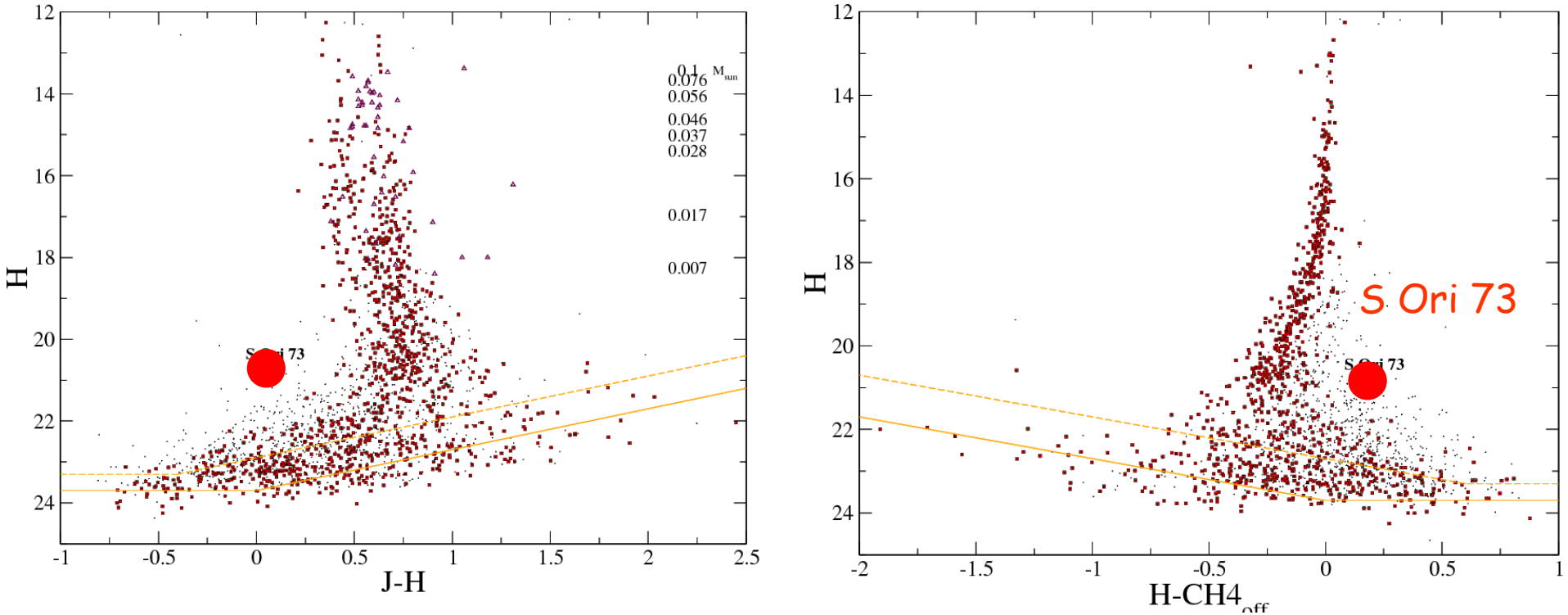
Part of Karla Peña Ramírez's PhD project

