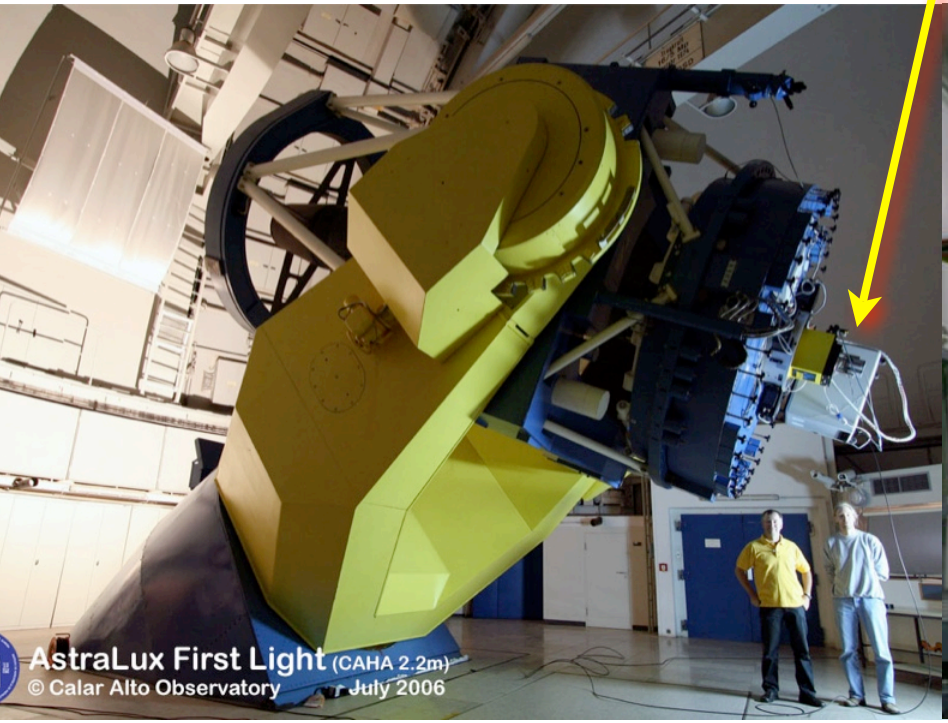
The AstraLux large M-dwarf survey: preparation for surveys for Exo-Earths around low-mass stars

AstraLux Norte & Sur: Electron Multiplication-CCD cameras for Lucky Imaging at CAHA 2.2m and ESO/NTT 3.5m telescopes



People involved at MPIA:
Carolina Bergfors, Markus Janson (now IAS Princeton), Felix Hormuth, Natalia Kudryavtseva, Taisiya Kopytova, Wolfgang Brandner, Thomas Henning, Stefan Hippler

First a historical note...

Astron. Astrophys. 298, 818–826 (1995)

ASTRONOMY
AND
ASTROPHYSICS

Low-mass star formation in CG1: a diffraction limited search for pre-main sequence stars next to NX Pup*

Wolfgang Brandner[1,2], Jerome Bouvier[3], Eva K. Grebel[4], Eric Tessier[5], Dolf de Winter[6], and Jean-Luc Beuzit[7]

[1] Astronomisches Institut der Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany
brandner@astro.uni-wuerzburg.de
[2] European Southern Observatory, Casilla 19001, Santiago 19, Chile,
[3] Laboratoire d'Astrophysique, Observatoire de Grenoble, Université J. Fourier, B.P. 53, F-38041 Grenoble Cedex 9, France
bouvier@gag.observ-gr.fr
[4] Sternwarte der Universität Bonn, Auf dem Hügel 71, D-53121 Bonn, Germany
grebel@astro.uni-bonn.de
[5] Royal Greenwich Observatory, Madingley Road, Cambridge CB3 0EZ, England
tessier@mail.ast.cam.ac.uk
[6] Astronomisch Instituut "Anton Pannekoek", University of Amsterdam, Kruislaan 403, NL-1098 SJ Amsterdam, The Netherlands
DOLF@astro.uva.nl
[7] Observatoire de Paris, DESPA (URA 264/CNRS), 5 place Jules Janssen, F-92195 Meudon, France
jlbeuzit@hplyot.obspm.circe.fr

