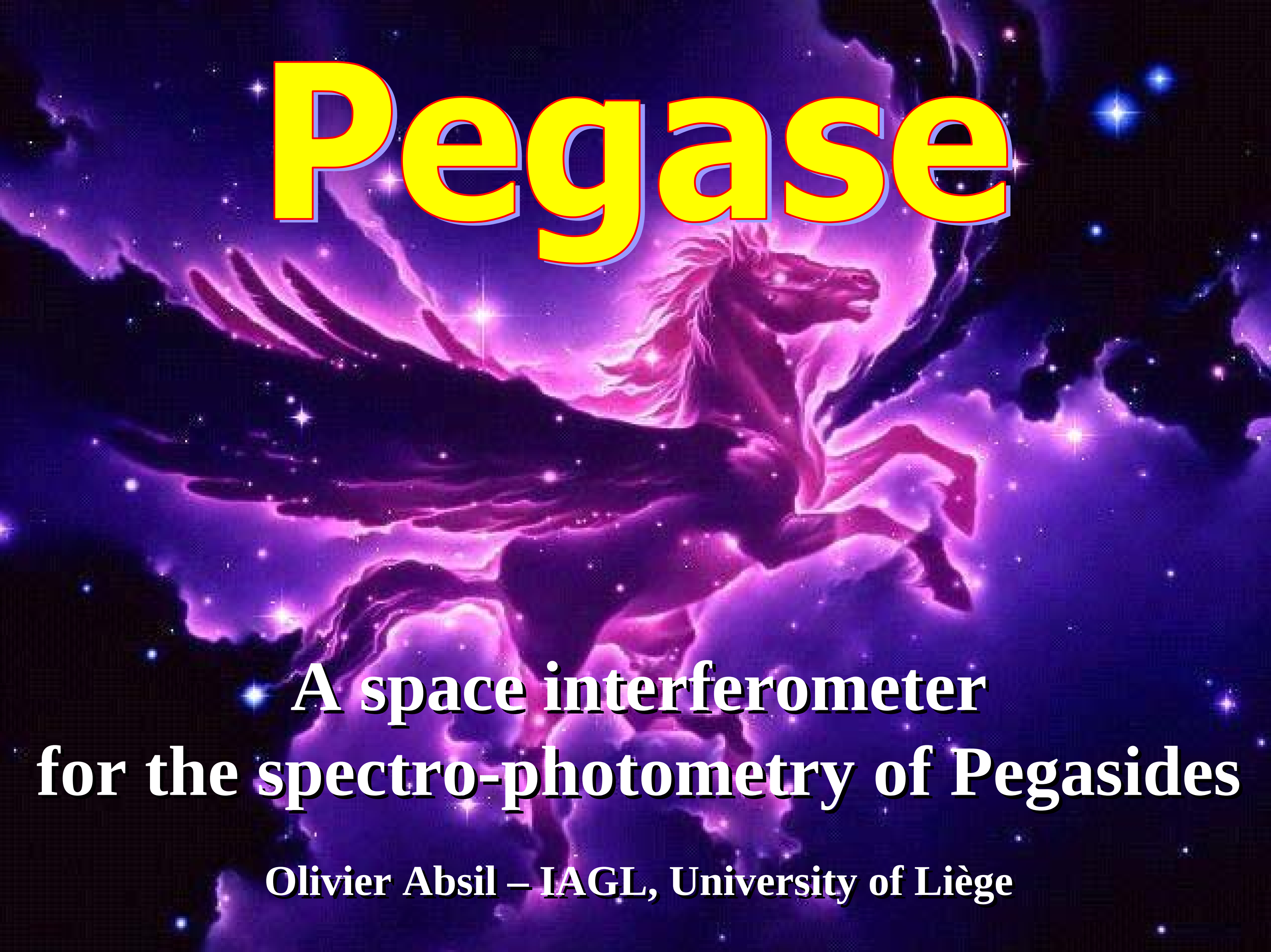


Pegase

A space interferometer for the spectro-photometry of Pegasides

Olivier Absil – IAGL, University of Liège

Proponents

- IAS Orsay
  - *A. Léger (PI), M. Ollivier…*
- LESIA – Observatoire de Paris
  - *D. Rouan, A. Boccaletti, V. Coudé du Foresto…*
- LUTH – Observatoire de Paris
  - *J. Schneider, D. Pelat…*
- GEMINI – Observatoire de la Côte d'Azur
  - *D. Mourard, J. Gay, Y. Rabbia…*
- ONERA
  - *G. Rousset, F. Cassaing…*
- Université de Liège
  - *J. Surdej, O. Absil…*
- Alcatel Space – Cannes
  - *X. Leyre, E. Thomas…*
- CRAL ─ ENS Lyon
  - *F. Allard, I. Baraffe…*
- LAOG ─ Observatoire de Grenoble
  - *F. Malbet, C. Dougados*
- Observatoire de Genève
  - *S. Udry*
- Instituto des Astrofisica de Canarias
  - *M. Edouardo*

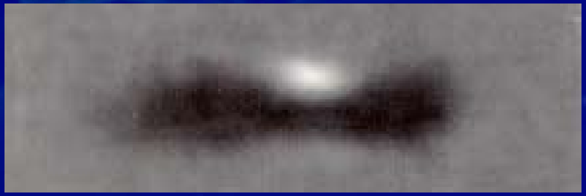
… a response to the formation flying call for ideas - CNES 2010