Mass function: very young open clusters



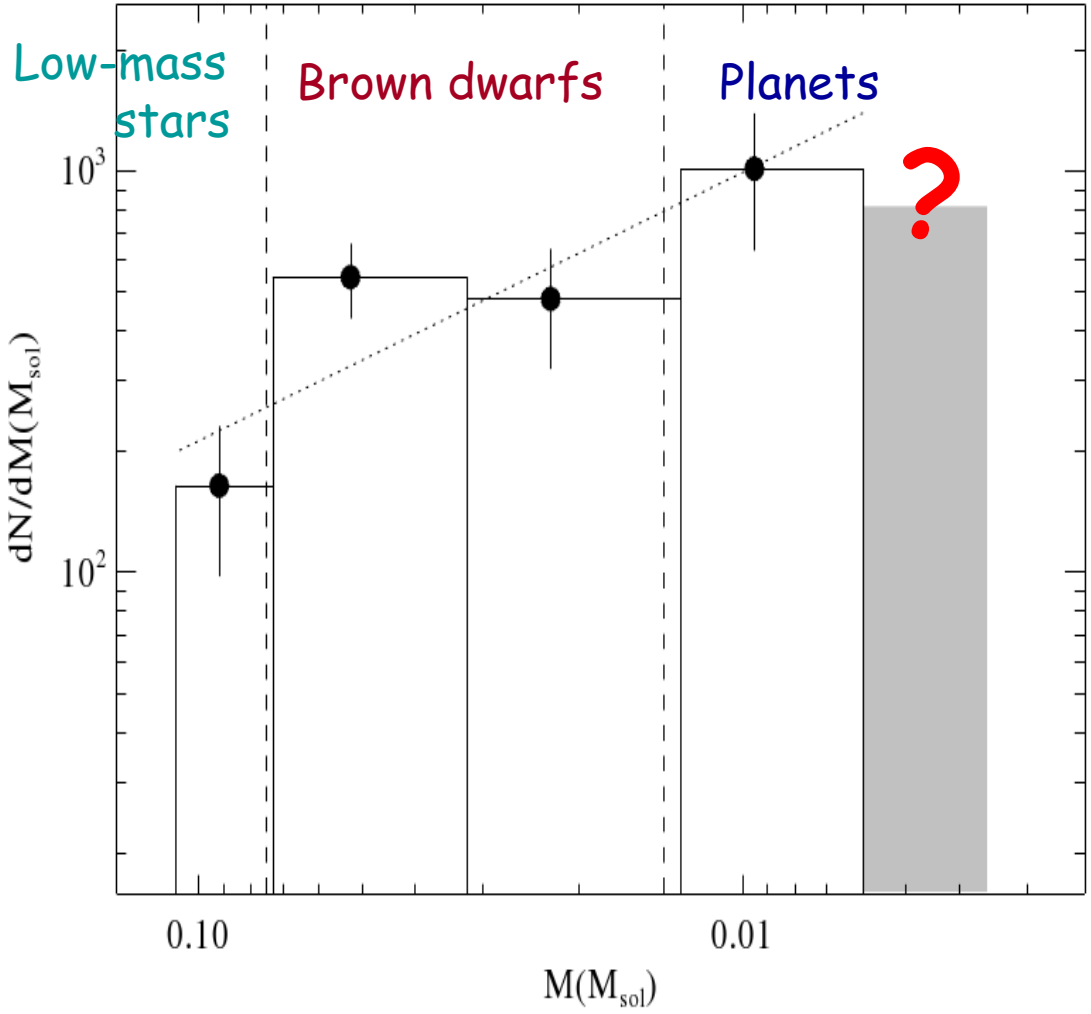
HAWK-I, pointing 1, detector 3, H, seeing = 0.34".

Mass function: very young open clusters



S Ori 73 is confirmed to have methane absorption in its atmosphere. However, its H-CH_4off color is not as red as that of S Ori 70.