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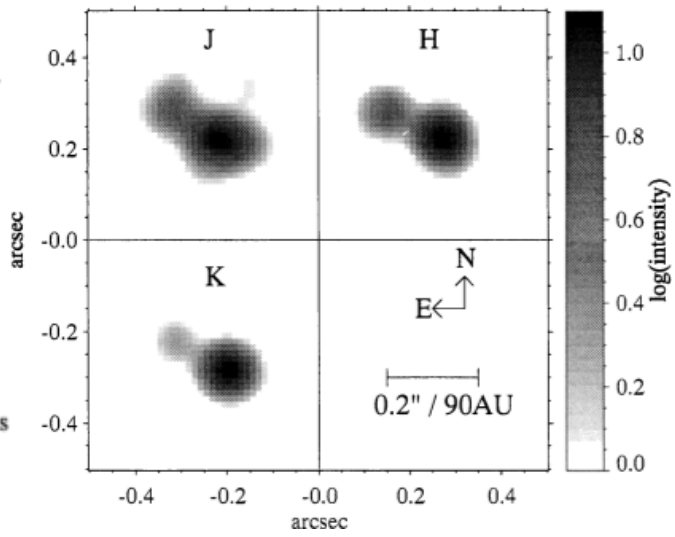
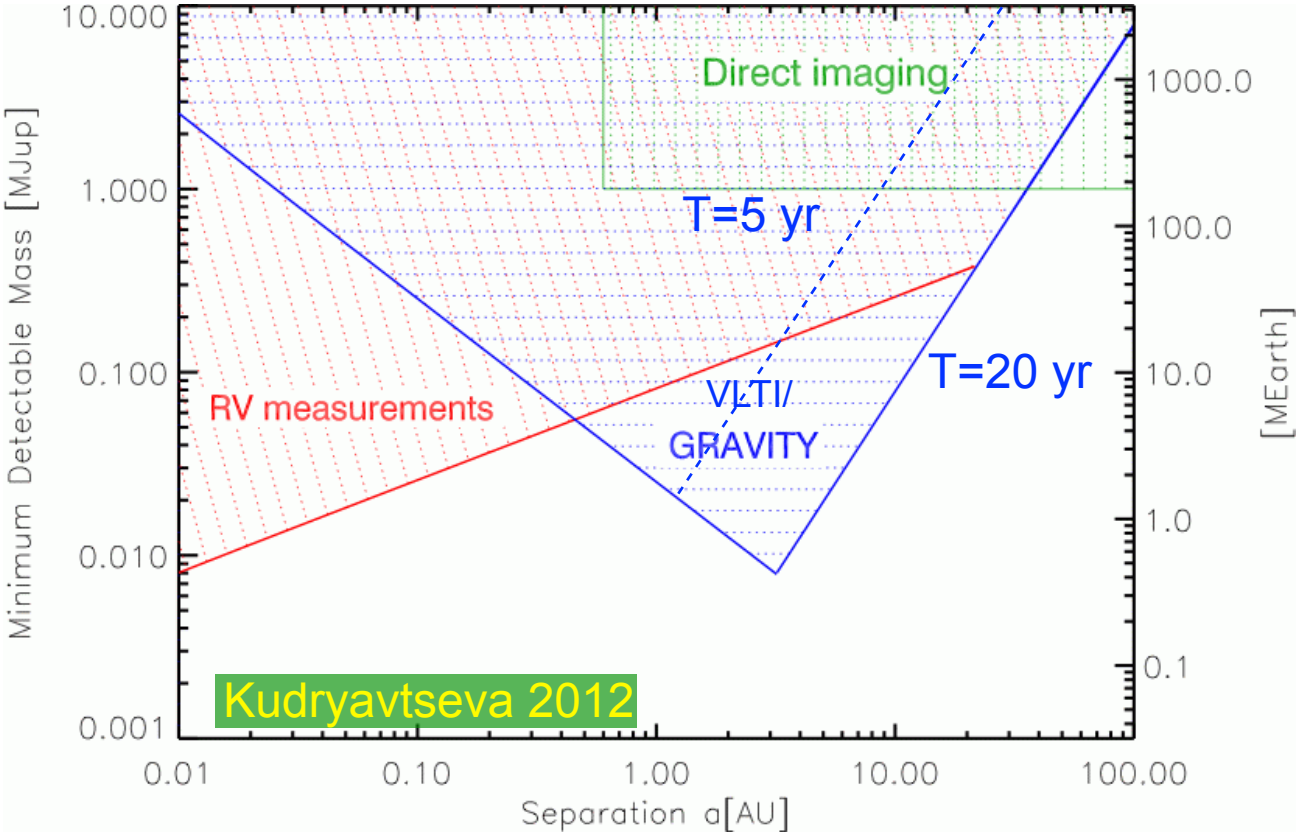


=> ComeOn+ Adaptive Optics observations of the 128mas Herbig AeBe binary NX Pup (Gum Nebula)

Motivation for Lucky Imaging characterization of M-dwarfs

Exoplanet surveys with indirect detection methods: lower mass exoplanets can more "easily" be identified around low-mass stars

