

Rotation velocities of T dwarfs and angular momentum evolution of brown dwarfs

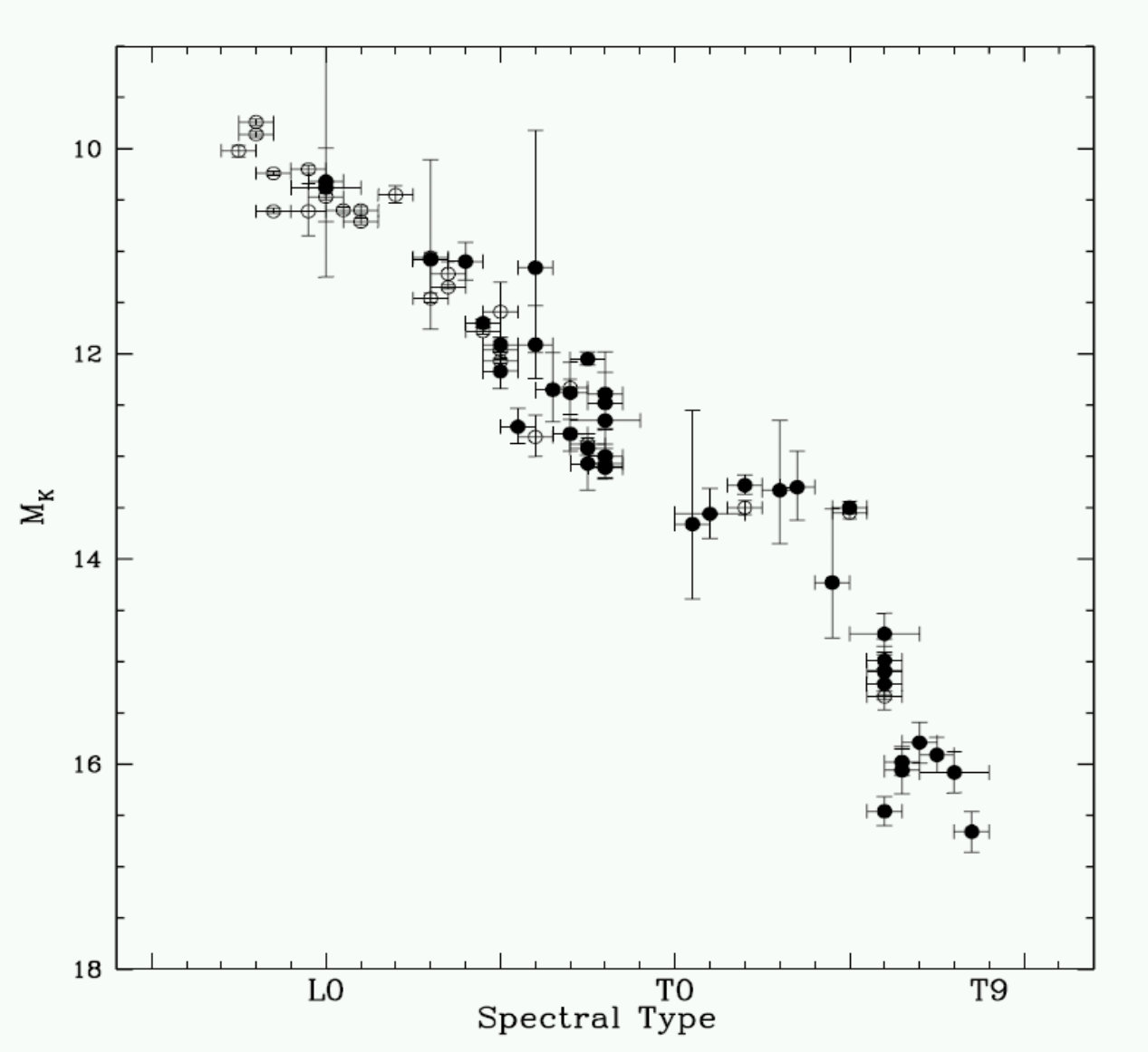
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