Mass function: very young open clusters

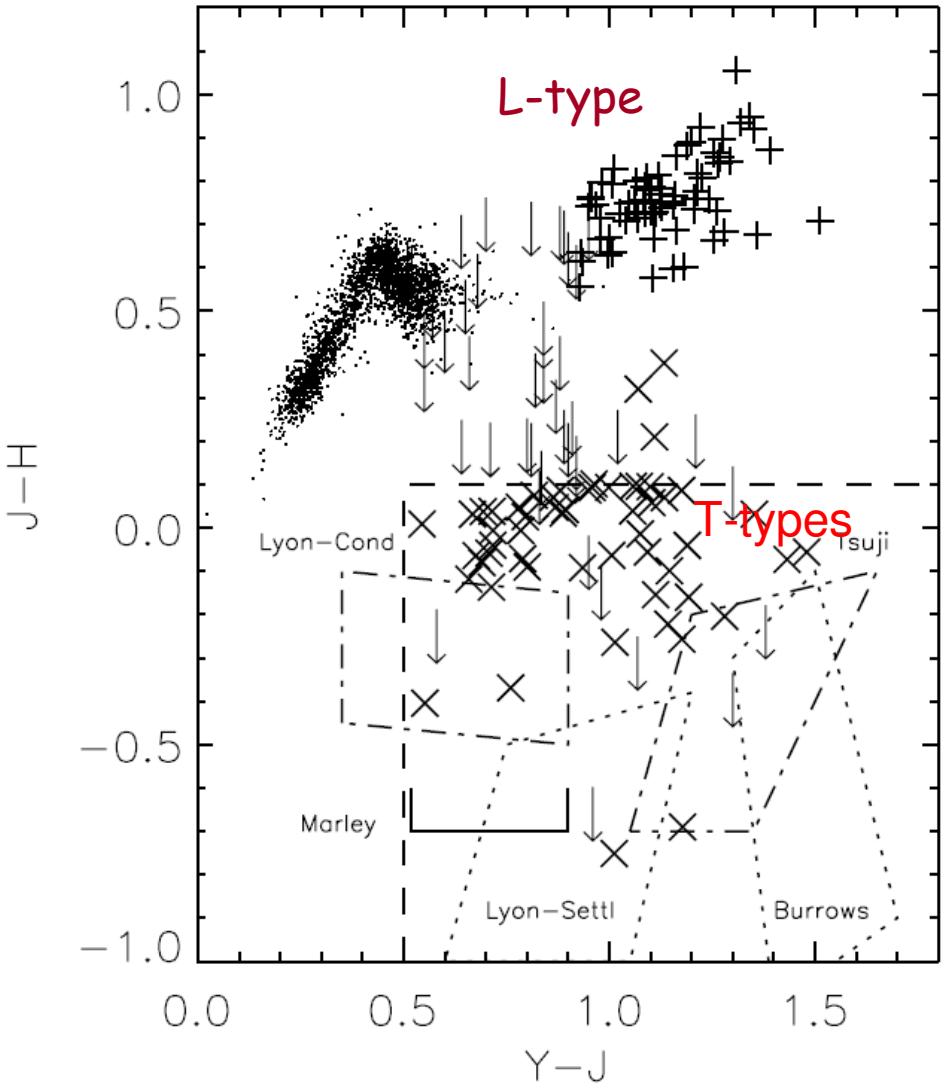


σ Orionis, Bihain et al (2009)

In a linear scale, the mass function is rising slowly with a slope α between 0.4 and 1.0 ($dN/dM \sim M^{-\alpha}$).

In σ Orionis, it appears to extend down to ~5 M_{jup}. The finding of smaller objects requires very deep images in both the optical (I>24) and near-infrared (JH>20).

Photometric search of "ammonia" objects



Pinfield et al. (2008)

The UKIDSS Large Area Survey (LAS) is intended to provide 4000 deg^2 of the sky covered in YJHK down to J ~19.5 mag.

Dwarfs cooler than ~700-800 K are eagerly searched in the region marked by the dashed square. Different theoretical models predict different locations in color-color diagrams.