Mass-ratio: stellar orbit around common center of mass (RV, e.g., SPIRou, CARMENES, ... -> talks by Xavier Bonfils, Andreas Quirrenbach, Astrometry, e.g., PRIMA, GRAVITY, NEAT,... -> talks by Neil Zimmerman, Fabien Malbet)



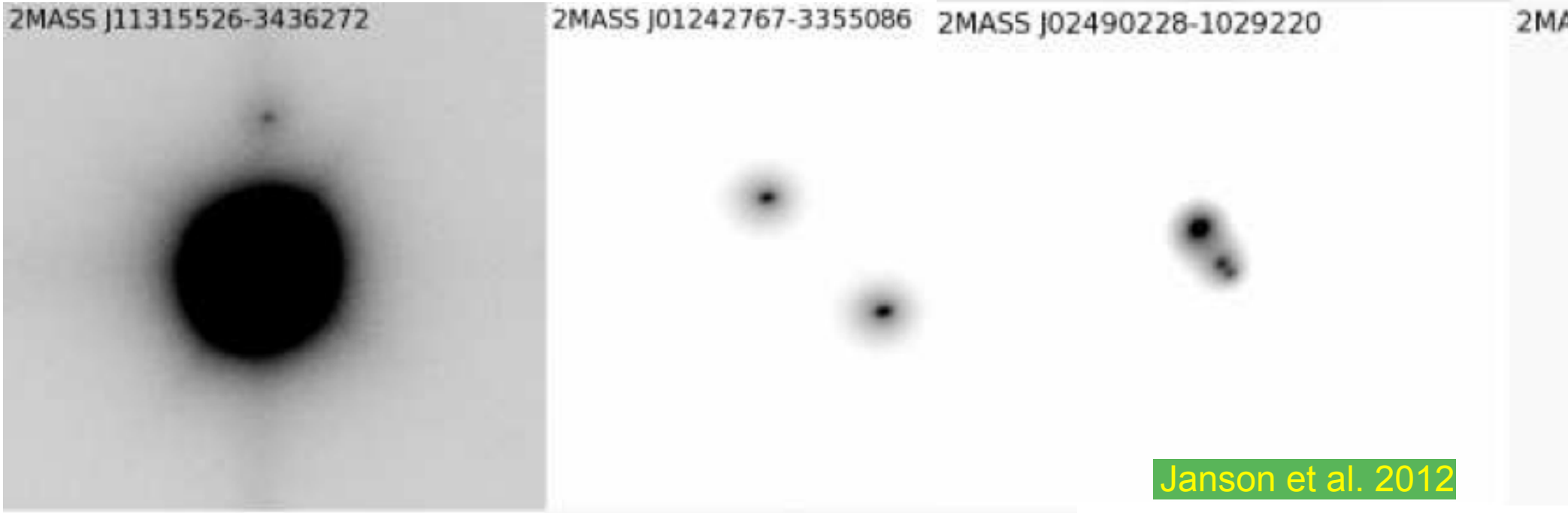
Blue area: parameter space for exoplanet detection with VLTI/GRAVITY for an M7.5V primary at 6 pc (right boarder for 20 year monitoring)

