Probing atmospheric dynamics in the ultra-cool dwarf binary 2MASS J04234858-0414035
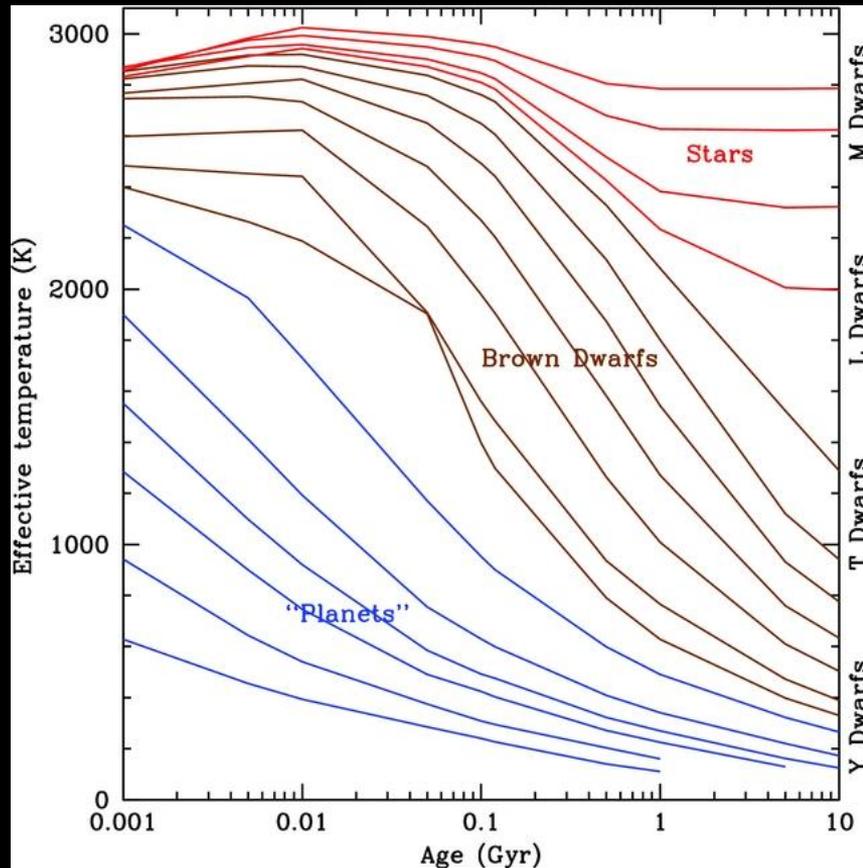
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Supervisors: Joan Climent Oliver, Paulo Miles Páez
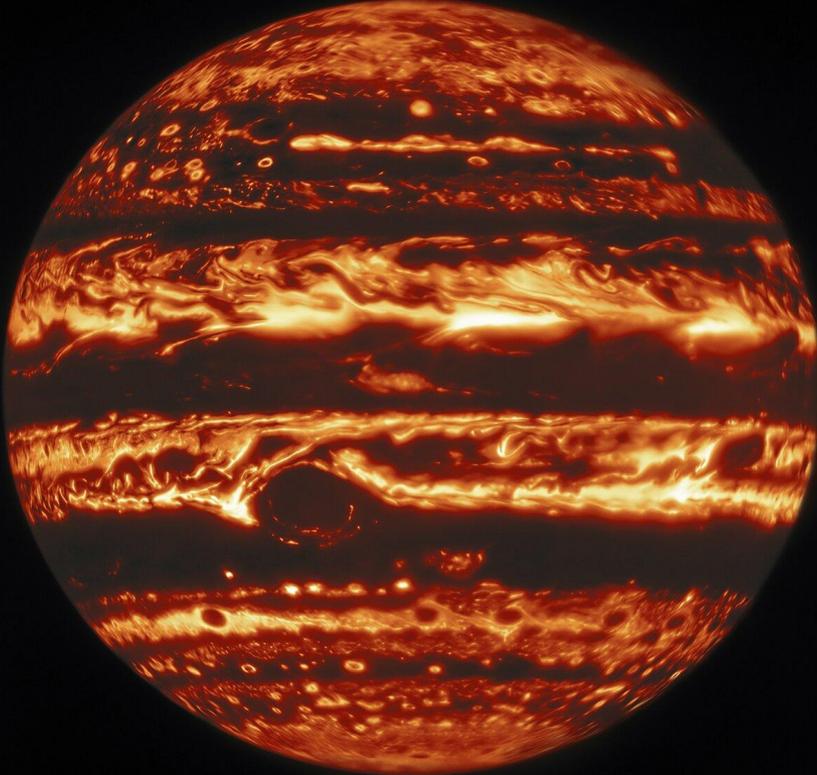Collaborators: María Rosa Zapatero Osorio, Jose Carlos Guirado Puerta

