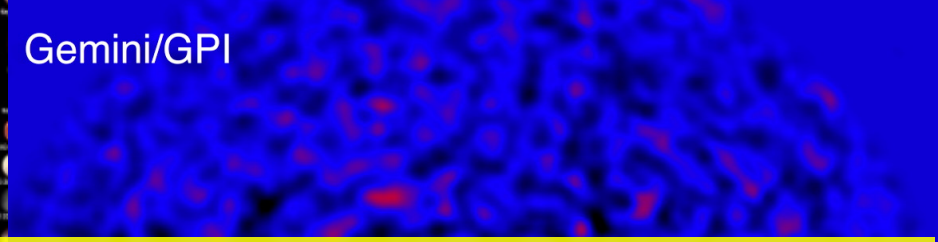
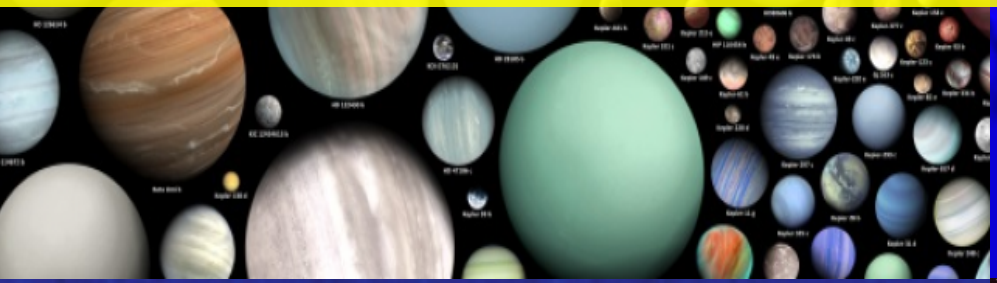
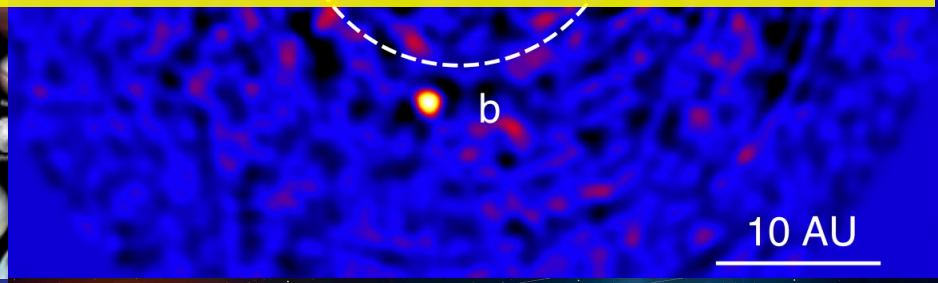
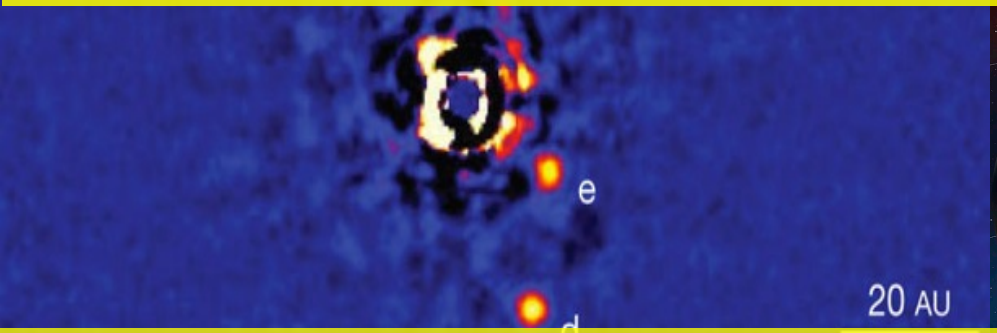


