Low-mass Habitable Exoplanets with a Wide-field IR Space Telescope

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Stellar/Substellar presentations

Microlensing (20+)
Stellar populations (2)
Radial velocity & transits (2)
Direct imaging (1)

WFCAM transit survey

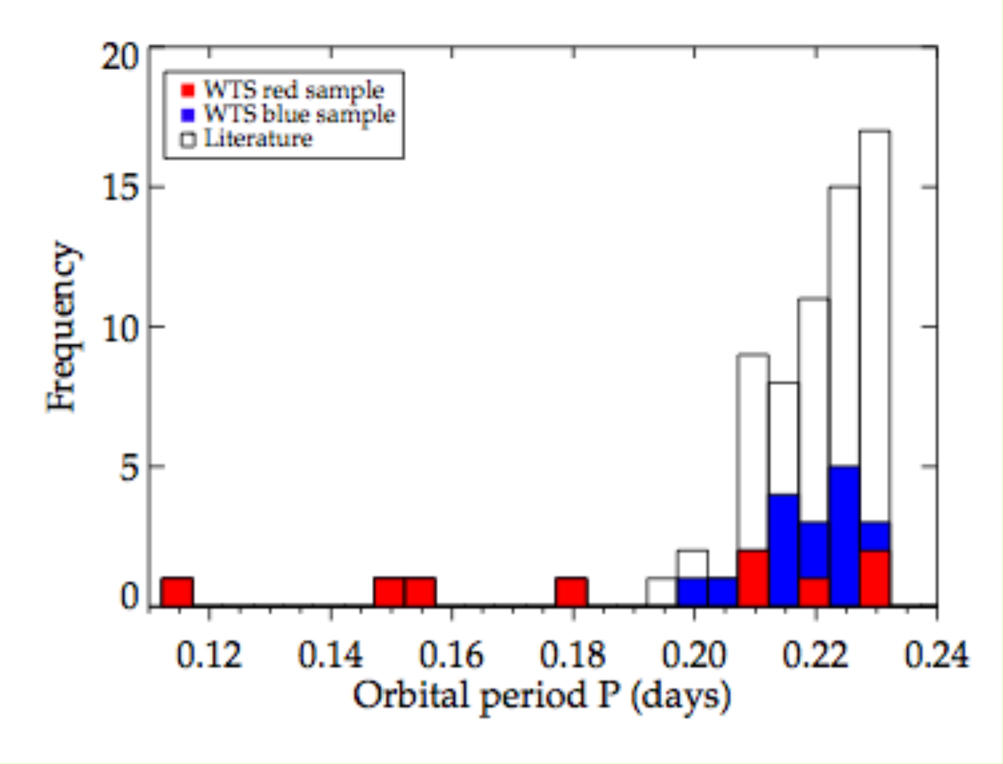
Name	(RA)	(DEC)	#stars	#epochs	#cand.
03hrfield	$03^h 39^m$	$+39^d 14^m$	10827(36306)	392	74
07hrfield	$07^h 05^m$	$+12^d 56^m$	16623(56070)	626	140
17hrfield	$17^h 14^m$	$+03^d 44^m$	9621(39879)	709	68
19hrfield	$19^h 35^m$	$+36^d 29^m$	34452(130320)	1154	375

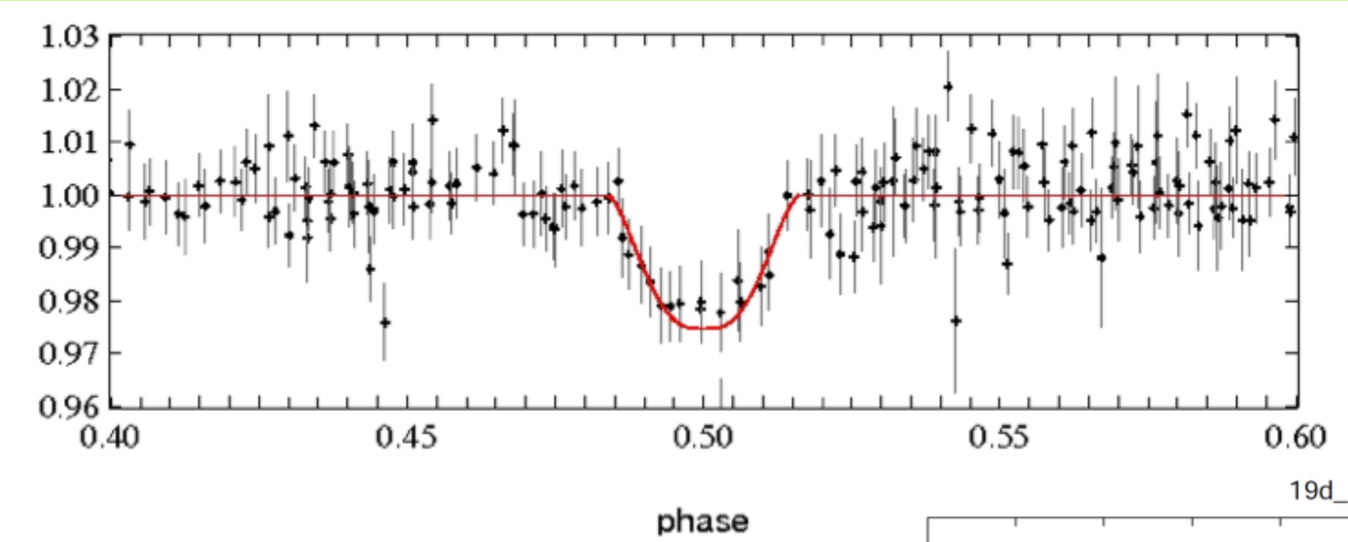
Table 1. The main properties of the four WTS survey fields. Indicated are the approximate centres of the fields (right ascension and declination), the total number of stars with $J \leqslant 16$ ($J \leqslant 18$ in brackets), the number of epochs in the most recent 3.0 lightcurve release and the number of binary candidates per field.