Solar neighbourhood: ~65 stars M5V or later within 7 pc

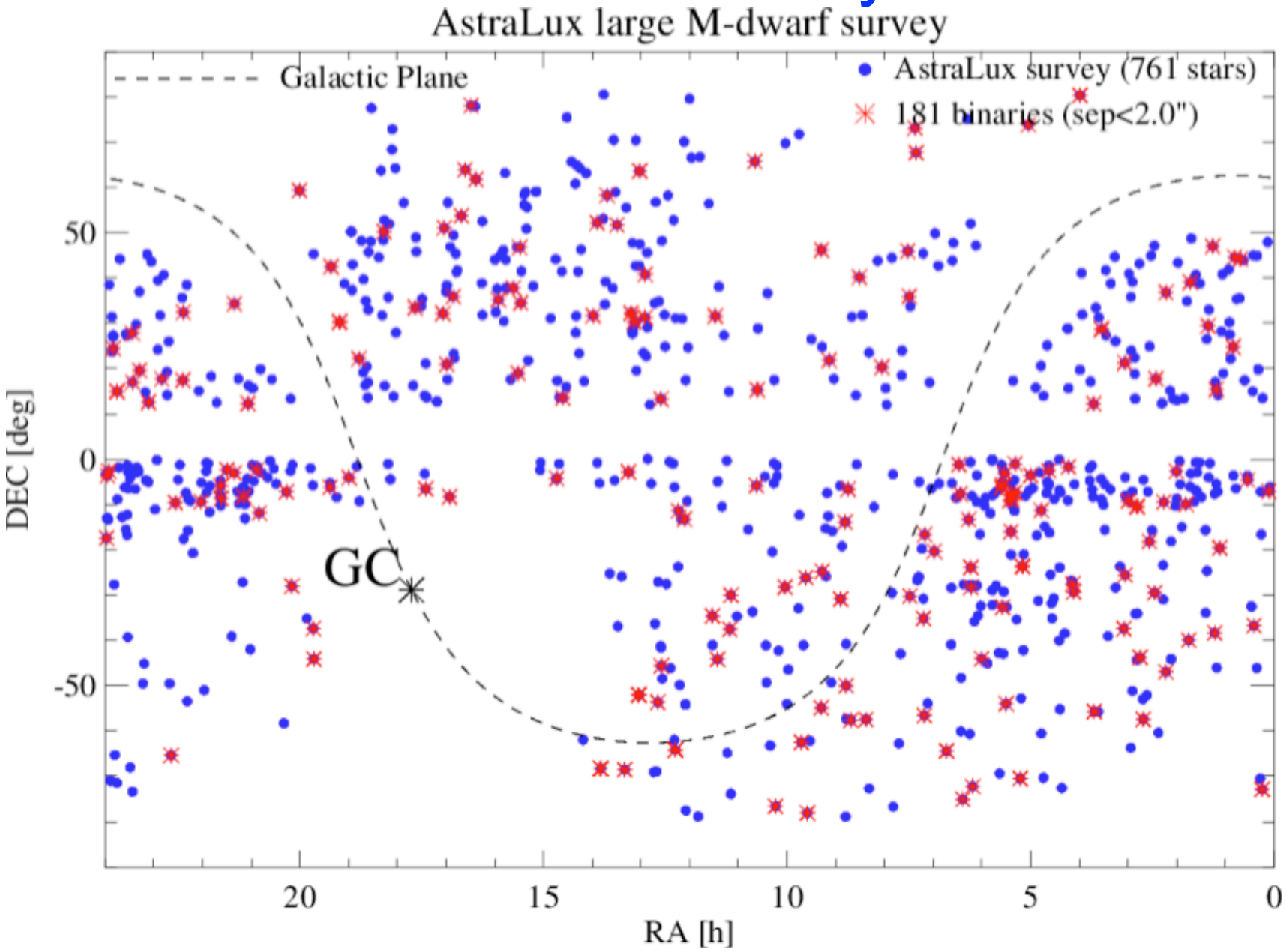
Phase 1 of M-dwarf survey

701 M-dwarfs (M0 to M5) and 60 late-K-dwarfs have been surveyed with AstraLux Norte and Sur at 0.1 arcsec resolution for stellar companions (15 observing nights each at CAHA 2.2m and ESO NTT)

=> largest M-dwarf binary survey to date (see Bergfors et al. 2010, A&A, 518, 567; Janson et al. 2012, ApJ 754,44)