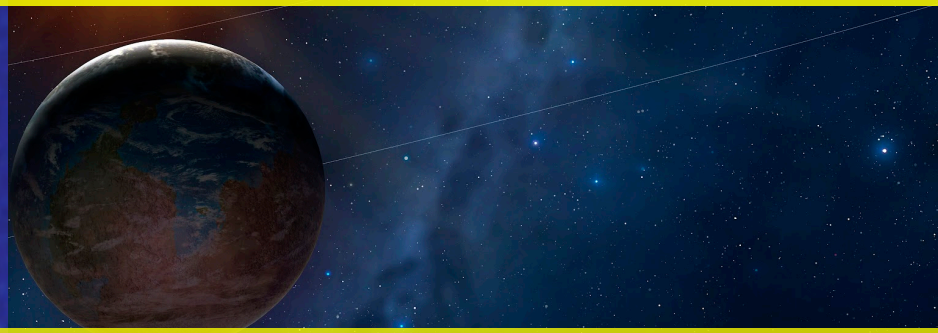
Science cases for SHAR(K)-NIR@LBT





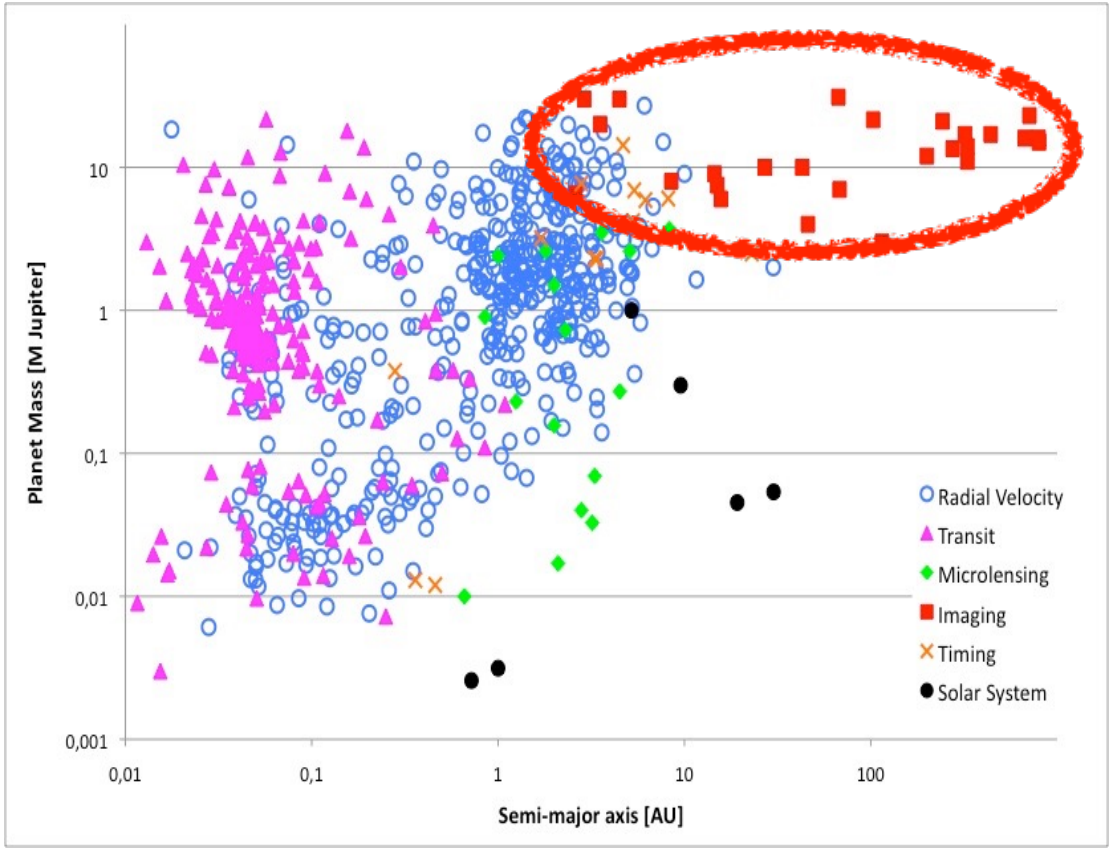
Valentina D'Orazi
(INAF Padova) + the science team





Meeting Macroarea 2, Bologna, 16 Giugno 2016

Direct Imaging Observations of Exoplanets



Direct technique: Planet's photons
(Targets: young & nearby stars)

Orbital & Physical properties:

> L, a , e, i, ω
> Giant planets at wide orbits (>10 AU)
> Multiple: Architecture & Stability
> Planet – disk connection

(Chauvin et al. 05, 10; Lafrenière et al. 07
Soummer et al. 11; Vigan et al. 12)

High-contrast spectroscopy

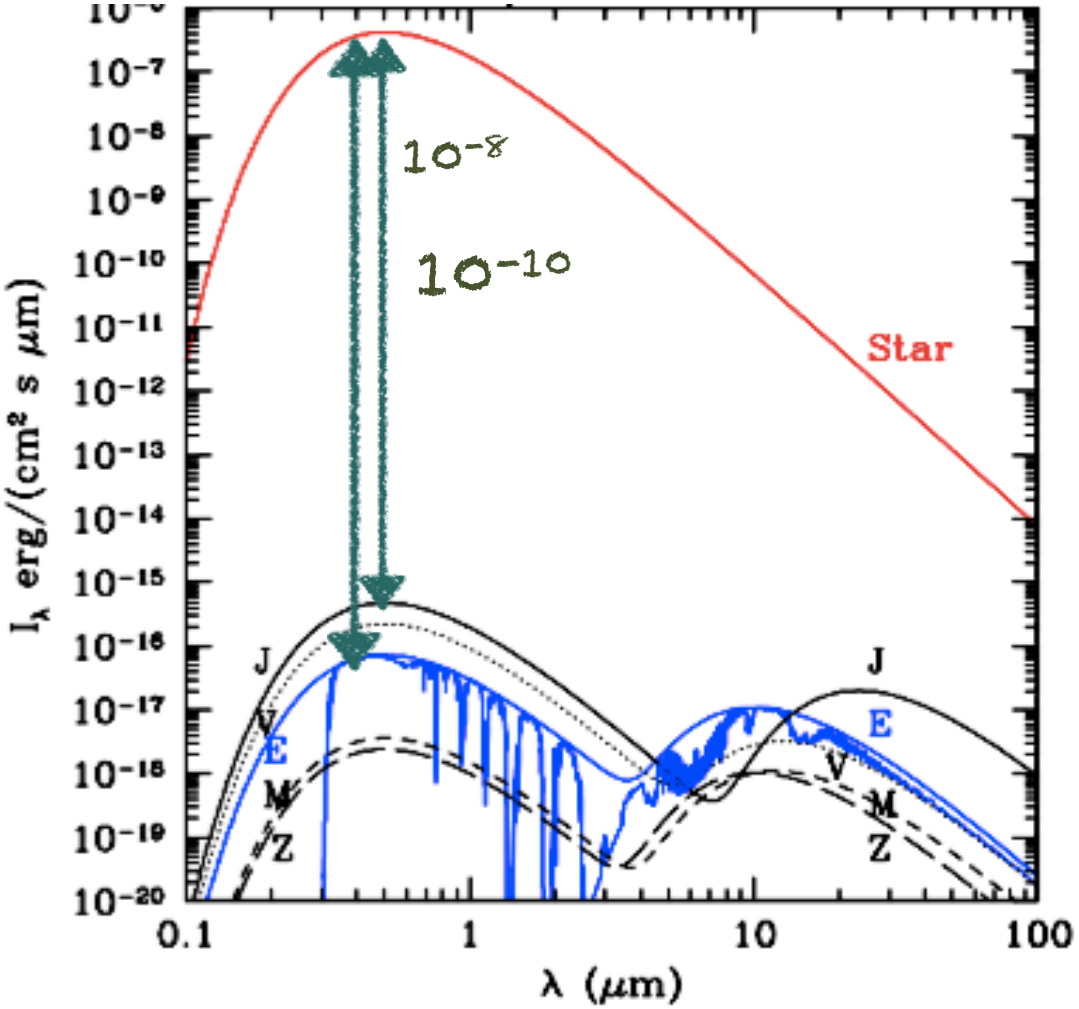
> Low-gravity, composition, non-LTE chemistry, cloud coverage...

