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

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Centro de Astrobiología & University of Florida
Stellar/Substellar presentations

- Microlensing (20+)
- Stellar populations (2)
- Radial velocity & transits (2)
- Direct imaging (1)
WFCAM transit survey

<table>
<thead>
<tr>
<th>Name</th>
<th>(RA)</th>
<th>(DEC)</th>
<th>#stars</th>
<th>#epochs</th>
<th>#cand.</th>
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</thead>
<tbody>
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<td>03hrfield</td>
<td>03$^h$39$^m$</td>
<td>+39$^d$14$^m$</td>
<td>10827(36306)</td>
<td>392</td>
<td>74</td>
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<tr>
<td>07hrfield</td>
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<td>16623(56070)</td>
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<td>9621(39879)</td>
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<tr>
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<td>+36$^d$29$^m$</td>
<td>34452(130320)</td>
<td>1154</td>
<td>375</td>
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</table>

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 $J \leq 16$ ($J \leq 18$ 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.
First WTS planet

M. Cappetta et al. in prep.

$J$-band = 15.38 mag.
$i$-band = 16.22 mag.
Synthetic spectral fits of HET spectra by L. Fossatti and Y. Pavlenko
Second WTS planet
J. Birkby et al.
σ Orionis cluster (circa 1790)

- D=350 pc
- Age=2-5 Myr.
- Low reddening
- Solar metallicity
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 $\sigma$ 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:

- $42 \pm 7\%$ for low-mass stars,
- $36 \pm 8\%$ for brown dwarfs,
- $31 \pm 11\%$ 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
Mass Spectrum

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)
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)