RoPACS Marie Curie FP7 network (P.I. David Pinfield)

Ultra-short P eclipsing dM binaries

S.V. Nefs et al.
MNRAS, subm.

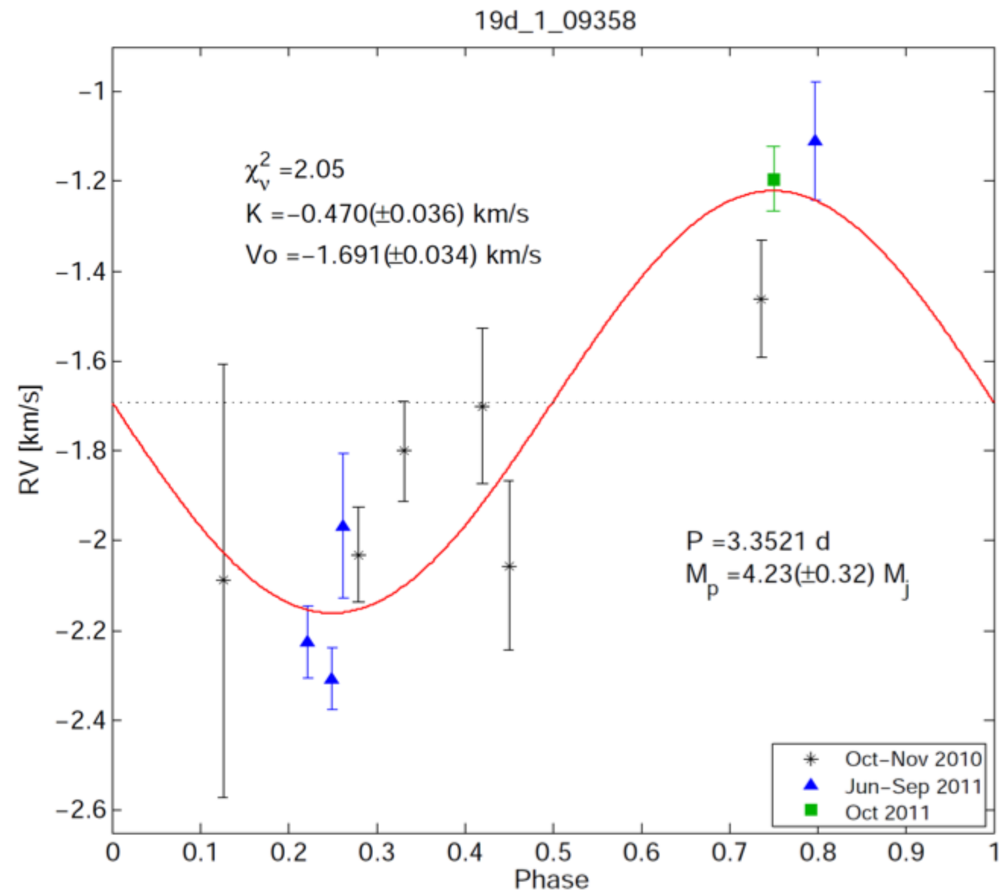




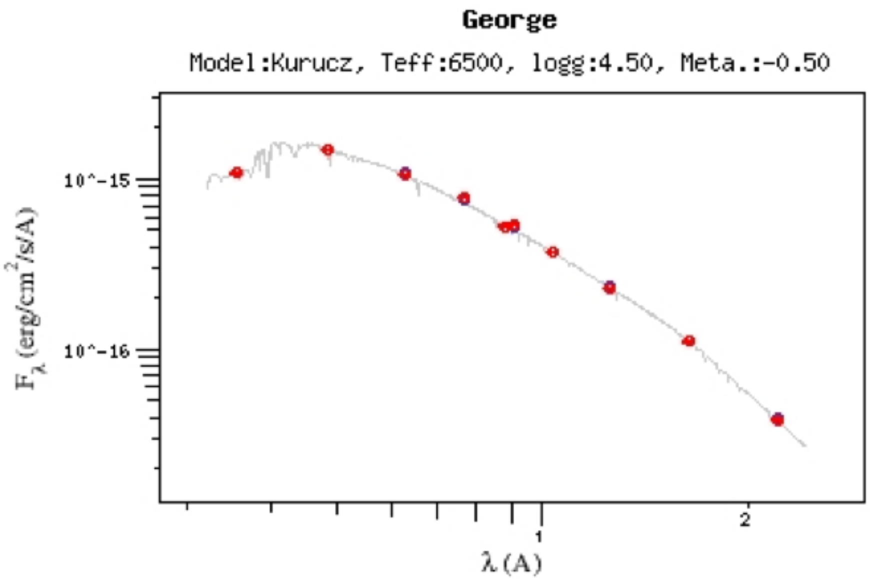
J-band=15.38 mag.
i-band=16.22 mag.