(Janson et al. 10; Bonnefoy et al. 09, 12)

Constrast + Angular Resolution

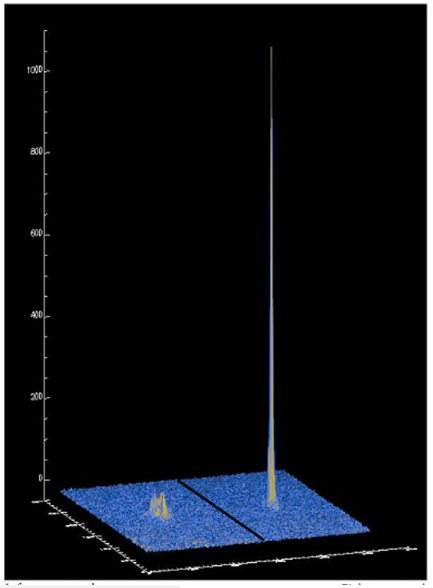
Contrast:
Jupiter/Sun ~ 10^{-8} = 20 mag
Earth/Sun ~ 10^{-10} = 25 mag

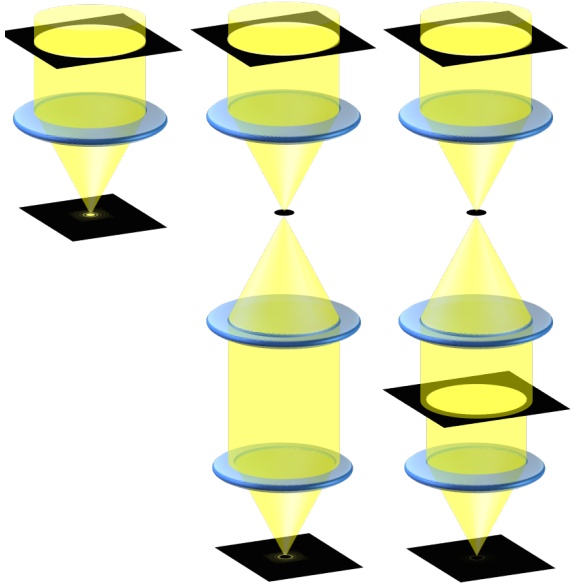
Angular Separation:
Jupiter = 0.5 arcsec @ 10 pc
Jupiter = 0.1 arcsec @ 50 pc



HIGH-CONTRAST IMAGING

PROBLEMS and TECHNIQUES





Atmosphere + speckles

➔ Extreme Adaptive Optics

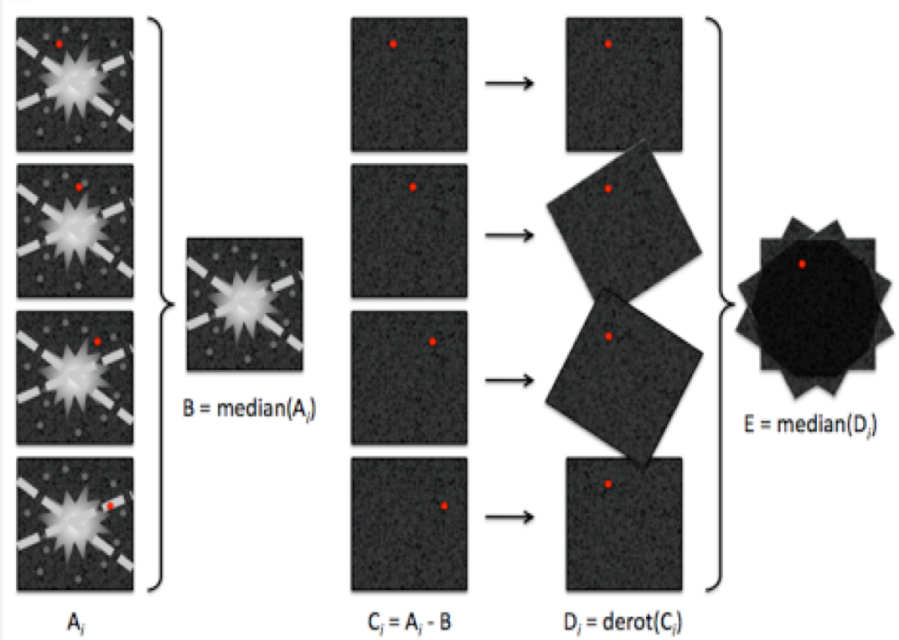
➔ Differential Imaging

Diffraction

➔ Coronography

(Lyot, Apodizing Masks,

Nulling, 4-quadrant..)