Main science goals

- **Sources:**
  - Pegasides (hot Jupiters)

  - Brown Dwarfs

  - Protoplanetary disks

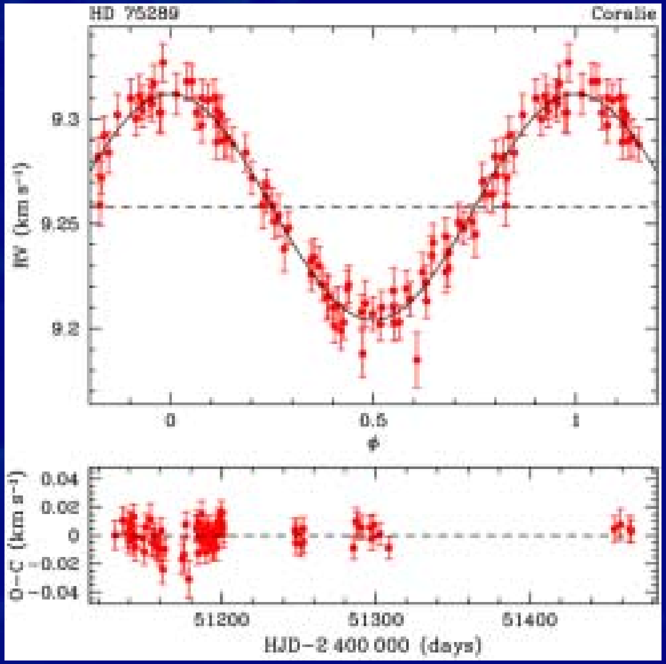


Requirements :

- High angular resolution
- High dynamic range

Science objective: Pegasides

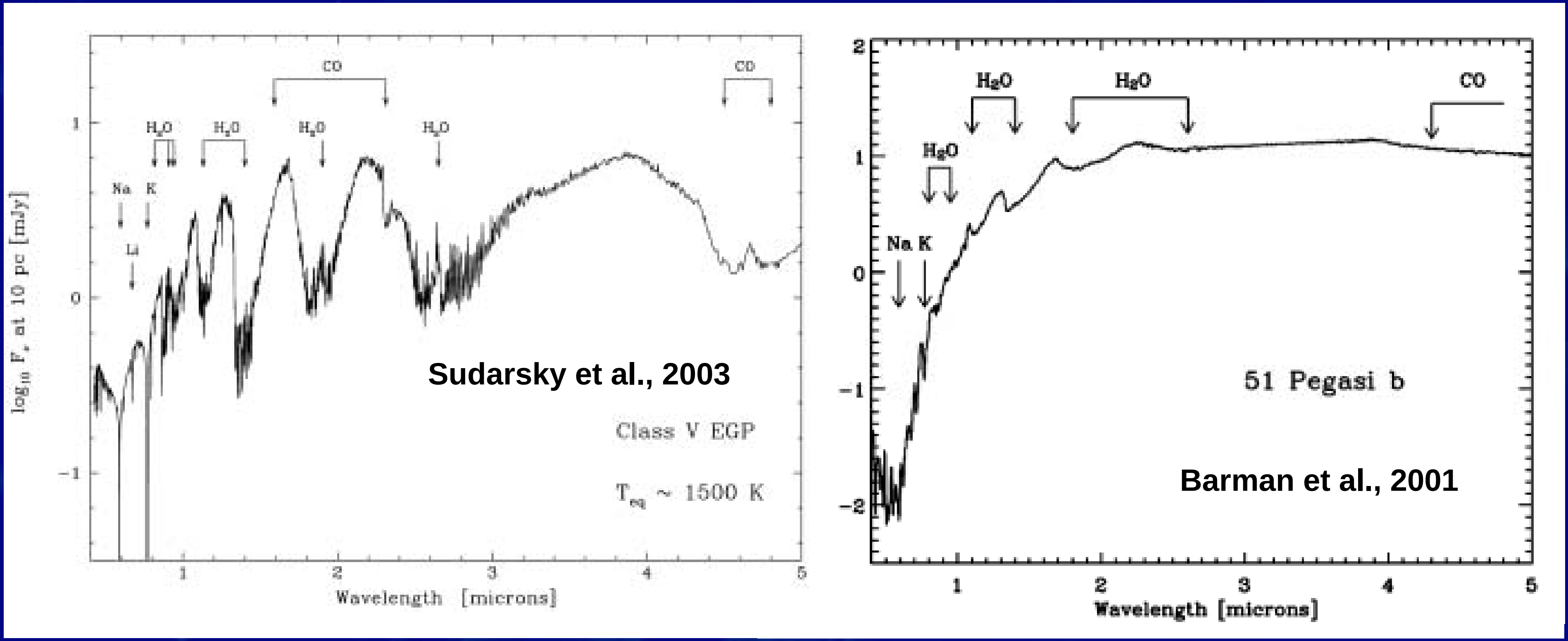
- **All nearby hot Jupiters (~0.05 AU) are known from radial velocity surveys**
- **We know:**
    - M sin *i*
    - Semi-major axis
    - Orbital eccentricity
    - Period + ephemeris
- **We want to know:**
    - Physical parameters (structure)
    - Mass (sin *i*) and radius
    - Atmosphere ?
        - Constituents
        - Irradiation, heating mechanisms
        - Thermalization between hemispheres
        - Clouds, dynamics



Tinney et al. 2000

→ need direct detection!