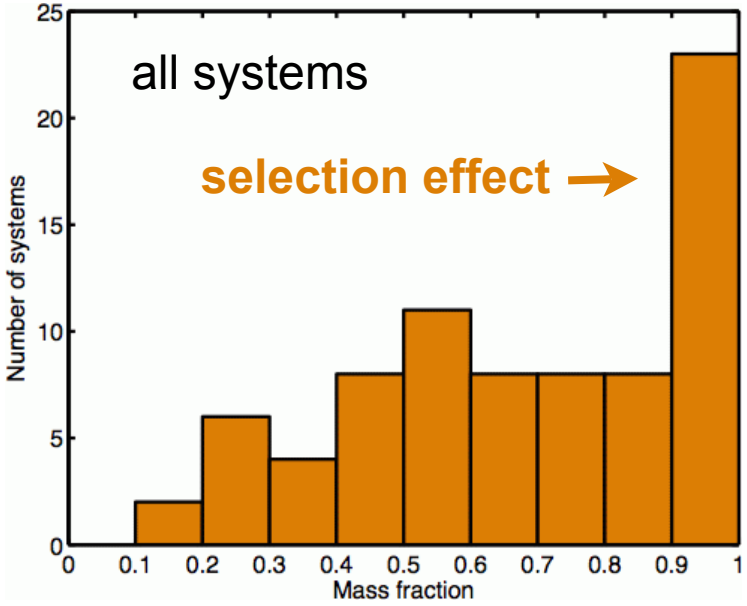


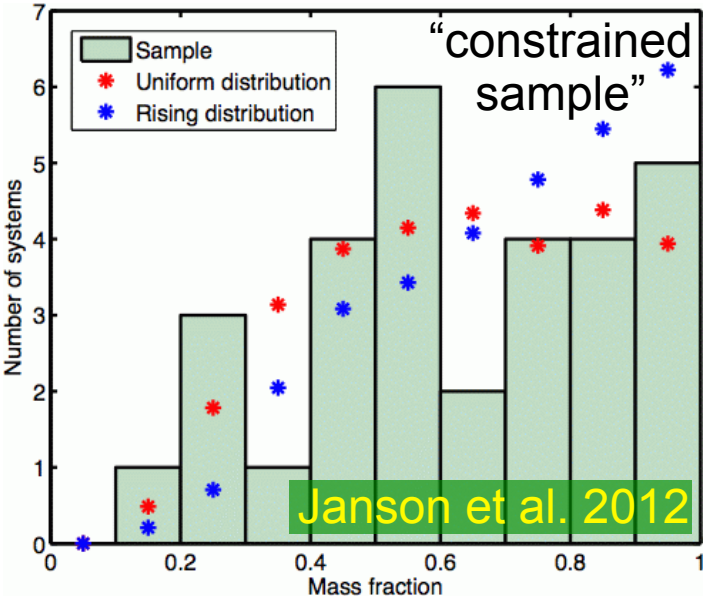
Phase 1 of M-dwarf survey



Scientific results of large M-dwarf survey

- Multiplicity fraction of M-dwarfs: 27±3% (intermediate between G-dwarfs and brown dwarfs)
- After correction for selection effects uniform distribution of mass-ratios is best fit <=> unlike brown dwarfs (preference of q≲1)