Planets around brown dwarfs

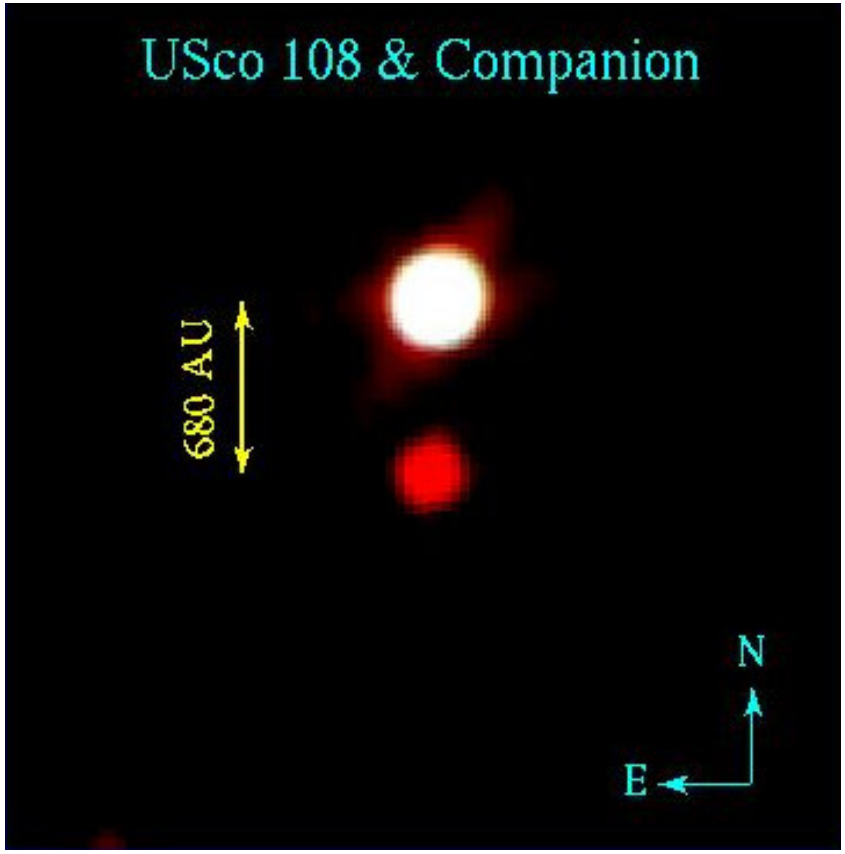
USco CTIO 108B

A 14 M_{jup} companion to a 60 M_{jup} brown dwarf at a projected separation of 680 AU.

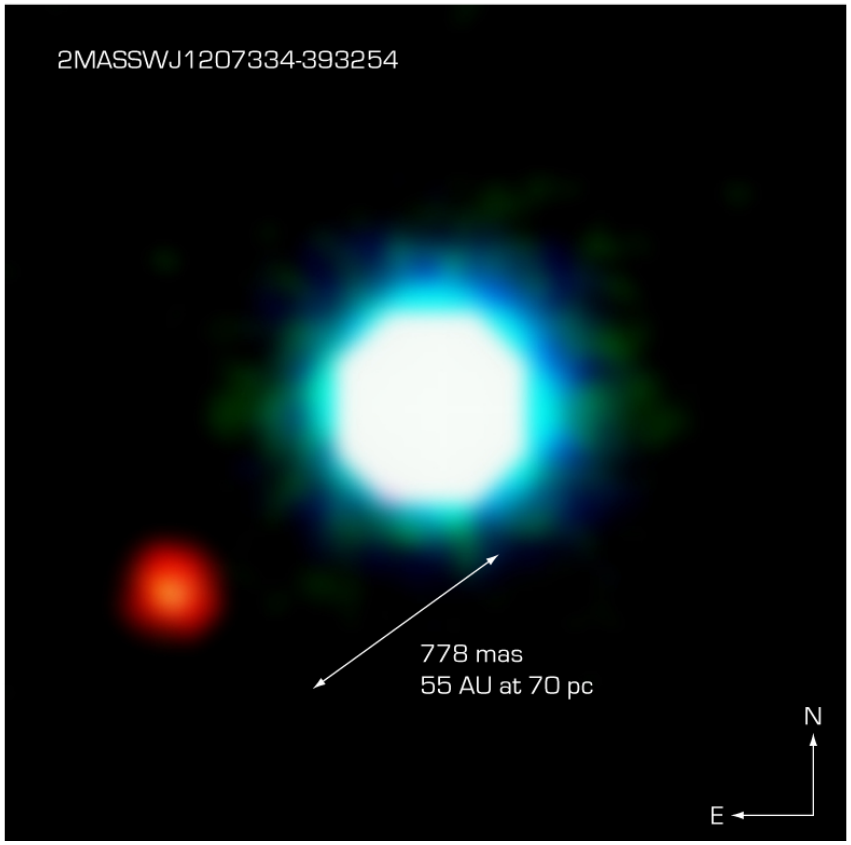
Age = 5 Myr.

Béjar et al. (2008)

To detect similar companions at the age of the field, surveys with J > 20 are required. AO surveys would have lost them, since orbital separations become ~1 arcmin @ 10 pc!