First WTS planet

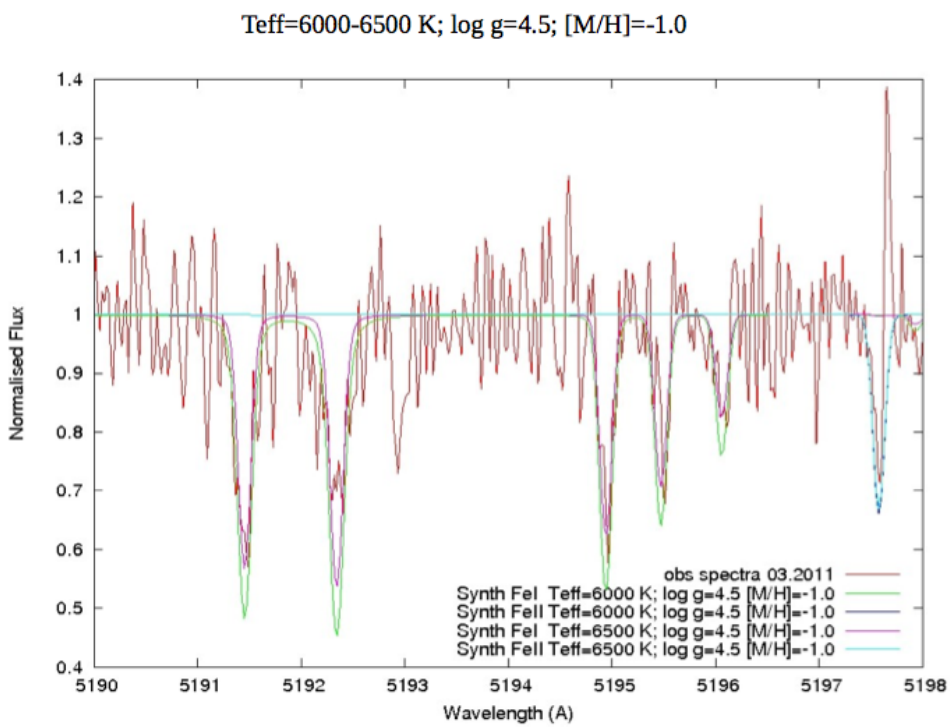
M. Cappetta et al.
in prep.