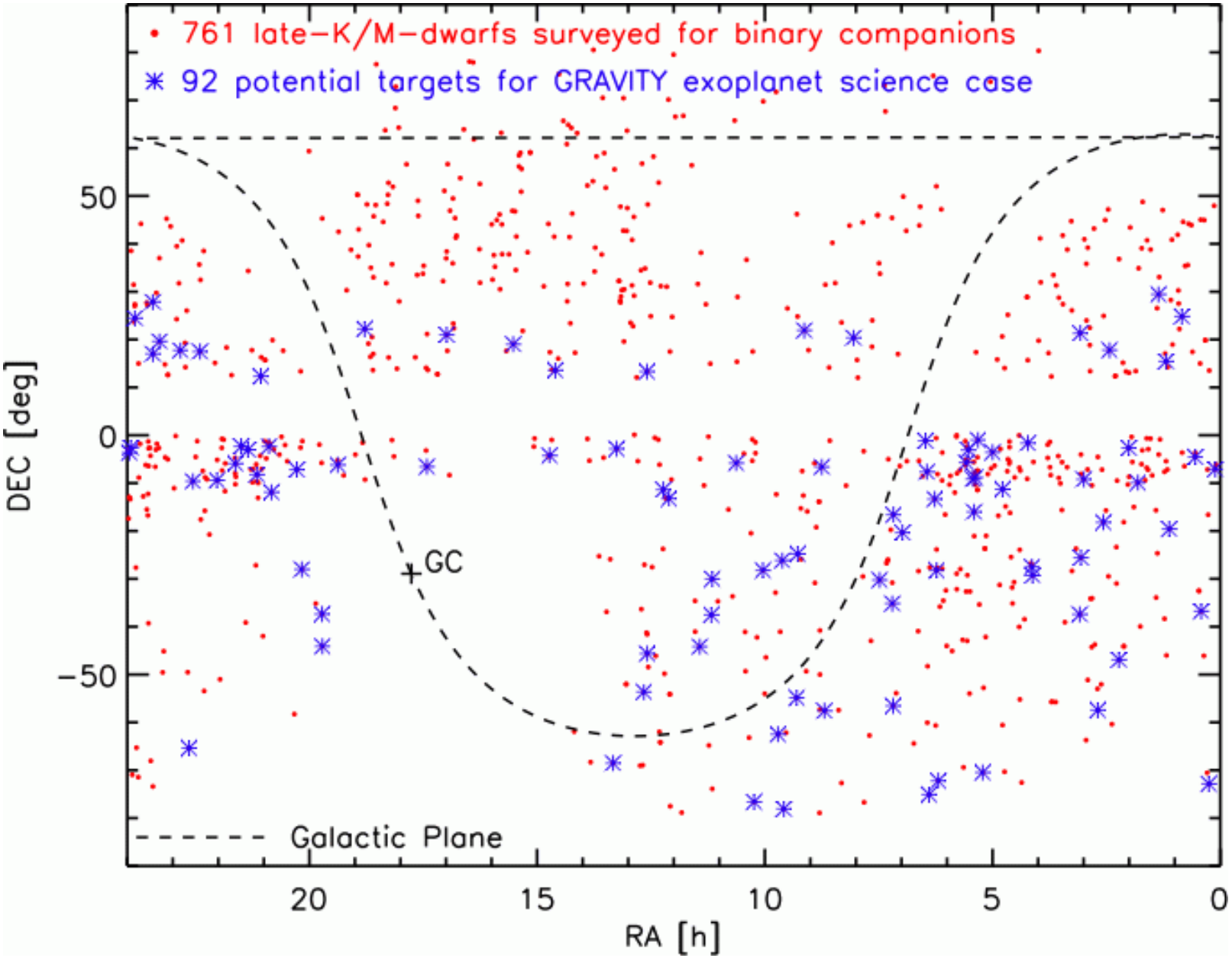




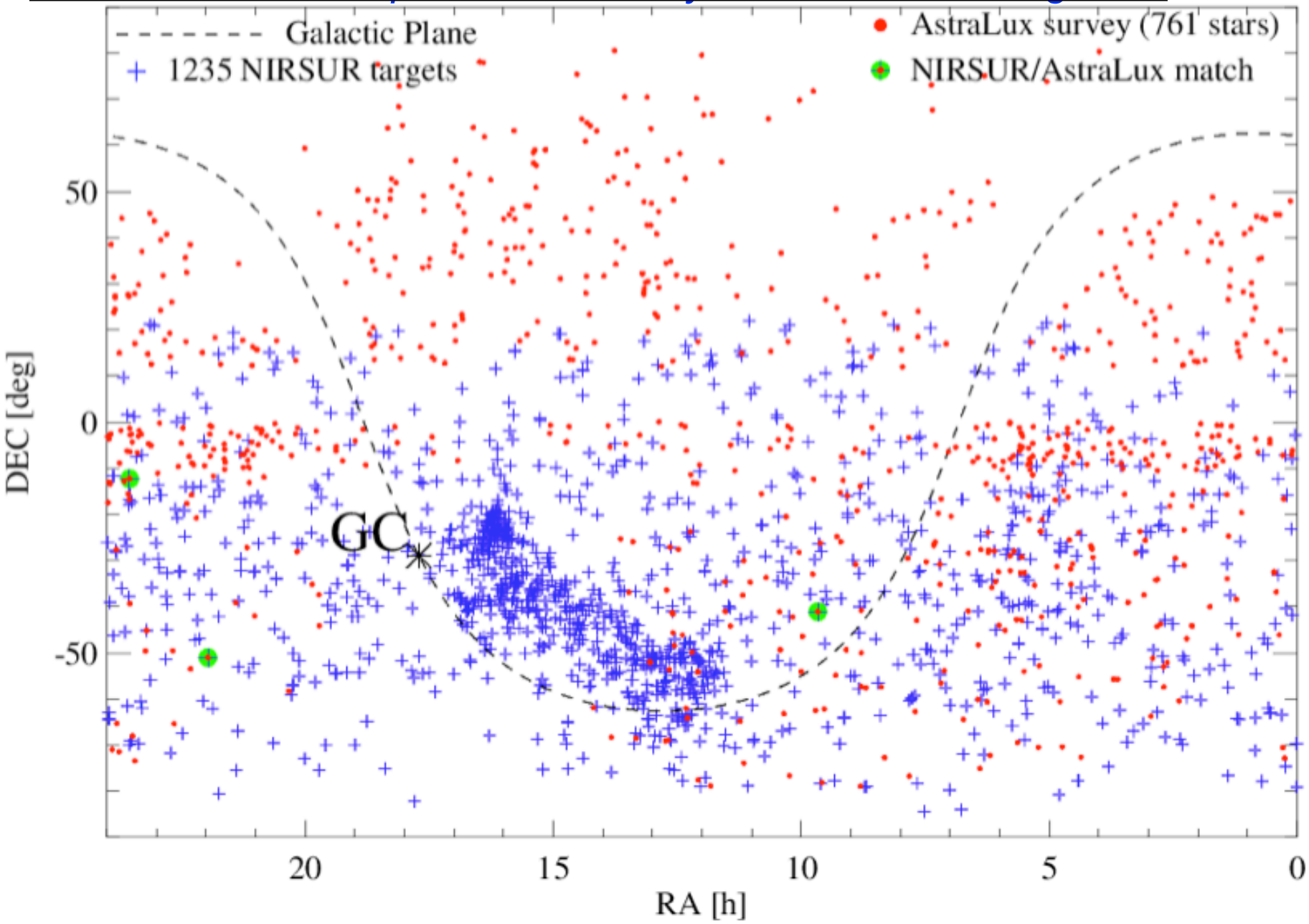
=> no clear evidence for different formation modes between "stars" and "brown dwarfs" as proposed by Thies&Kroupa (2007)

<=> need to extend survey to M5V to M7V primaries for final answer

VLTI/GRAVITY: 92 binary targets suitable for astrometric search for planets *(Kudryavtseva, PhD thesis)*