Physics of Pegasides ?



- **Spectroscopy is the tool to constrain their physics**

  (ex: atmosphere, clouds, thermalization night/day…)

- **Continuous wide (1.5–6µm) spectral coverage needed to study main molecular species (H_2O, CO, CH_4…) ⇒ space**

Main Pegaside targets

Star	Ups And	Tau Boo	51 Peg	HD179949	HD75289	HD73256	HD49674	HD209458	HD83443	HD330075
Spectral type	F8V	F6IV	G2IV	F8V	G0	G8/K0V	G0	G0V	K0V	K1
Distance [pc]	13.47	15.6	14.7	27	28.94	36.5	40.7	47	43,54	50.2
Radius [Rsun]	1.220	1.220	1.300	1.180	1.100	0.878	0.920	1.100	0.850	0.88
Angular. [mas]	0.421	0.364	0.411	0.203	0.177	0.112	0.105	0.109	0.091	0.092
Teff [K]	6276	6276	5770	6194	6030	5350	5770	6030	5250	5017
Orbit [AU]	0.059	0.050	0.051	0.040	0.046	0.037	0.057	0.045	0.040	0.039
Period (day)	4.62	3.31	4.23	3.09	3.51	2.55	4.95	3.52	2.99	3.388
Max angular sep. [mas]	4.380	3.205	3.483	1.481	1.589	1.014	1.396	0.957	0.919	0.78
Temp [K]	1235.93	1342.56	1259.12	1456.93	1277.00	1128.64	1005.66	1291.11	1048.08	990

- **Angular Separation from 0.8 to 4 mas ⇒ interferometer**
- **Spectroscopy is the tool to constrain their physics**

  (ex: atmosphere, clouds, thermalization night/day…)
- **Continuous wide (1.5–6µm) spectral coverage needed to study main molecular species (H_2O, CO, CH_4…) ⇒ space**

Nulling mode

Contrast between 1.5 & 6 µm :

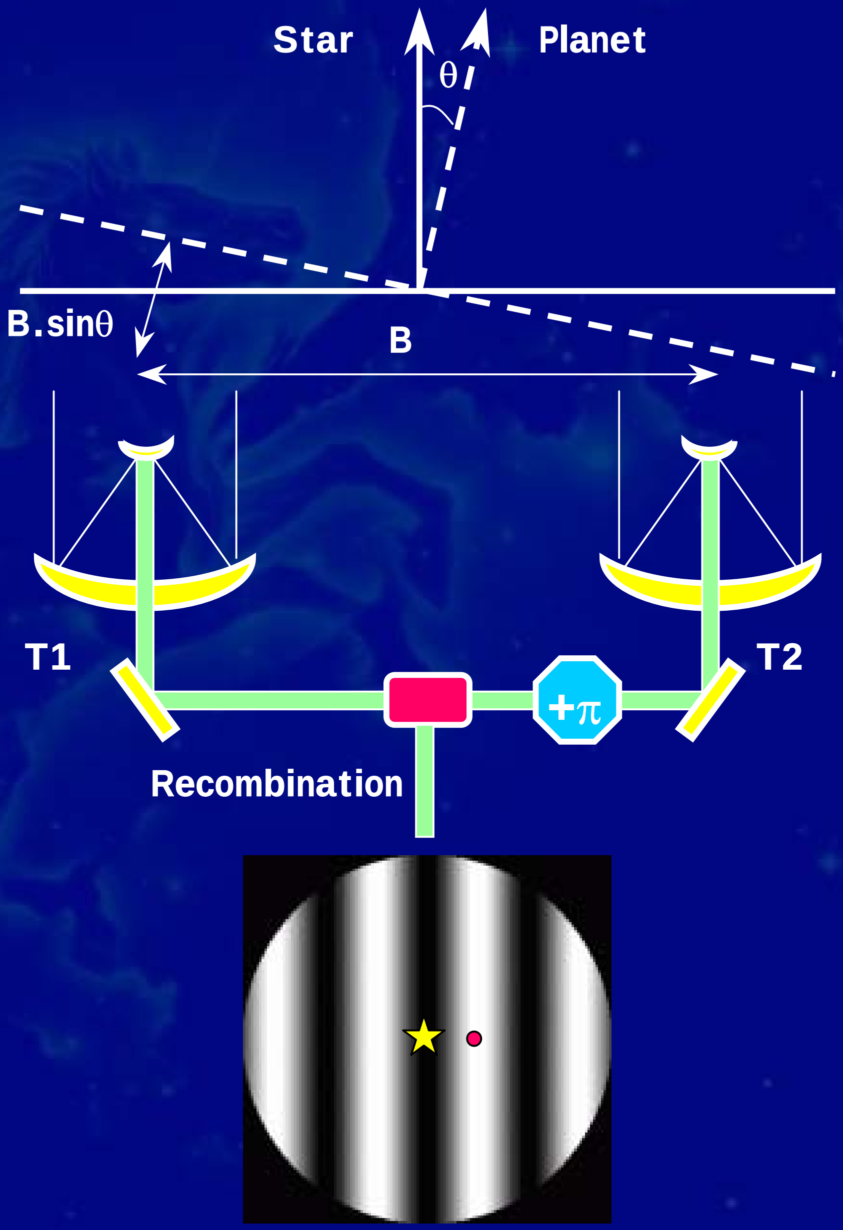
10^5 to 10^3
(lower contrast for the longest wavelength)