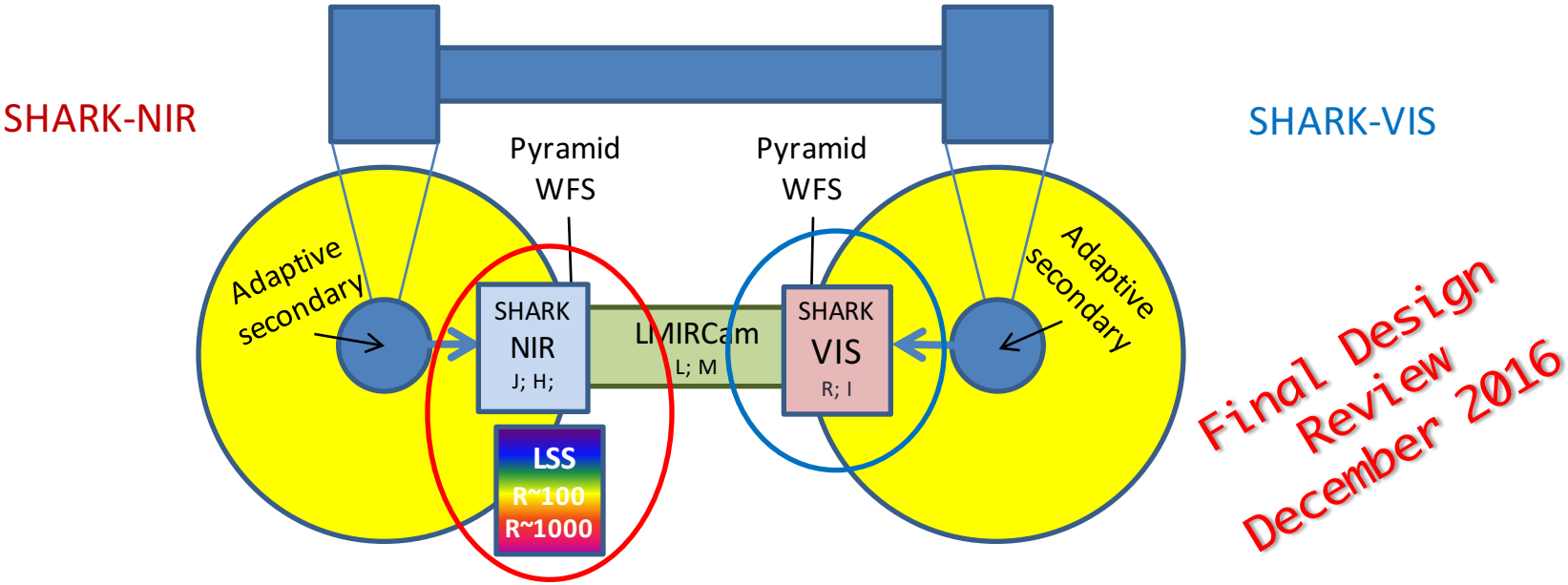
SHARKs@LBT

a high contrast imager with coronagraphic and spectroscopic capabilities for the large binocular telescope

The SHARK Instrument Team: J.Farinato, F.Pedichini, E.Pinna, C.Baffa, A.Baruffolo, M.Bergomi, L.Carbonaro, E.Carolo, A.Carlotti, M.Centrone, L.Close, J.Codona, M.De Pascale, M.Dima, S.Esposito, D.Fantinel, G.Farisato, W.Gaessler, D.Greggio, J.C.Guerra, O.Guyon, P.Hinz, F.Lisi, D.Magrin, L.Marafatto, A.Puglisi, R.Ragazzoni, B.Salasnich, M.Stangalini, D.Vassallo, C.Verinaud, V.Viotto

The SHARK science Team: VD, S.Antoniucci, V. Testa, F.Bacciotti,S.Benatti, M.Bonavita, A.Bongiorno, M. Bonnefoy, L. Borsato, E. Brocato, E. Cappellaro, G. Chauvin, R. Claudi, I. Crossfield, P. Delorme,S. Desidera, F. Fiore, A. Fontana, E. Giallongo, T. Giannini, V. Granata, R. Gratton, T. Henning, M. Kasper, F. Leone, AL Maire, L. Malavolta, J. Males, F. Massi, D. Mesa, G. Micela, V. Nascimbeni, B. Nisini, I. Pagano, G. Piotto, L. Podio, M. Rieke, E. Sani, G. Scandariato, E. Sissa, A. Sozzetti, M. Turatto, S. Zibetti, A. Zurlo.

What is SHARK?



SHARK basic features are:

- ✓ NIR Coro-Camera (J,H)
- ✓ NIR Low Resolution Spectroscopy (2 spectral resolutions, R~100 and R~1000)
- ✓ VIS Coro-Camera (R,I)

Direct Imaging of Exoplanets: detection and characterisation

Discs around young stars and their jets (F. Bacciotti)

Extragalactic science: AGN and QSO (A. Bongiorno)

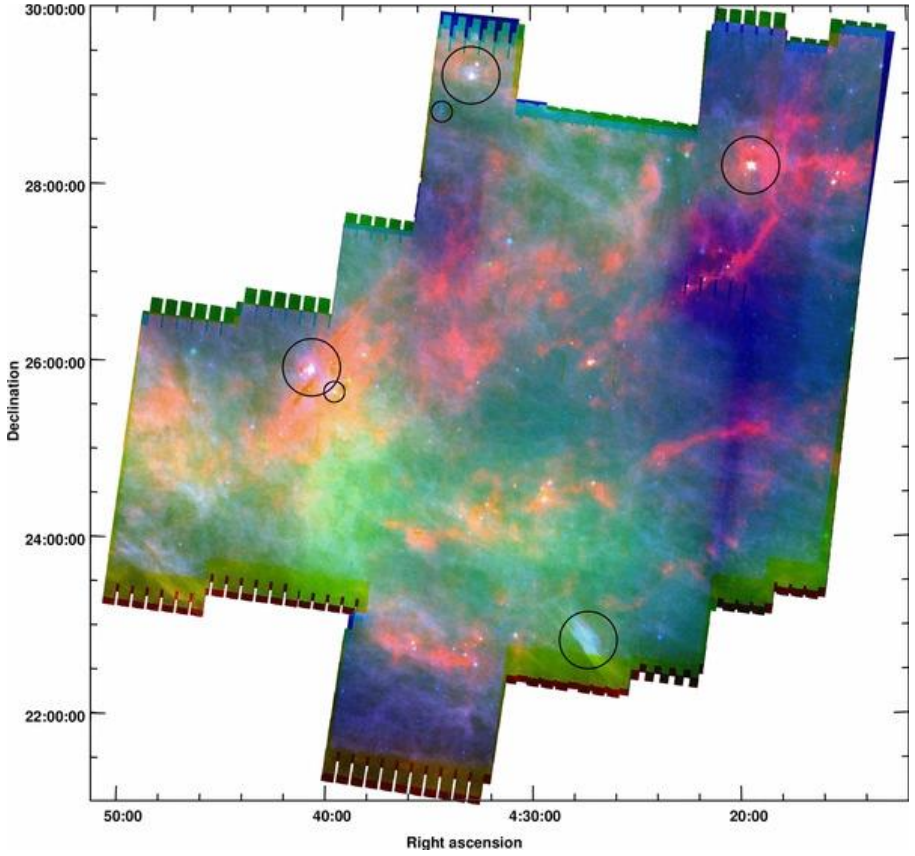
Planets in wide orbits of low-mass stars