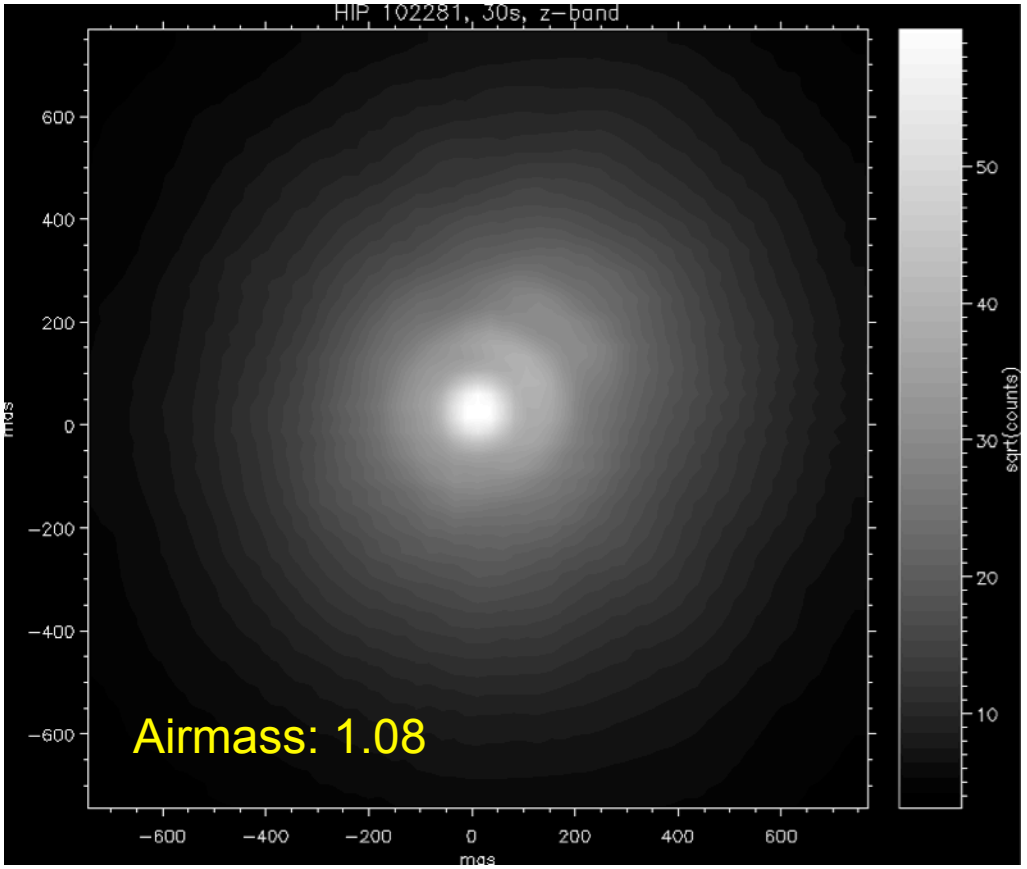
VLT/SPHERE: comparison with May 2012 NIRSUR target list