Nulling mode :

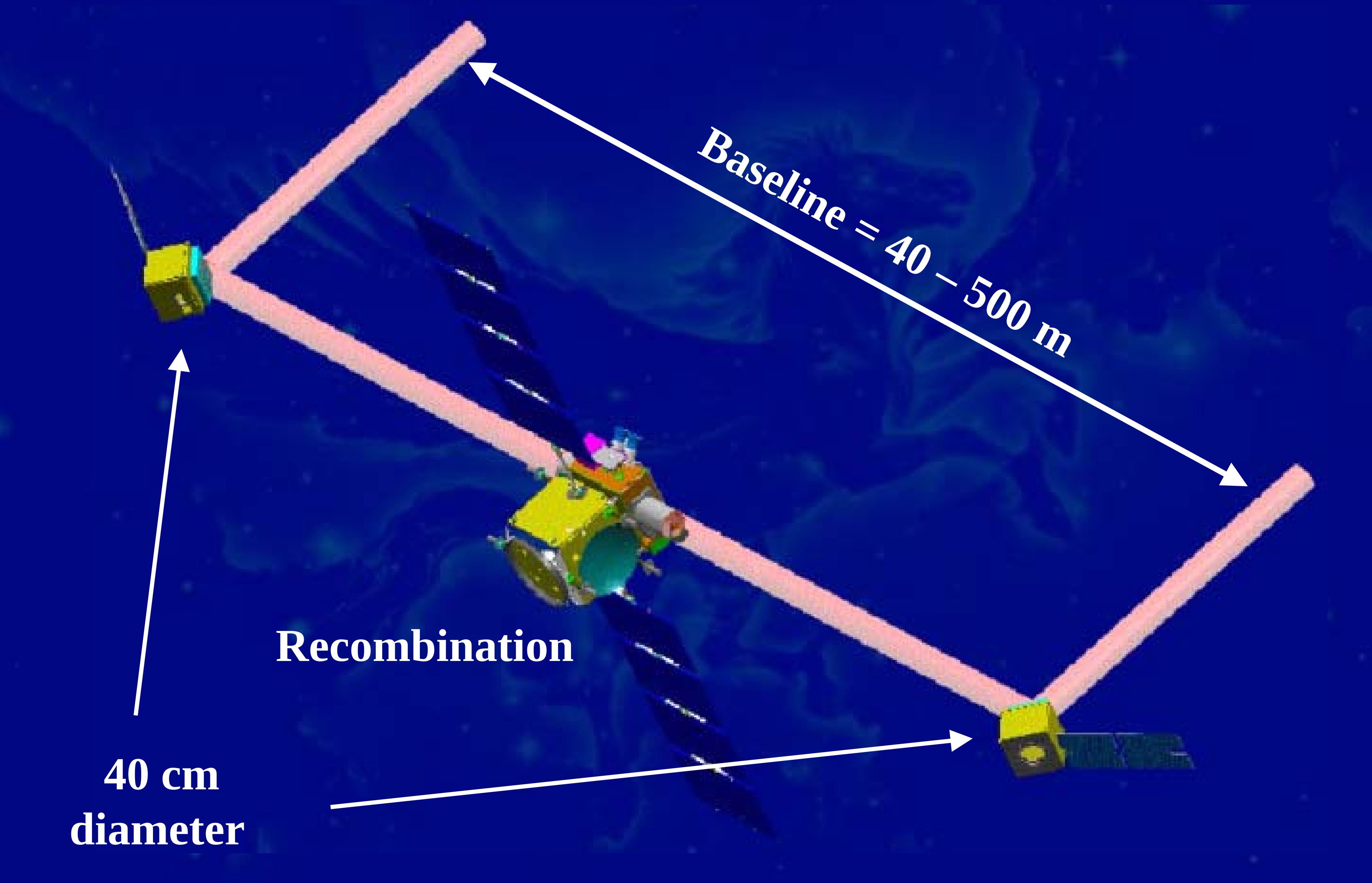
Bracewell Interferometer

Angular Resolution of Bracewell Interferometer: λ/(2B)