Radial velocity and sinusoidal fit

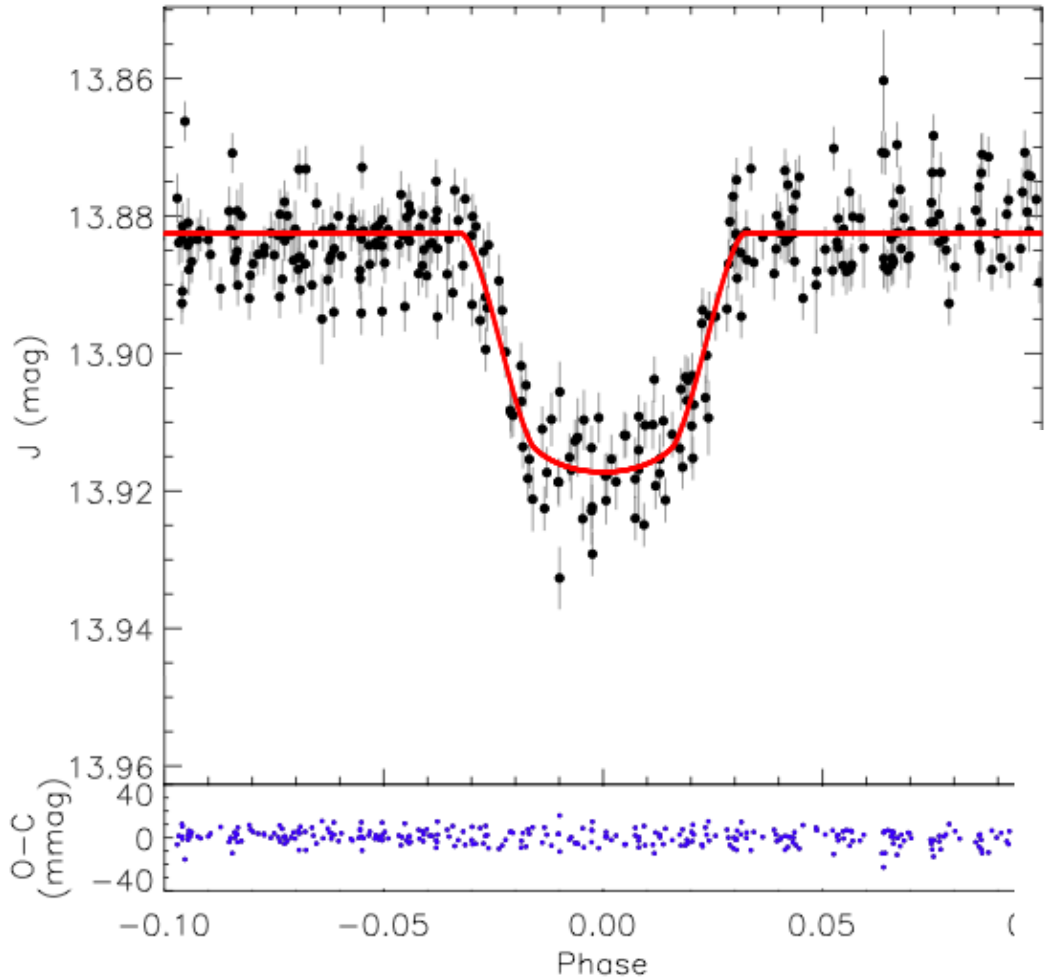


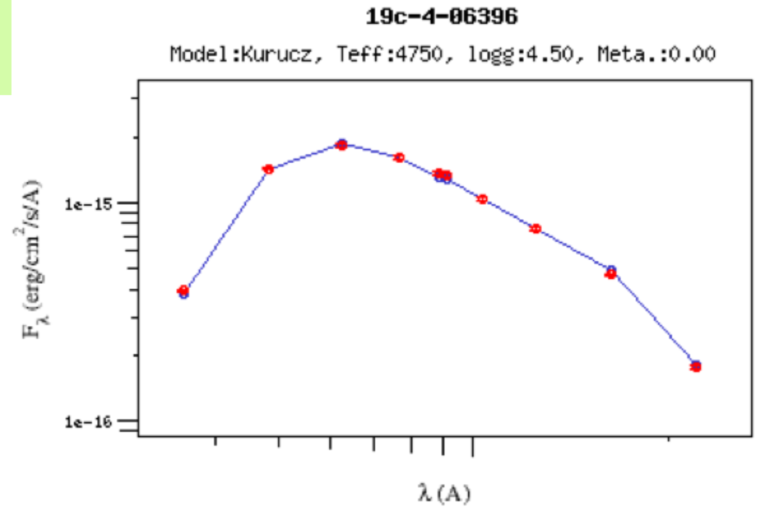
Best-fitting model result of the SED analysis with VOSA with Av=0.42

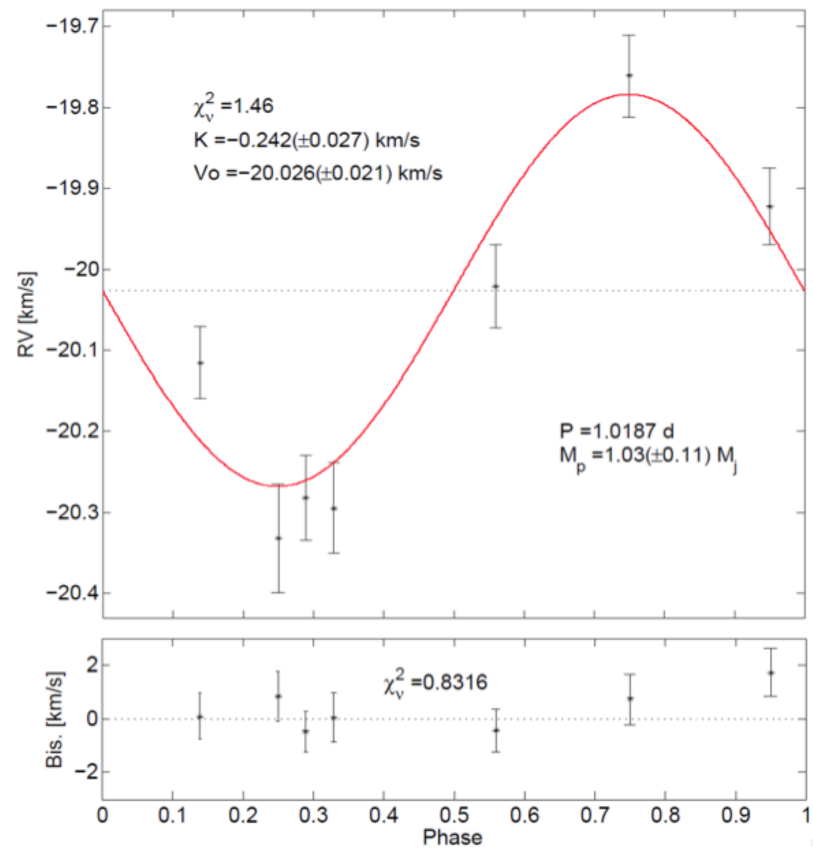


Synthetic spectral fits of HET spectra by L. Fossatti and Y. Pavlenko

Second WTS planet
J. Birkby et al.

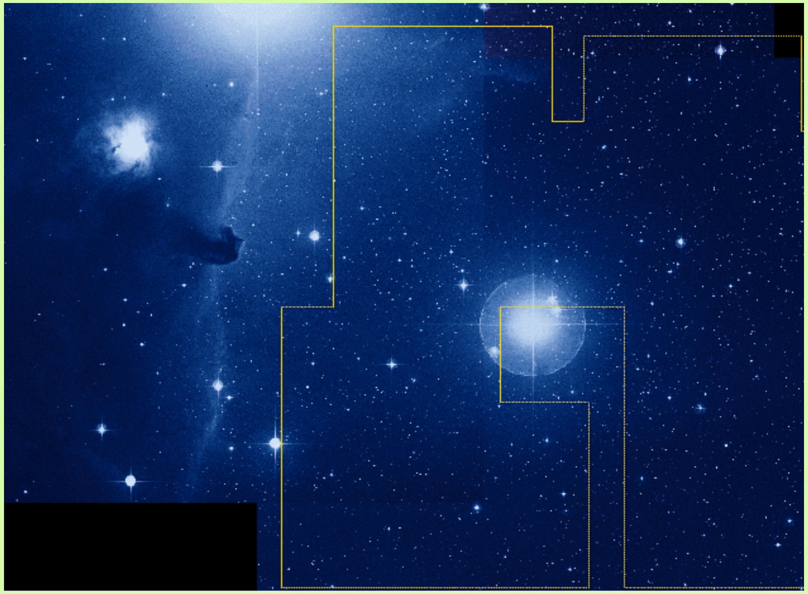






σOrionis cluster (circa 1790)