A special niche for SHARK is offered by the LBT AO at faint mag, especially with AO upgrade: wide planets orbiting low-mass stars (e.g., K/M dwarfs in young associations and SFRs like Taurus)

Giant planets in Star Forming Regions

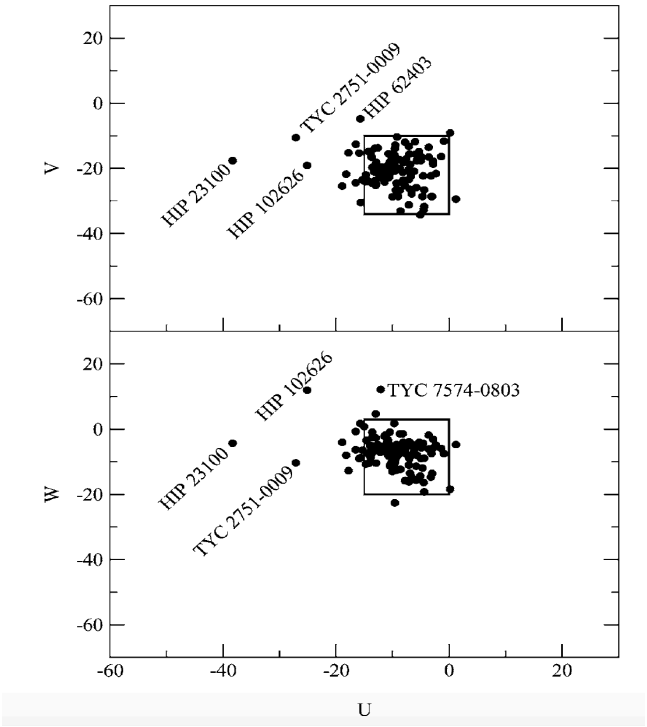
Taurus-Auriga: ages of about 1-2 Myr, at a distance of about 140 pc. About 350 members were identified, 130 of which brighter than R=15.

The search for planets in star-forming regions represents a program capable of fully exploits the potential of SHARK@LBT.
The NIR channel will be used to reveal planet thermal emission.

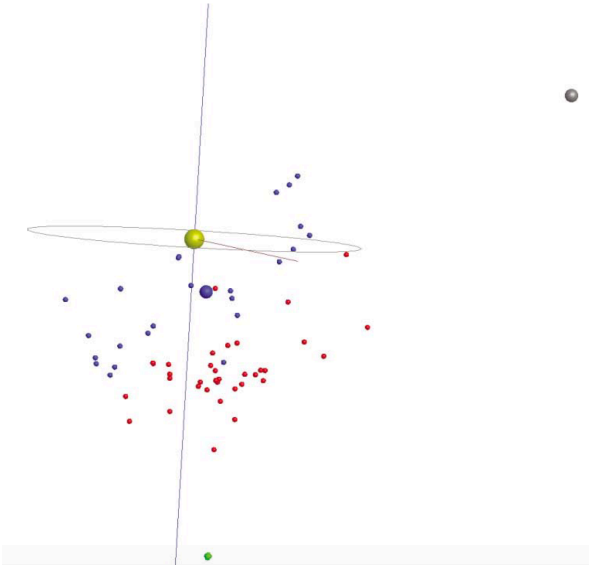


Planets around K/M type stars in young (loose) associations

Several members of young moving groups (age~10-100 Myr) were recently identified, with special effort for low-mass stars.
→ stream of stars with common age and motion through the Milky Way and with no overdensity of stars discernable in any region (e.g., the Ursa Maior, AB Dor, Beta Pic)