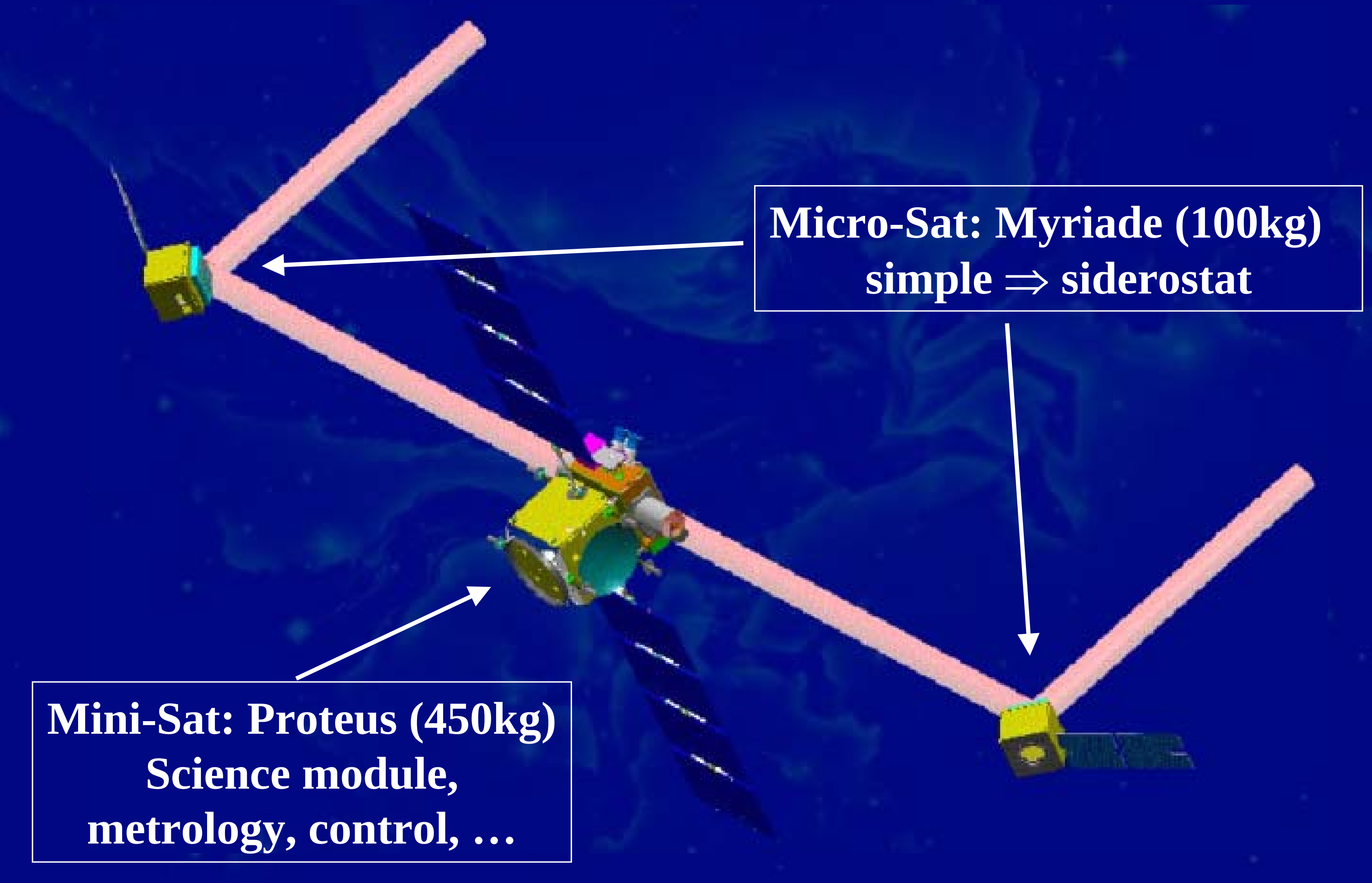
1 mas @ 5 µm ⇒ B=500 m



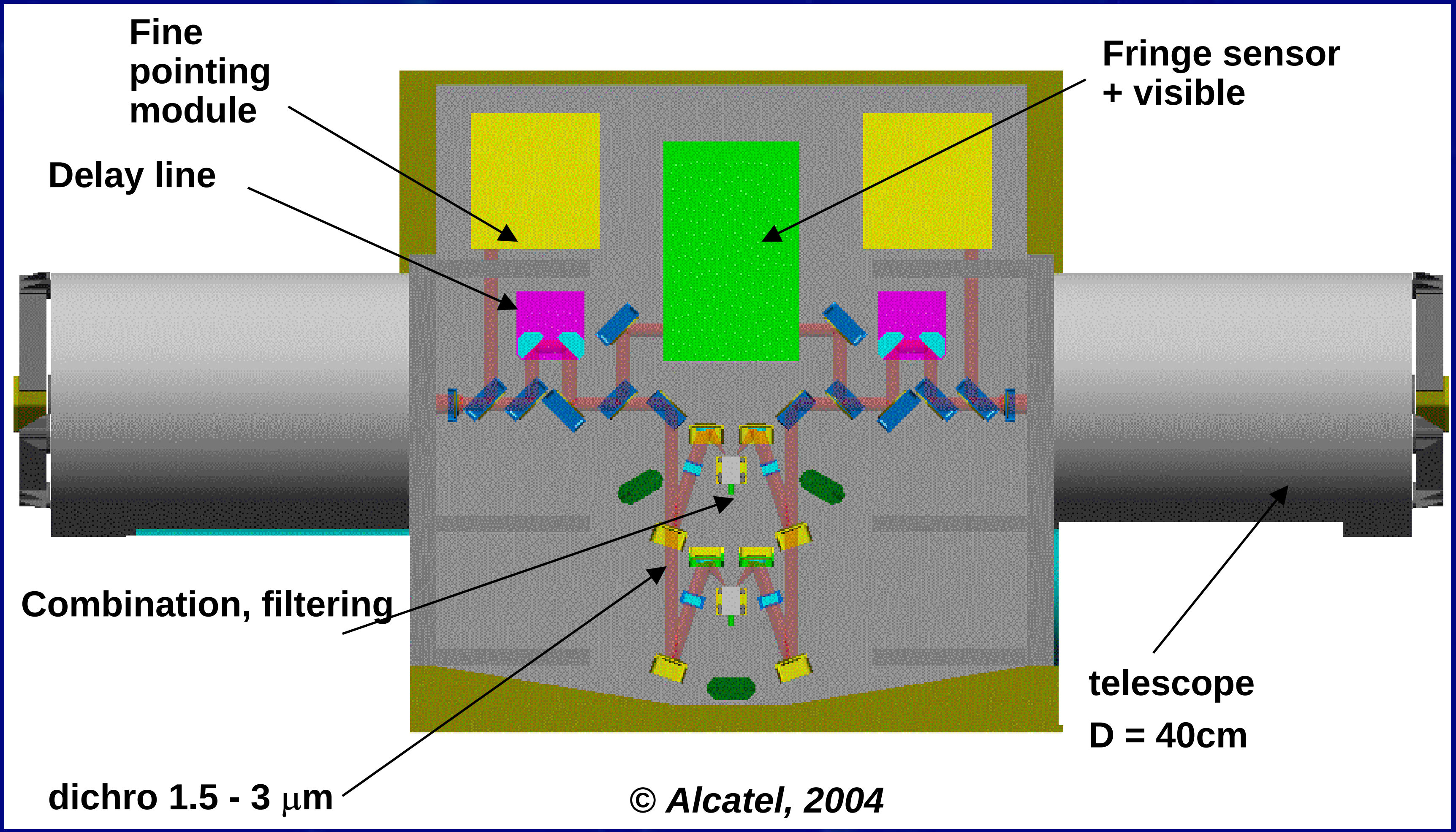
Flying configuration



Flying configuration



Proteus


Fine pointing module
Fringe sensor + visible
Delay line
Combination, filtering
telescope
D = 40cm
dichro 1.5 - 3 µm
© Alcatel, 2004

Pegase technical sheet

Mission duration	3 years
Relative positionning of satellite :	
- longitudinal	0.1 mm
- transversal	0.1 mm
- angular	50 mas
Fringe Sensor precision	3 nm