Planets around brown dwarfs



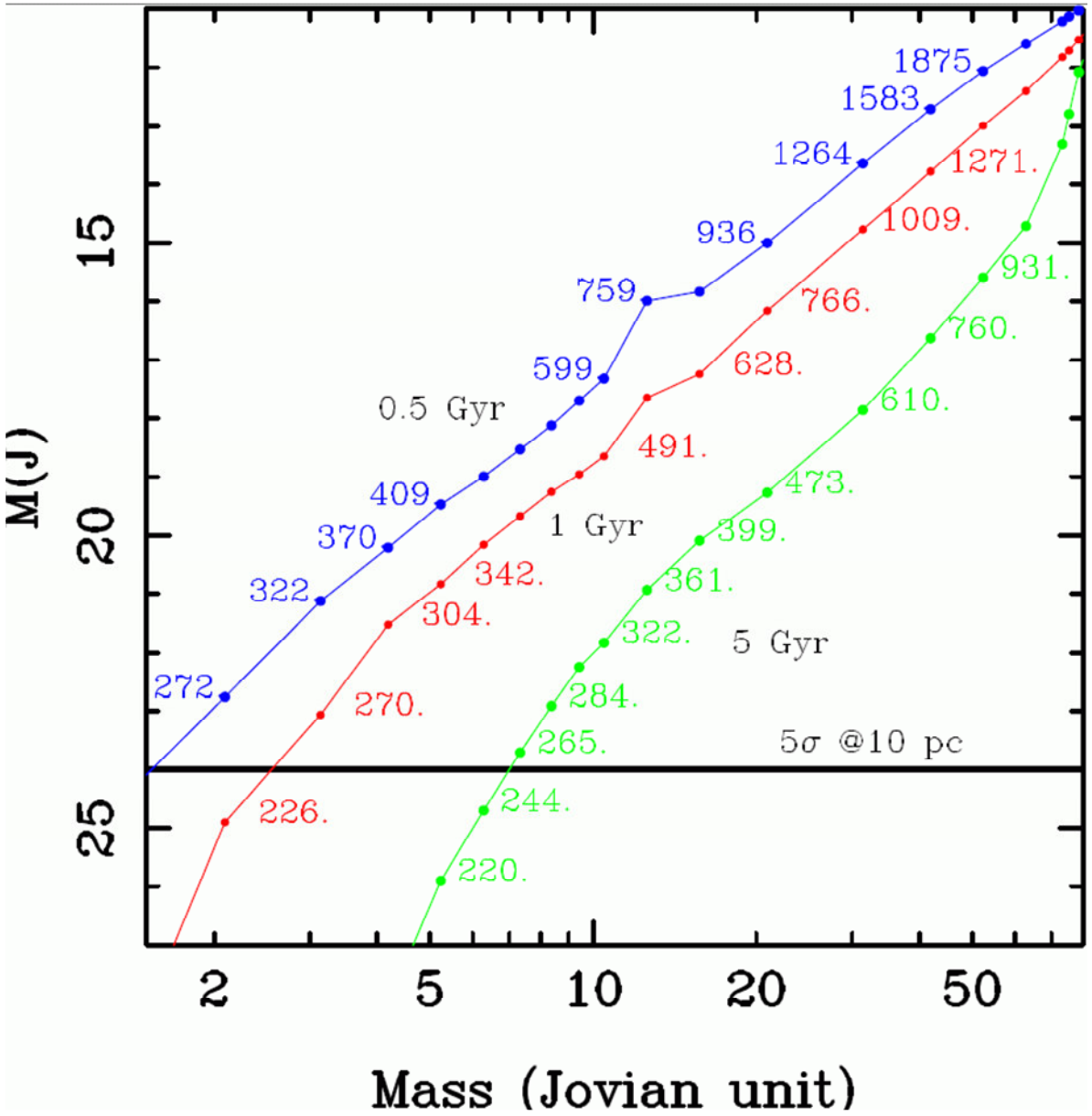
Chauvin et al. (2004)

A 5-M_{jup} planet is orbiting around a 25-M_{jup} brown dwarf in TW Hya. The age of the system is ~10 Myr.

At the typical age of the field (a few Gyr), the companion would have T_{eff}= 220-350 K, and M(J) > 21.5 !!!

Very deep (J > 22) near-infrared surveys are required to detect such cool sources in the field.