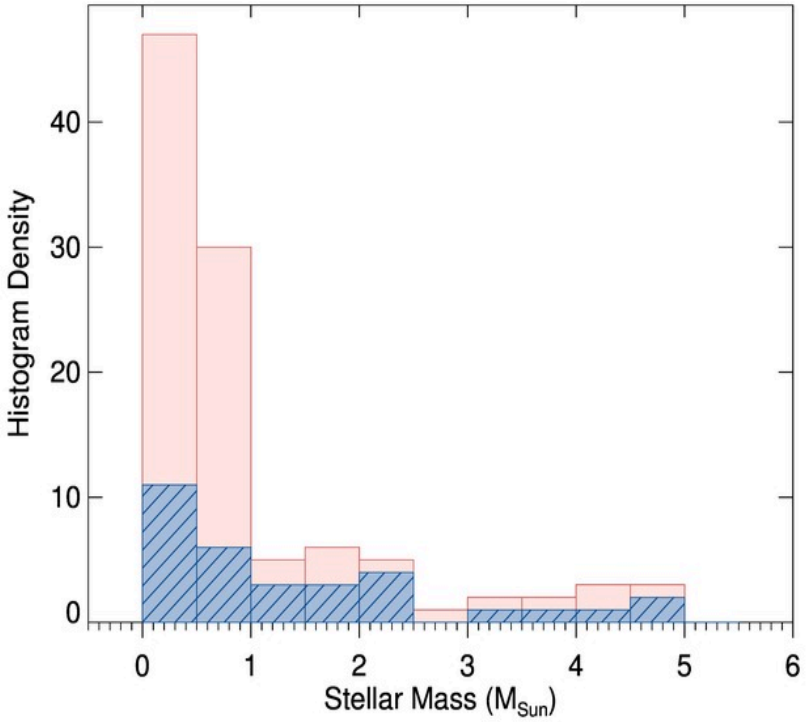
Zuckerman & Song (2004)



Observational investigations of planetary system and theoretical studies indicate that giant planets form in < 10 Myrs and Earth-like terrestrial planets in ~30 Myrs.
→ Thus, local, post T Tauri stars promise to reveal the story of the formation and early evolution of planetary systems.

There are several tens of potential targets, depending on exact magnitude limit of the instrument, accessible for a deep search for planets in wide orbits

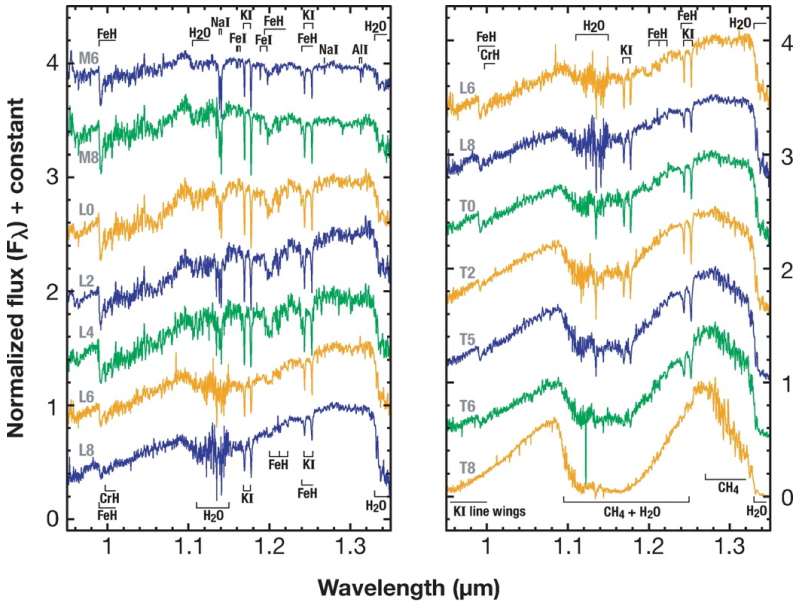
With the current limit at R<10.5 our sample comprises 33 targets, whereas adopting R=12.5 we would gain more than a factor of three in sample size (that is 108 objects)

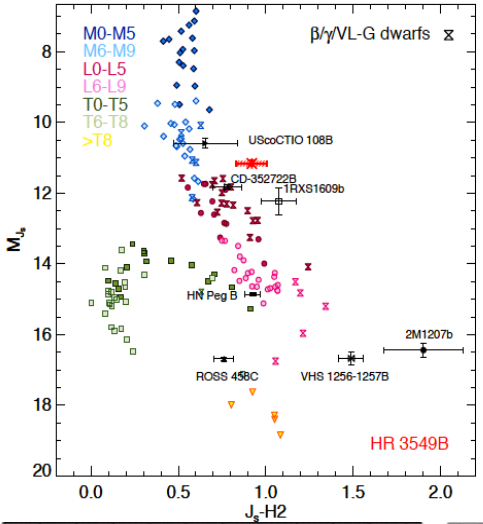


SPHERE and GPI will be mostly limited to solar-type and early-type stars (in the Southern hemisphere)

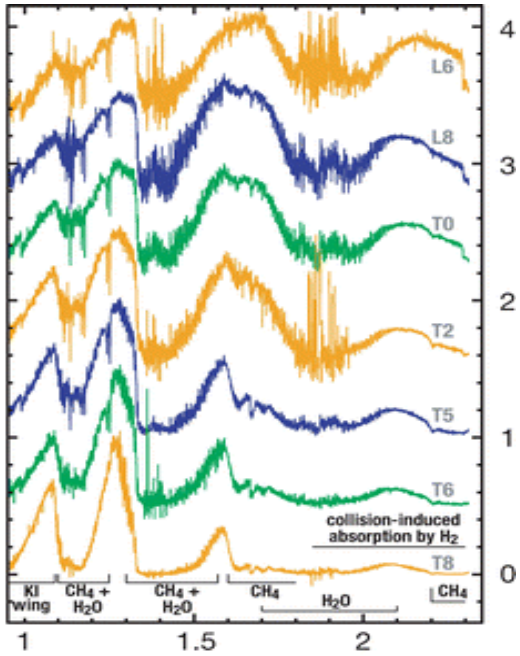
Photometric and spectroscopic characterisation of known planets/BDs