UltraCool Dwarfs

- M7 or later
- Effective temperatures < 2700 K
- Spectral Types late-M, L, T, Y

- Stars (> 0.075 M☉)
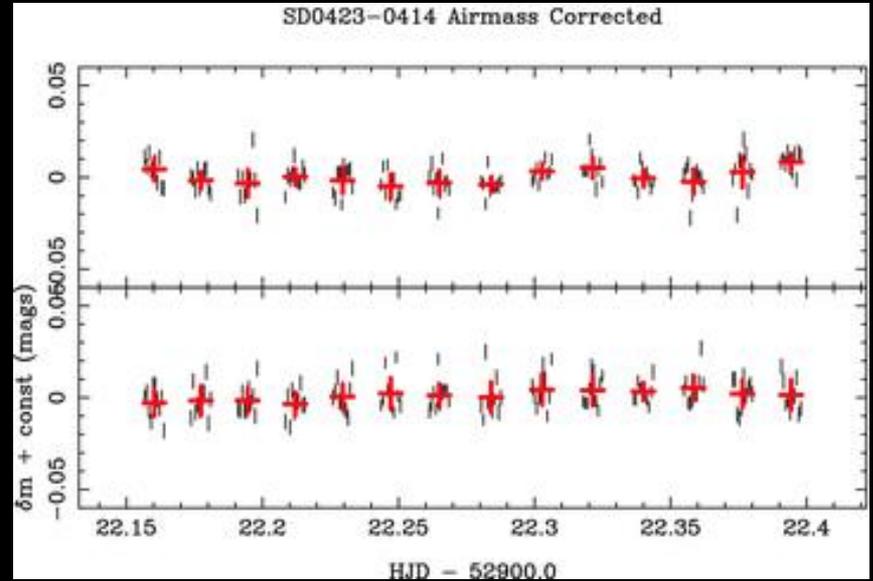- **Brown Dwarfs (0.0125 - 0.075 M☉)**
- Planetary mass (< 0.0125 M☉)

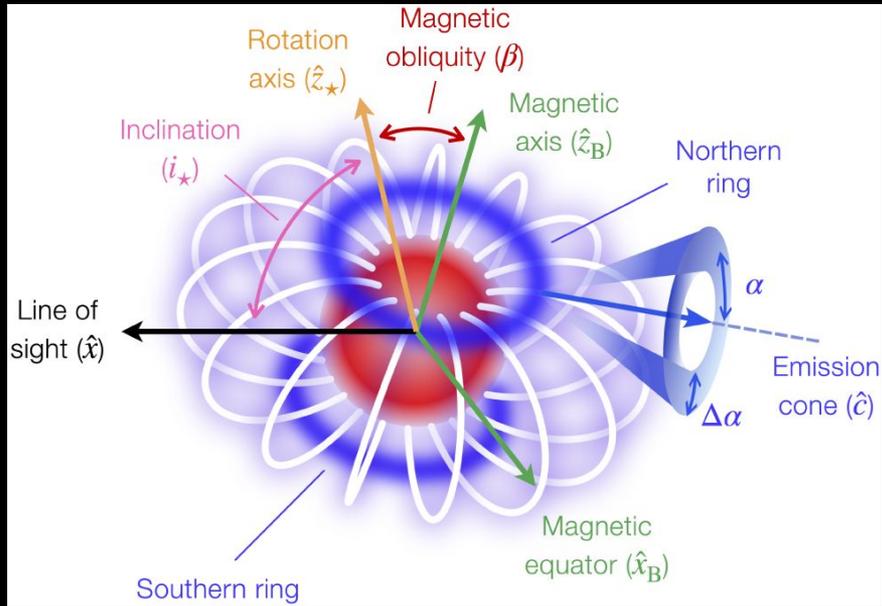Baraffe et al. (2003)