- D=350 pc
- Age=2-5 Myr.
- Low reddening
- Solar metallicity



VISTA telescope @ ESO

Karla Peña´s Thesis

(directed by Víctor Sánchez Béjar & Maria Rosa Zapatero)

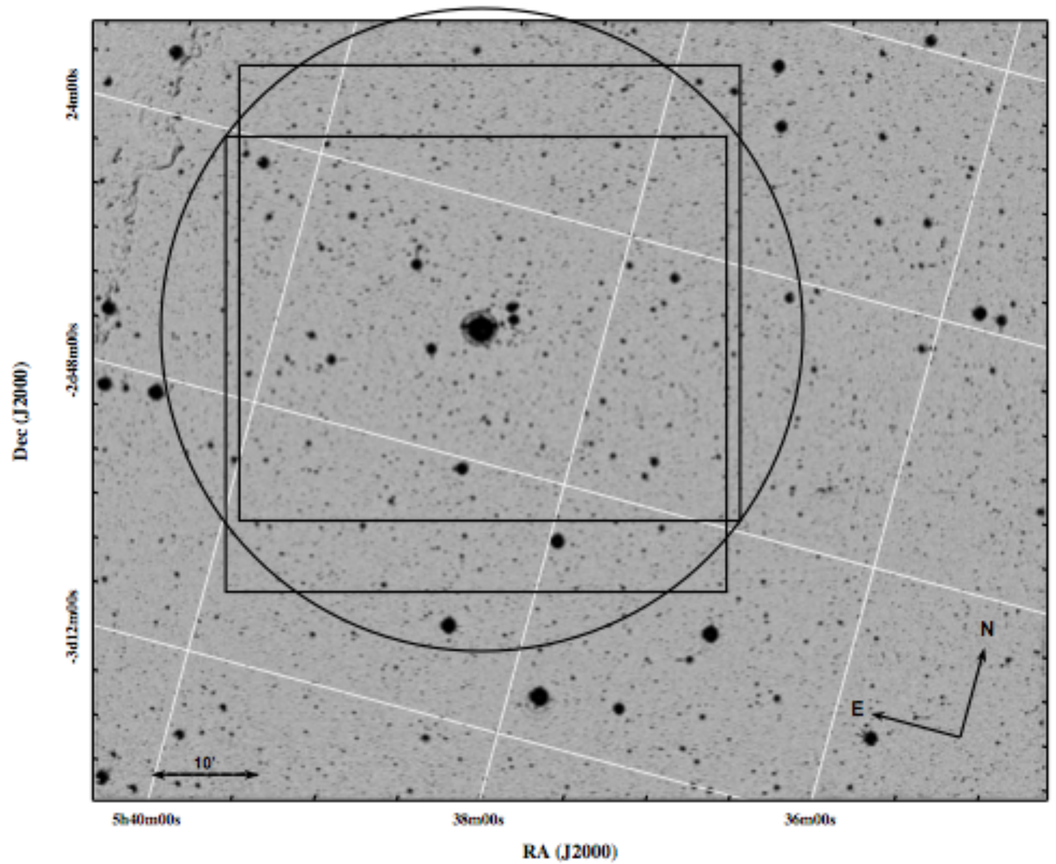


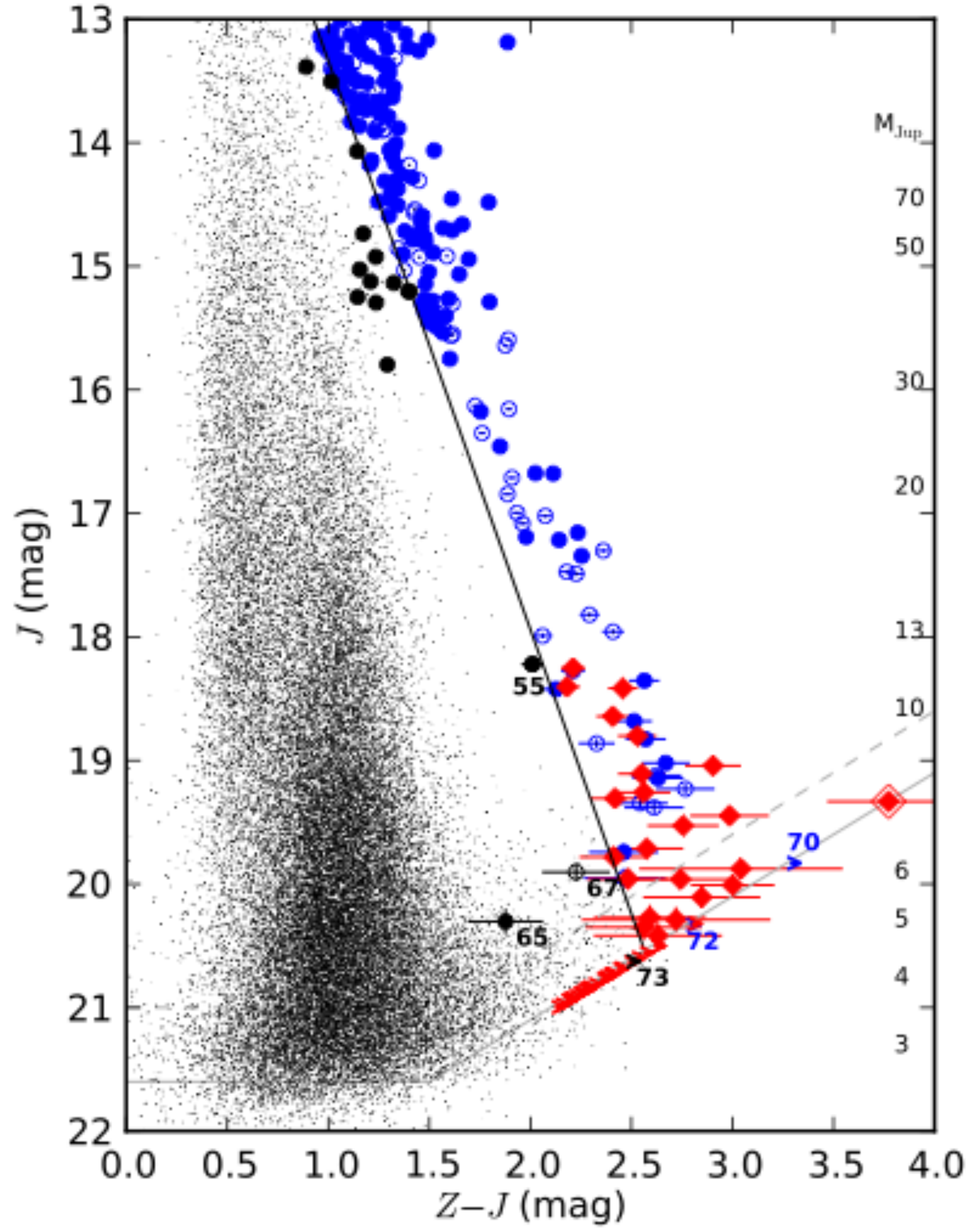
Fig. 1.— VISTA Orion survey tile 16, J-band, 1.2×1.5 deg^2 in size. Our search has explored the region inside the $30'$-radius circle centered on the bright, massive σ Ori star. The regions explored by *Spitzer* are shown with squares, the top square corresponds