The L-T transition

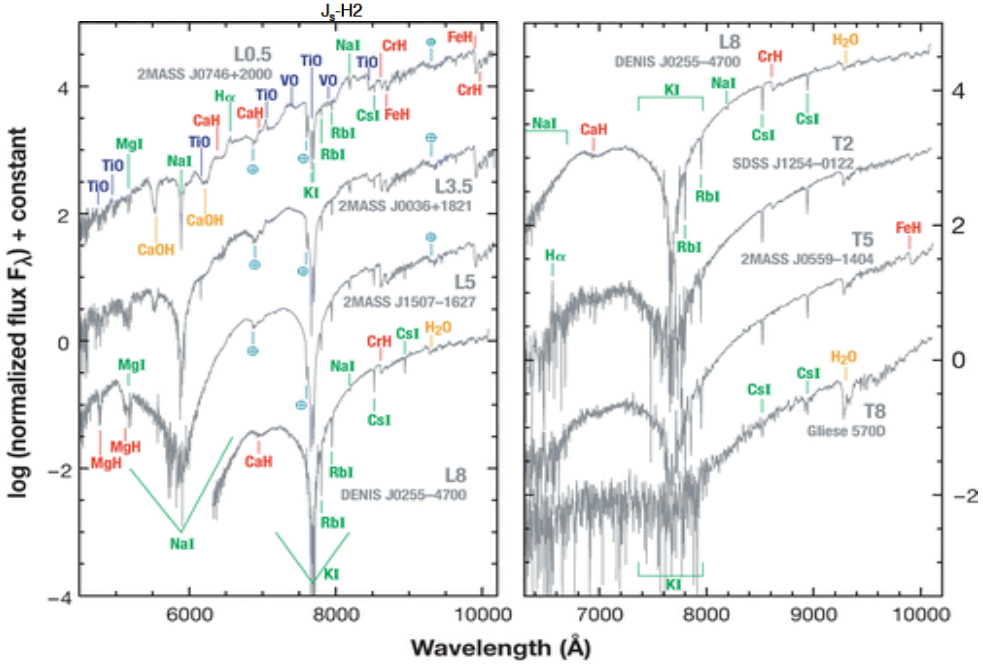




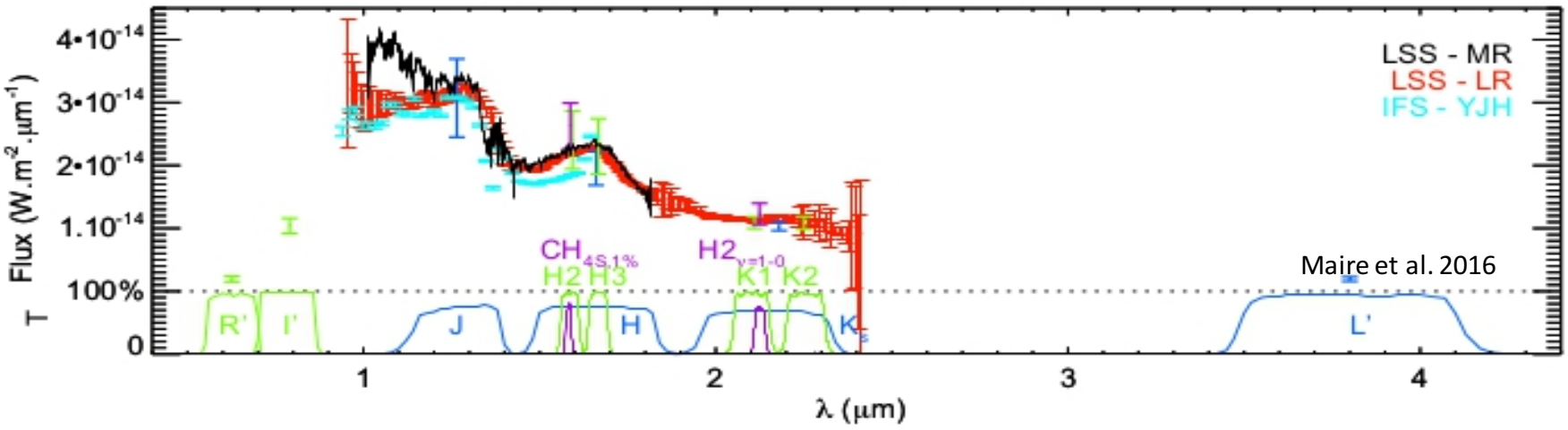
Mesa+ 2016, submitted



CH_4: the hallmarks of T-type



The implementation of a long slit spectroscopic mode will furnish spectral classification (L vs T) if R=30 and molecular band identification if R > 100.

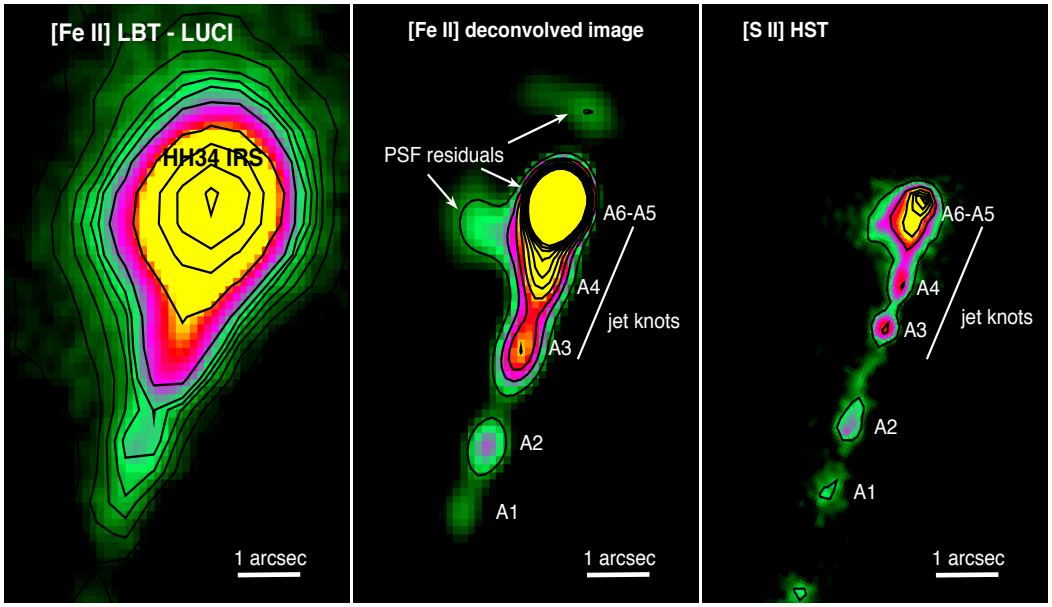


We plan to have two LSS modes: a low-resolution (R~100) and a high-resolution (R~1000), depending on target magnitudes and properties, as needed.