PHOTOMETRIC VARIABILITY
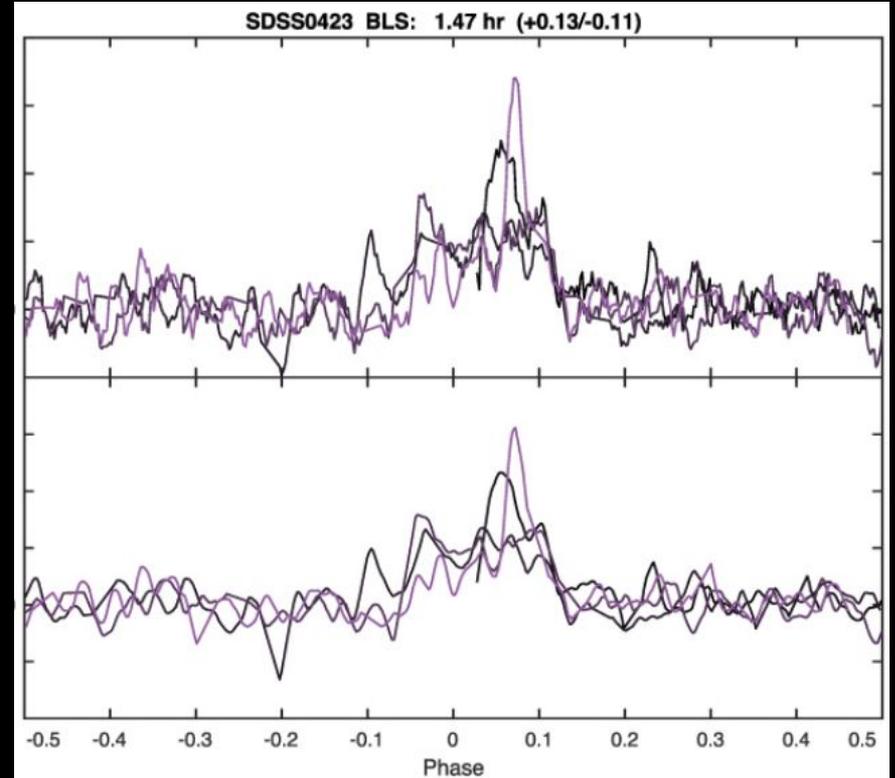

Jupiter IR

Credits: Gemini North

Clarke et al. 2008

RADIO VARIABILITY

Bloot et al. 2024

SDSS0423 BLS: 1.47 hr (+0.13/-0.11)

Kao et al. 2018

WIND MEASUREMENT

- **IR/VIS** variability comes from the **photosphere**
- **Radio** variability comes from the **magnetosphere**
- Difference between these period could allow us to measure zonal winds

$$v_{wind} = 2\pi R \left(\frac{1}{T_{IR}} - \frac{1}{T_{RAD}} \right)$$

See Allers et al. 2020

- **We need precisions of ~ 1 min**

An UCD binary: 2MASS J04234858-0414035

Parameters	Value
Spectral Type	L6.5 + T2
$J(mag)$	14.465 ± 0.027
Separation	$0.16''$
Orbital Period	$\sim 15 - 20\,yr$
Distance	15.2 ± 0.4 pc
P_{rot} IR	$2 \pm 0.4\,h$
P_{rot} Radio	$1.47 \pm 0.13\,h$

Discrepancy?

- IR and Radio periods are still compatible at 1σ

- If both from same component:
  - Wind measurement

- If from different component:
  - First time individual rotational periods in an UCD binary are measured via multi-wavelength photometry

PANIC4K observations

GOALS

- Refine the rotation period measurement of 2MJ0423 to identify which component drives the variability

METHODOLOGY

- J-band photometric monitoring using PANIC4K mounted on the 2.2 m telescope

TECHNICAL DETAILS

- Expected J-band variability amplitude: 8 mmag (Clark et al. 2008)
- 30s exposures lead a S/N of $\sim$ 70
- Combining each 15 images we could get to an error of 3 mmag ($\sim 3\sigma$)
- 2 nights -> Total of $\sim$ 7 rotations. We will improve the measurement by a factor of 3.5