Integration time on a Pegaside	
(SNR=20, 51 Peg)	~60 mn - see poster 64
Number of targets	50 (incl. ~15 Pegasides)
Passive cooling	optics: 100 K, detector: 50K

Brown dwarfs and low-mass stars

Science:

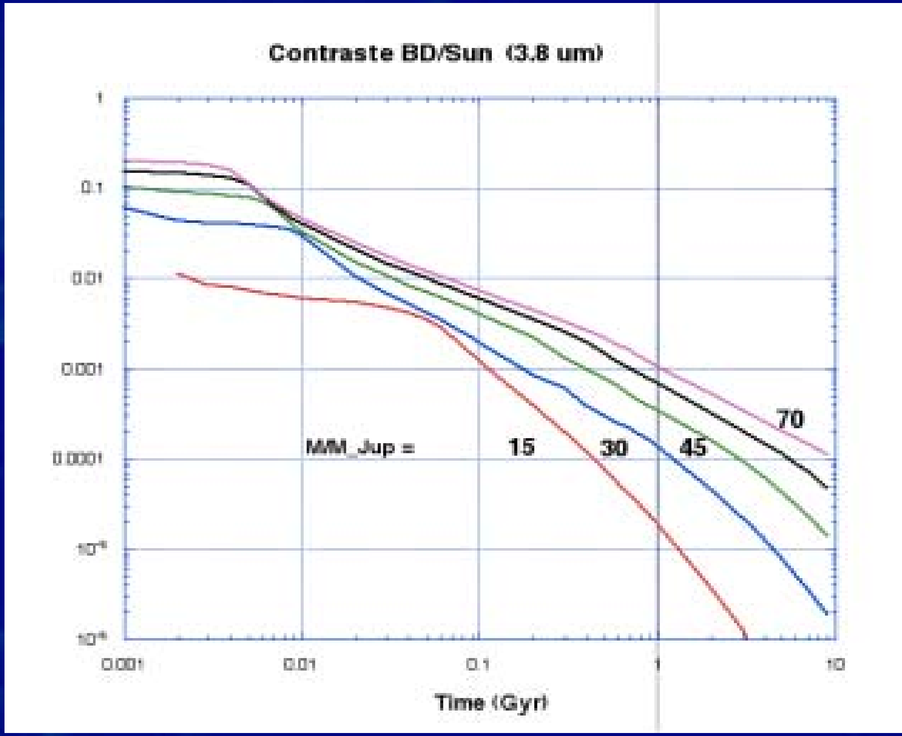
- Evolution: $R(M,t)$, $F_{\lambda}(M,t)$
- Need to know M

$\Rightarrow$ **Study bound systems**

$\Rightarrow$ **Explore (M,t) diagram**

- old objects: known

- young objects to be discovered by 2010 (VLT-PF)



What spectroscopy will provide:

- T_{eff}
- Clouds (refractory elements)
- Presence of CH_4 molecular bands

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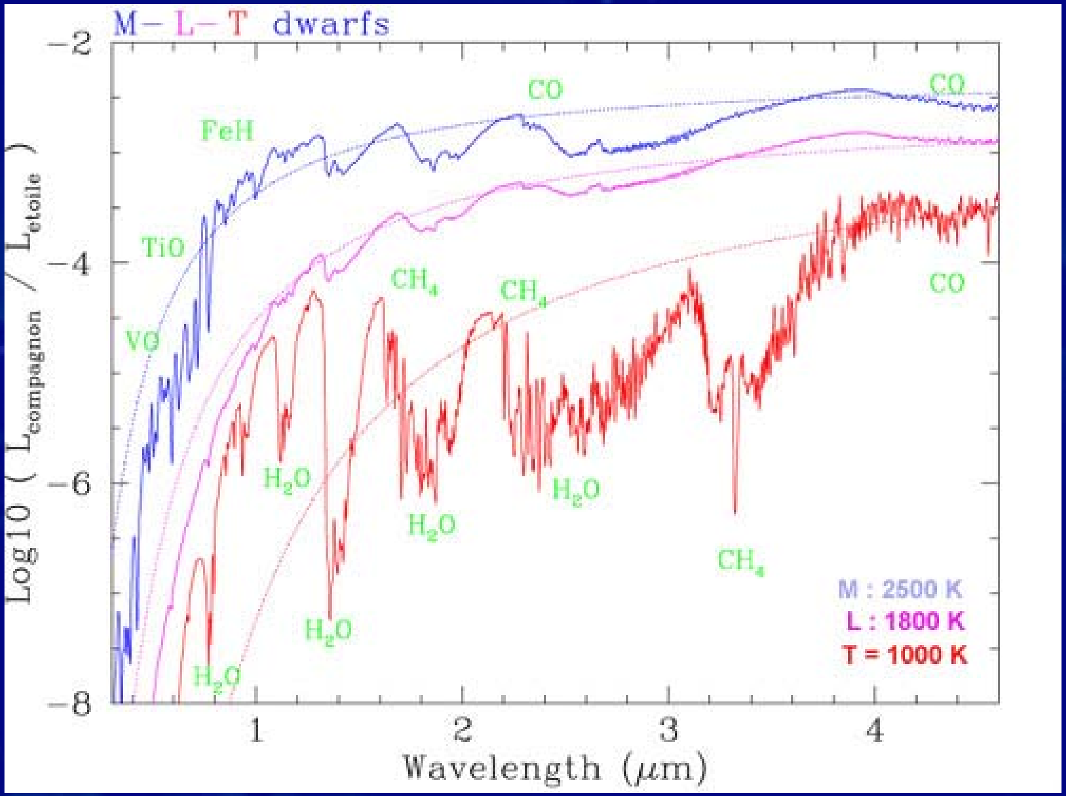

What spectroscopy will provide:

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- Clouds (refractory elements)
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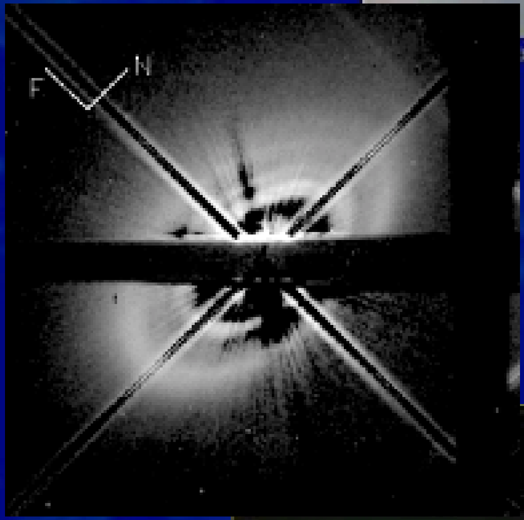
Protoplanetary disks

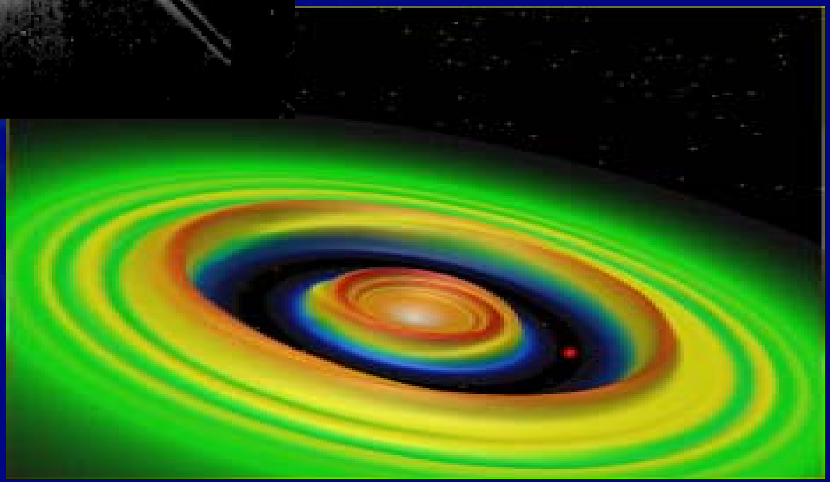
Goals:

- Understand the mechanisms of planet formation



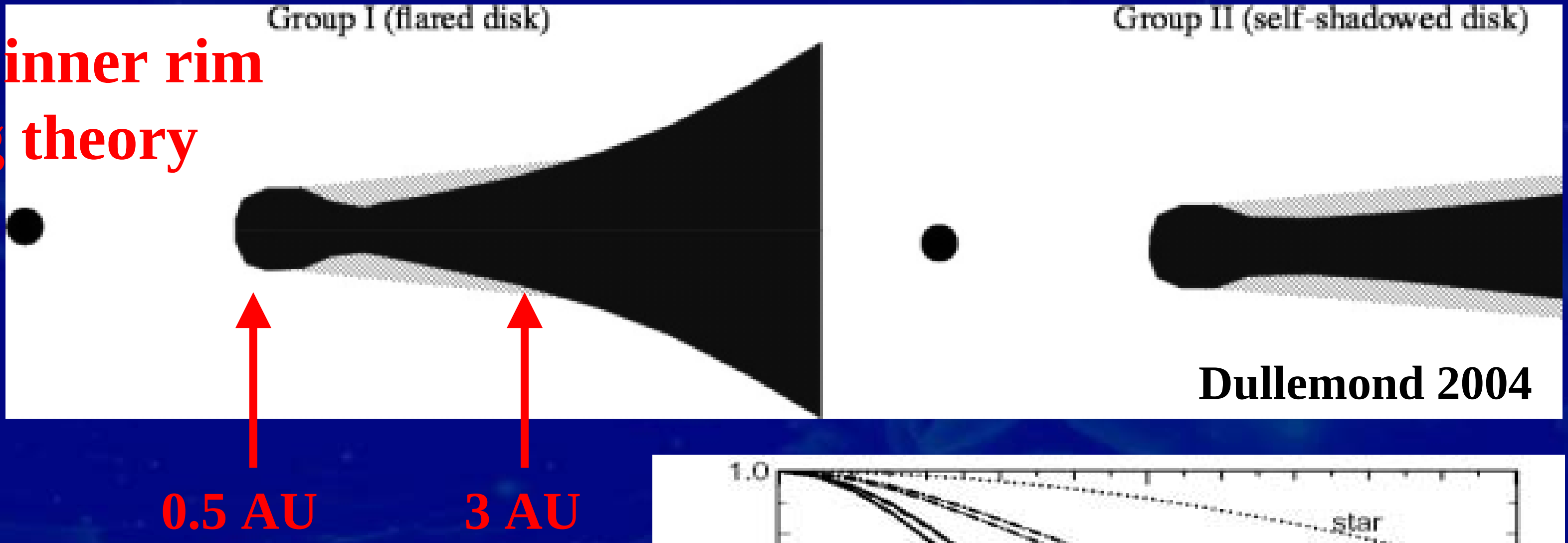
- Star/disk interaction: dust transport in the very inner region (within 1 AU)

- Planetary gaps / bands? (TBC)



Inner disk shape of YSO

Puffed-up inner rim shadowing theory

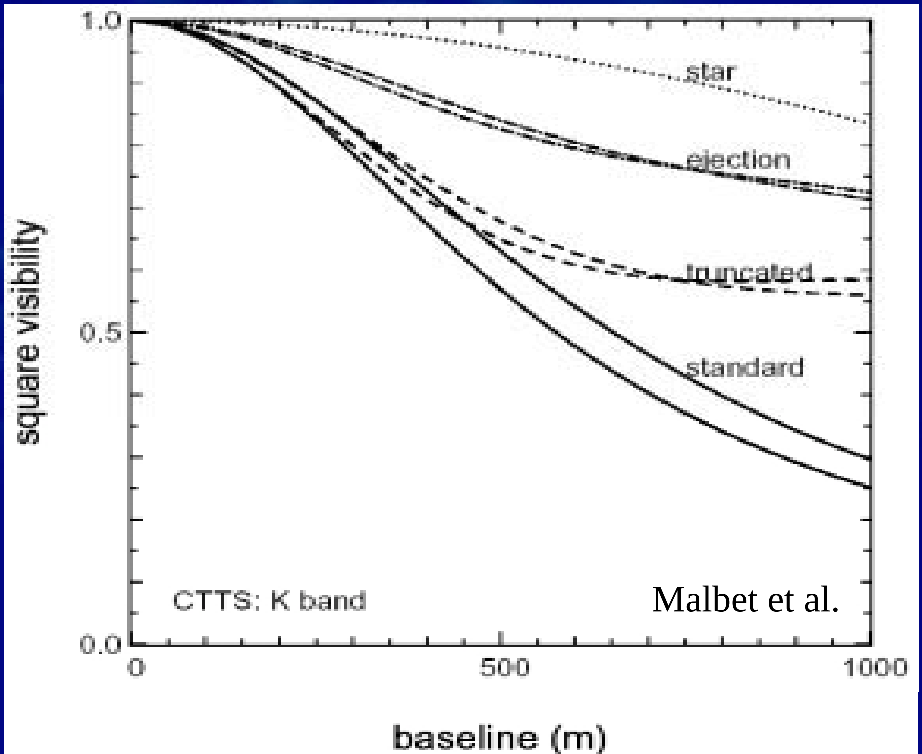


T Tauri magnetosphere size:

500m @ 0.5 mm

⬇

0.03 AU @ 140 pc
(Taurus distance)



Conclusion

- Full spectrophotometric characterization of ~15 closest hot exoplanets
- Modelling of atmospheric structures of Brown Dwarfs
- Inner region of protoplanetary disks

- Collaborations welcome
- Next few months are critical:
  - Selection of ideas by CNES July 04 (Pegase + 3 others)
  - Then (18 months) pre-phase A study ?
  - Target flying date 2010–2012