to the [3.6]- and [5.8]-band images, and the bottom square to the [4.5]- and [8.0]-band images.

Color-mag. diagram

20 new candidates members with masses 13—5 Jupiters

Confirmation of 187 candidate members

Rejection of 16 candidates from previous surveys



CMD with Spitzer data

Extension of VISTA survey to J=21. 30 new candidate members not included in IMF.

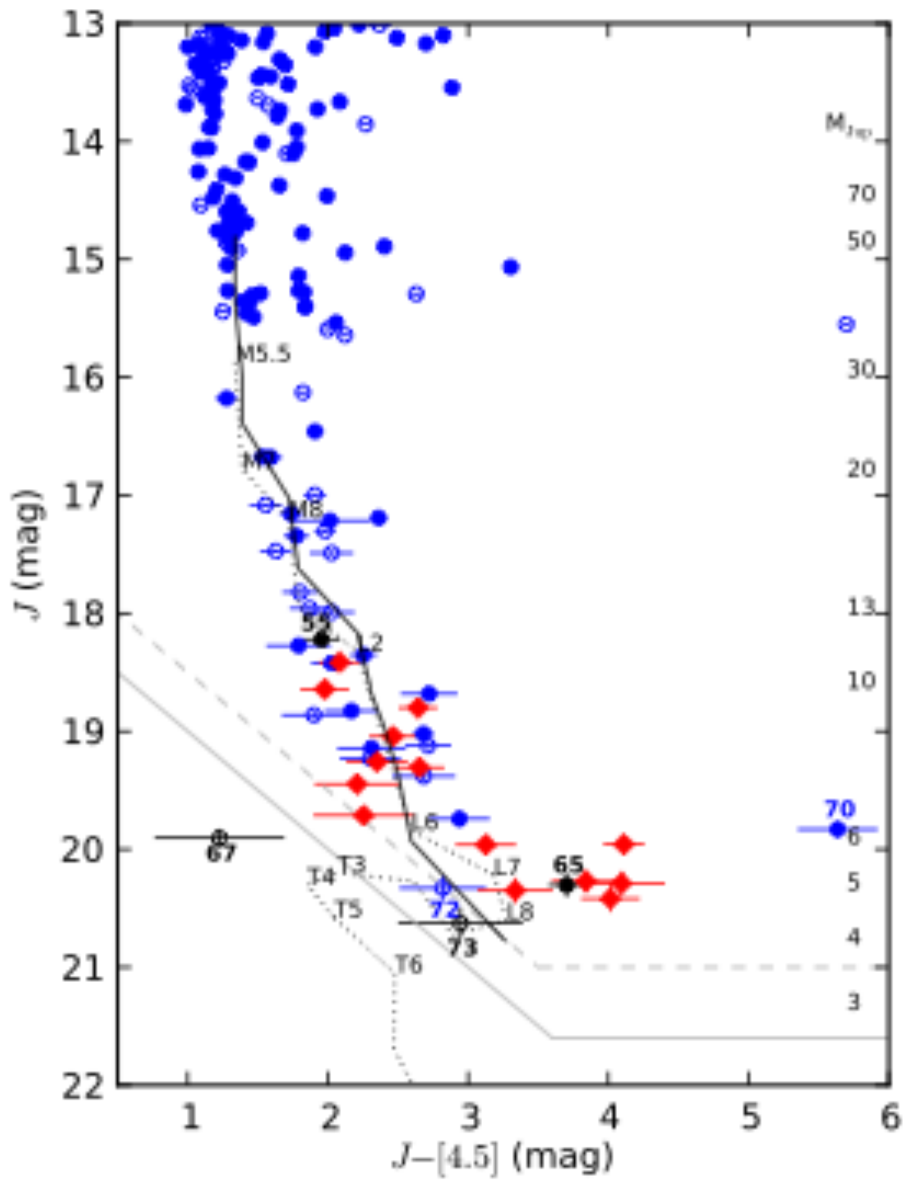
Detection of infrared excesses allows to infer disk frequencies as a function of central mass:

42 +/- 7% for low-mass stars,

36 +/- 8% for brown dwarfs,

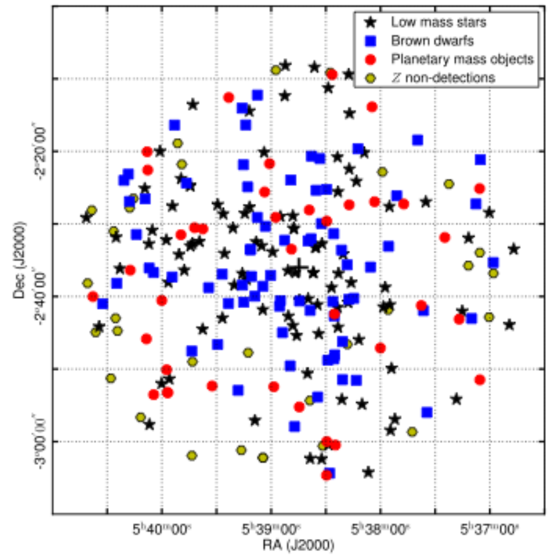
31 +/- 11% for cluster planets

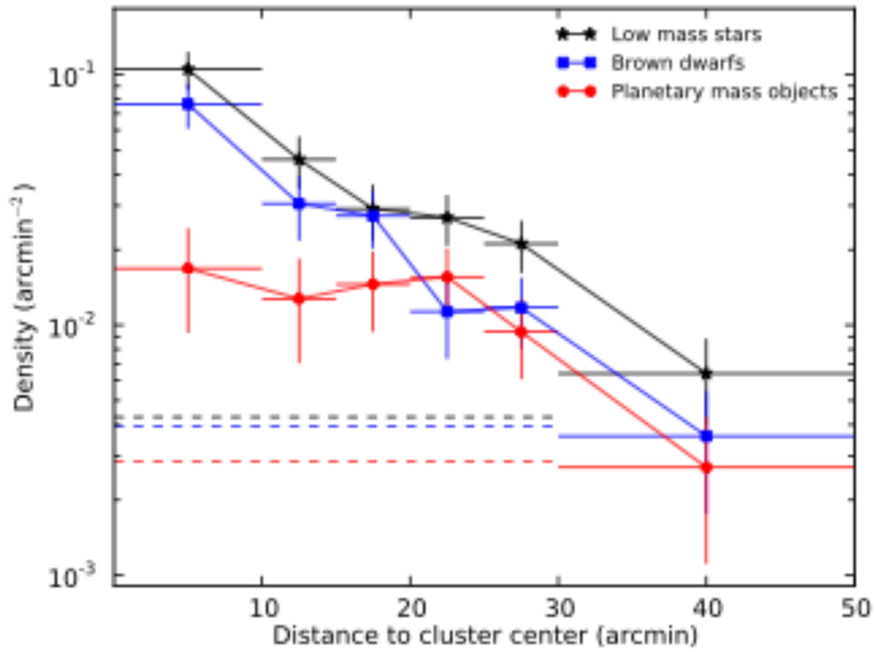
Rejection of highly reddened extragalactic objects.



Surface Density Radial Profiles

- Stars and BDs have similar surface density radial profiles
- Cluster planets may have a flatter profile
- Field dwarf contamination becomes significant beyond 30 arcmin distance from the cluster core
- Central cluster density 0.37 objects per sq. arcmin
- Effective radius 1.23 pc