Discs around Young Stars and their Jets

- High-contrast imaging of circumstellar discs with NIR coronagraphy.
- Coronagraphic or classical imaging of stellar jets
- 2D kinematical maps of Jets

Narrow-band images of jets reveal the generation mechanism and its feedback on the star/disc



Antoniucci+ (2014)

Goals:

understand dynamic role of jets in shaping the disc structure

Probe the innermost regions of discs and jets in T Tauri stars (Binocular observations VIS+NIR)

H_2 as key tracer: SYNERGY with LMIRCAM

Requirements: Classical Imaging + CORO IWA<3λ/D (~100 mas);
Contrasts 10^{-4} for discs and 10^{-3} for jets

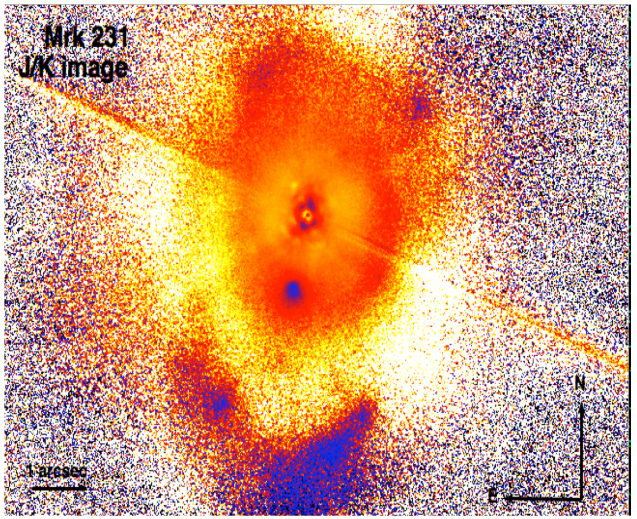
AGNs and QSOs

(1) Discover and fully characterise the AGN close pairs;
(2) Constrain the Black Hole feeding mechanism (e.g., SN driven winds *vs* gravitational asymmetries) in local Seyfert galaxies
(3) Trace, in bright quasars, molecular outflows powerful enough to clean the inner kpc and quench the star formation

- Dust lane maps on scales down to hundreds pc to investigate whether outflows are dusty or rather the AGN driven feedback has already swept the ISM;

- Color maps of SF regions in the galaxy nucleus and disk to constrain the SF rate, the age, and the metallicity.

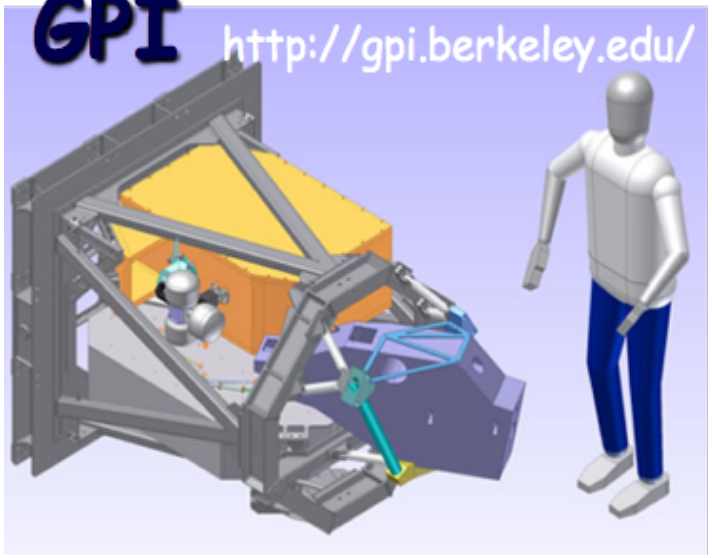
Mrk231 PISCES AO J/K image



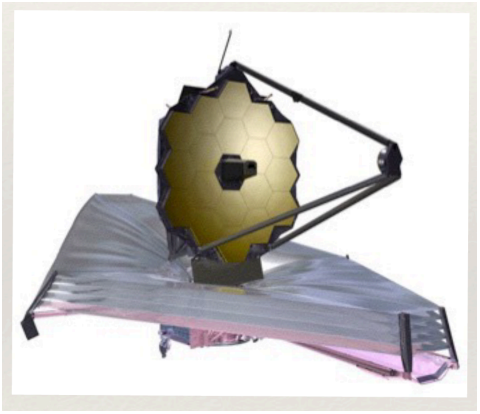
Requirements:
Binocular VIS and NIR both imaging and coro modes. + Synergy with LMIRCAM for H2
Coronagraphs with 2<λ/D<8; FoV of 5”x5” and ~20”x20” for DLAs and AGN inner morphology.

Planet imagers for the next future

Ground based 8 m telescopes (2013 -)
Hi-Ciao (Subaru)
SPHERE (VLT)
GPI (Gemini)
SHARKs (LBT)



JWST (2018 -)
- < 5 micron NIRCAM/TFI
- > 5 micron: MIRI



ELT Instruments (> 2020 -)
-NIR: PCS (E-ELT), PFI (TMT),
HRCAM (GMT)
-MIR: METIS (E-ELT),
MIRES (TMT), MIISE (GMT)