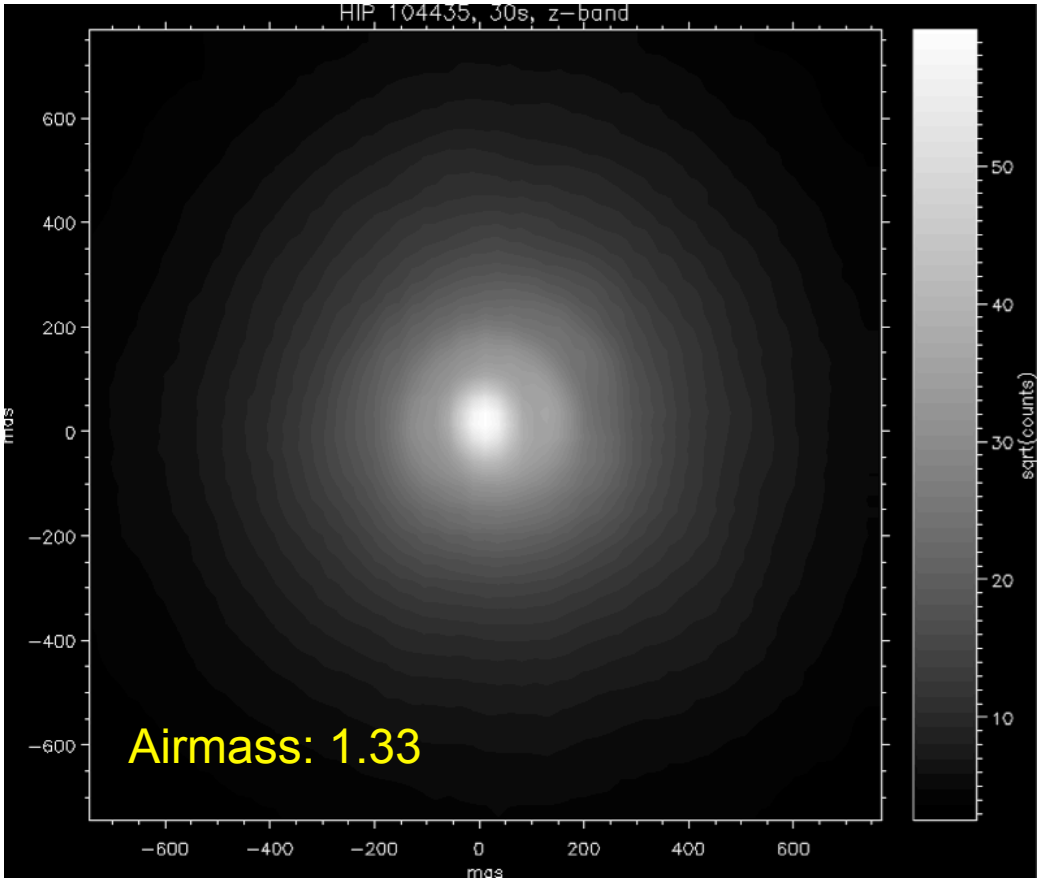


=> 3 M-stars in common with NIRSUR catalog, all 3 are single

Characterisation of ~350 SPHERE/NIRSUR targets with AstraLux

1st results from Aug/Sep 2012 (AstraLux Norte), part of PhD studies by Taisiya Kopytova





z-band: 10 000 frames with 30ms each: 10% image selection:
=> inner two Airy rings (partially) recovered
=> diffraction limited core on extended seeing halo

Outlook: Ongoing AstraLux projects

Phase 2 of M-dwarf survey

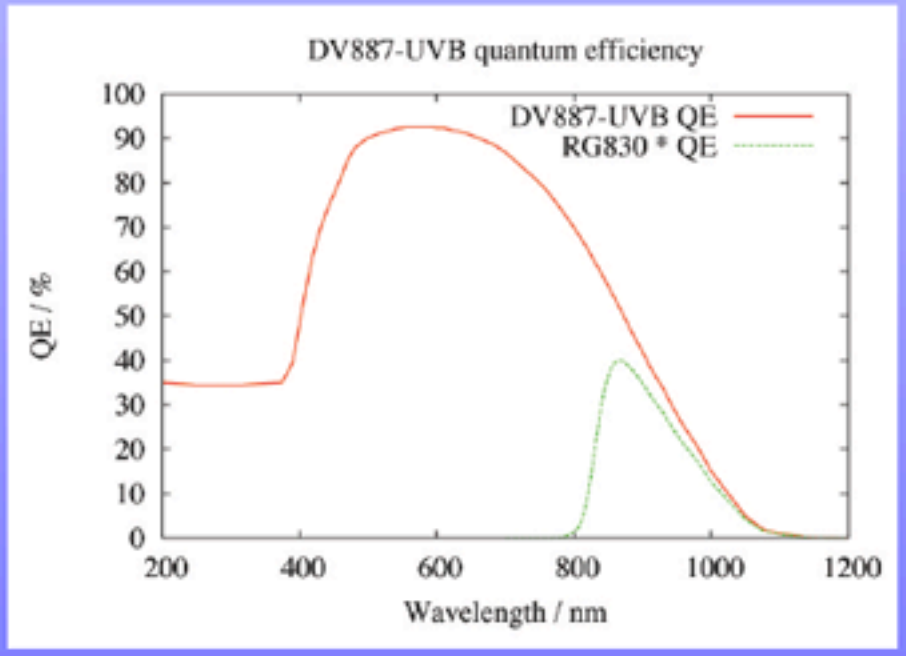
- Survey of ~200 M5 to M7 stars within ~20 pc for stellar companions at separations ≳100 mas started in 2012,
- ~50% complete (Bergfors et al., in prep)

Characterization of SPHERE NIRSUR targets

- Survey of ~350 potential SPHERE targets still lacking high-angular resolution imaging, started in 2012
- ~15% complete, i.e. 50 targets observed

Cooperation with CARMENES on M-dwarfs

- informal collaboration with Jose Caballero, Miriam Cortés-Contreras (CAB Madrid)



Commercial camera DV887-UVB from Andor Technologies:

- Back illuminated, QE>90% at 600nm and 40% at 900nm
- 512x512 pixels, 16μm pixel size
- Peltier cooling down to -75°C, no LN_2 necessary
- Up to 34Hz frame rate with full FOV, or several 100Hz using subarrays
- Shortest exposure time is 20μs
- EM- and conventional amplifier
- Adjustable EM-Gain, readout clock and voltages