Planets around the nearest T-type brown dwarfs

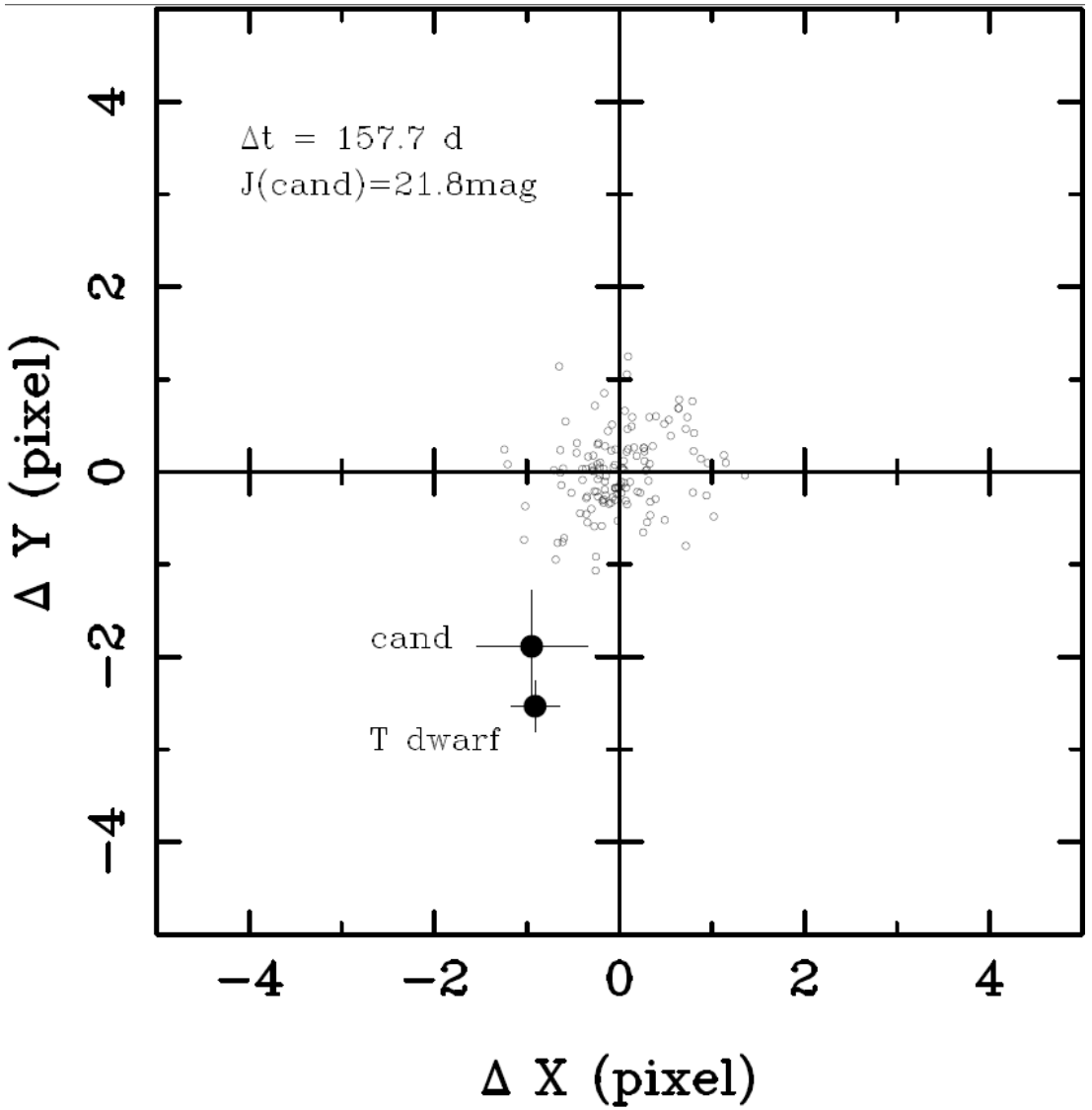


Program with HAWK-I:

Imaging down to J=24 mag the surroundings of the nearest T-type brown dwarfs.

This will allow the detection of very cool objects (~300 K), which may become benchmark sources for the search of "Y-dwarfs" in other surveys.

Planets around the nearest T-type brown dwarfs



Program with HAWK-I:

Imaging down to J=24 mag the surroundings of the nearest T-type brown dwarfs.

True physical companions will be recognized by their high proper motions, which should be tha same than those of the primary T-type sources.

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