$$(\Delta N/\Delta M \propto M^{-\alpha})$$

Mass Spectrum

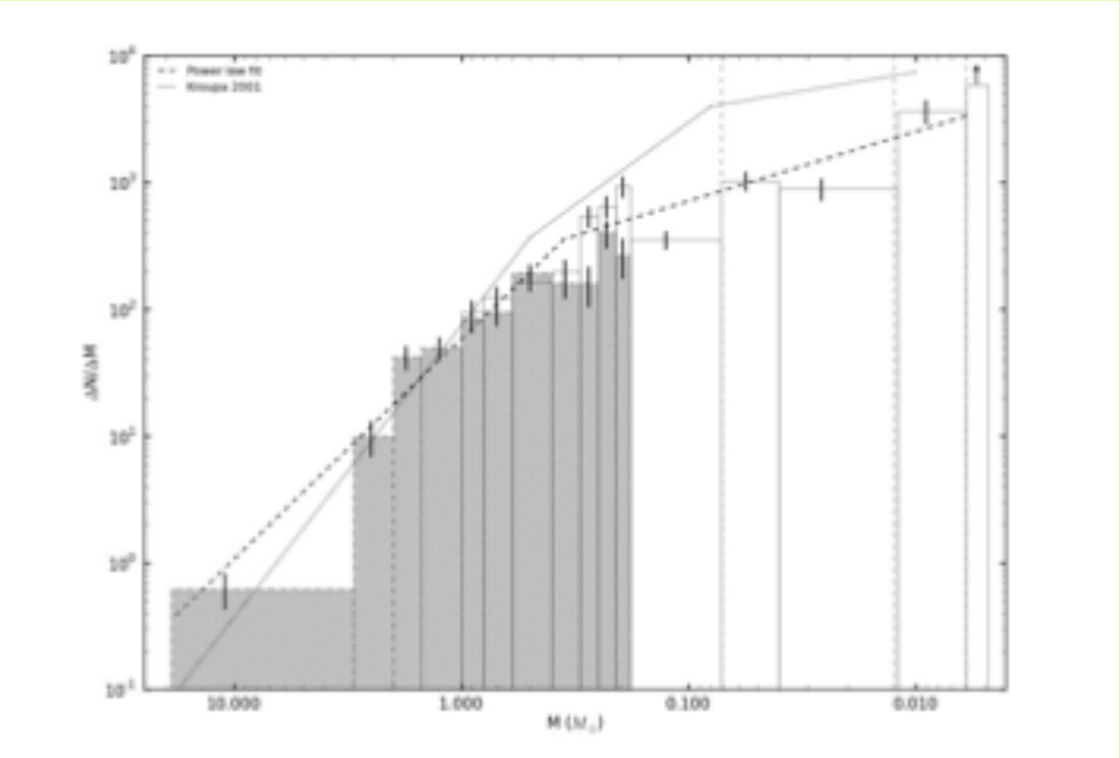
Siess et al. 2000 models (hatched area) & Baraffe et al. (2003) models.

Kroupa (2001) mass spectrum normalized at 0.9 Msun (solid line).

Power law fits shown as dotted lines.

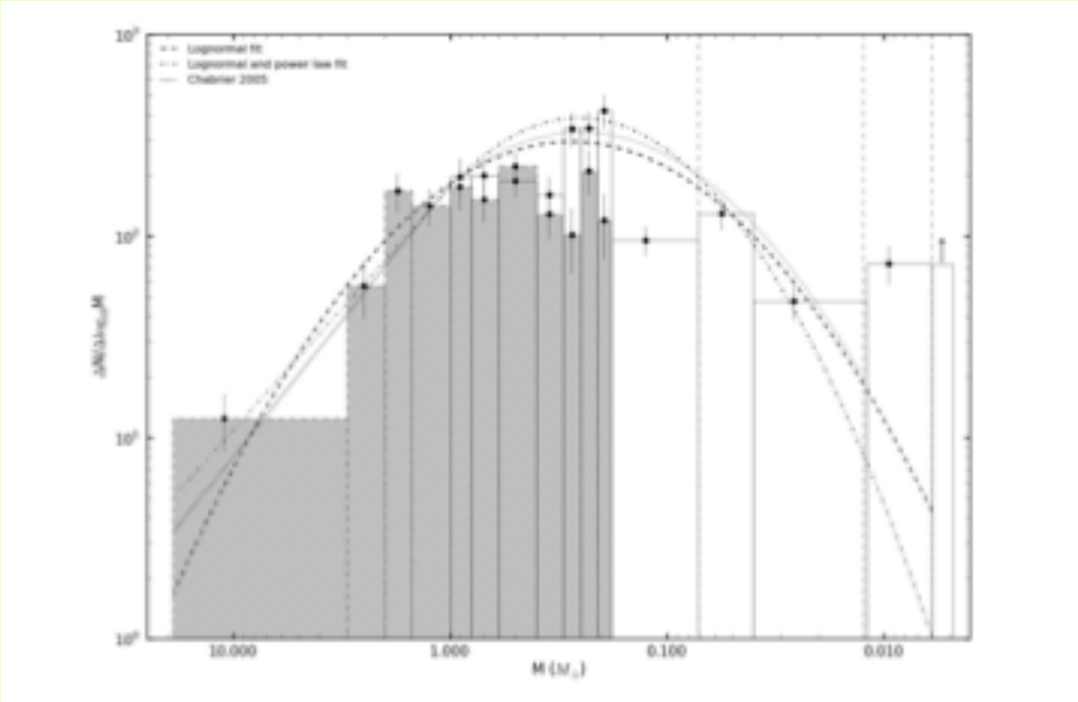
Best fit of Sigma Ori mass spectrum requires only 2 power laws, not 3

IMF similar to other associations and clusters (Lodieu et al. 2009)



Mass Function

$$\xi(\log M) \sim \exp\left(-\frac{(\log M - \log M_c)^2}{2\sigma^2}\right)$$



Best log-normal fit (dashed line)

Combined log-normal and power-law fit (dash-dotted line)

Chabrier (2005) mass function (dotted line)

Conclusions

- THE WTS IS DETECTING M BINARIES WITH PERIODS SHORTER THAN THE CUTOFF AND GIANT PLANETS AROUND G,K STARS
- VISTA IS DETECTING NUMEROUS UNBOUND PLANETS IN CLUSTERS, NO SIGNS OF EJECTION
- A wide-field infrared telescope in space needed for:
- Detect and characterize smaller planets around M dwarfs (complementary to Kepler)
- Image sub-Jupiter mass free floating planets in young clusters (complementary to microlensing)