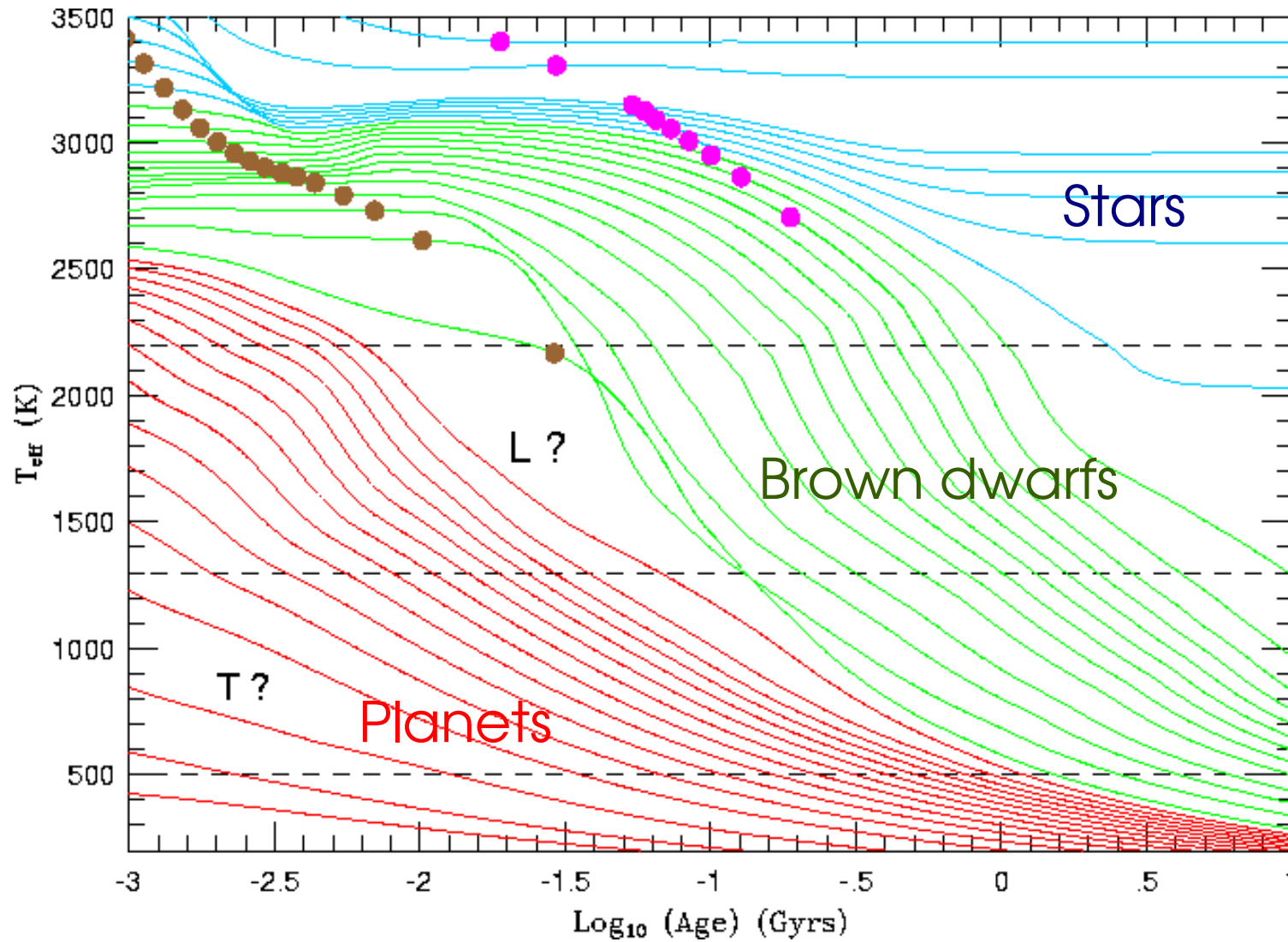
Outline

- L and T dwarfs: the sample
- Equatorial velocities: angular momentum evolution
- LP944-20: Radial velocity monitoring

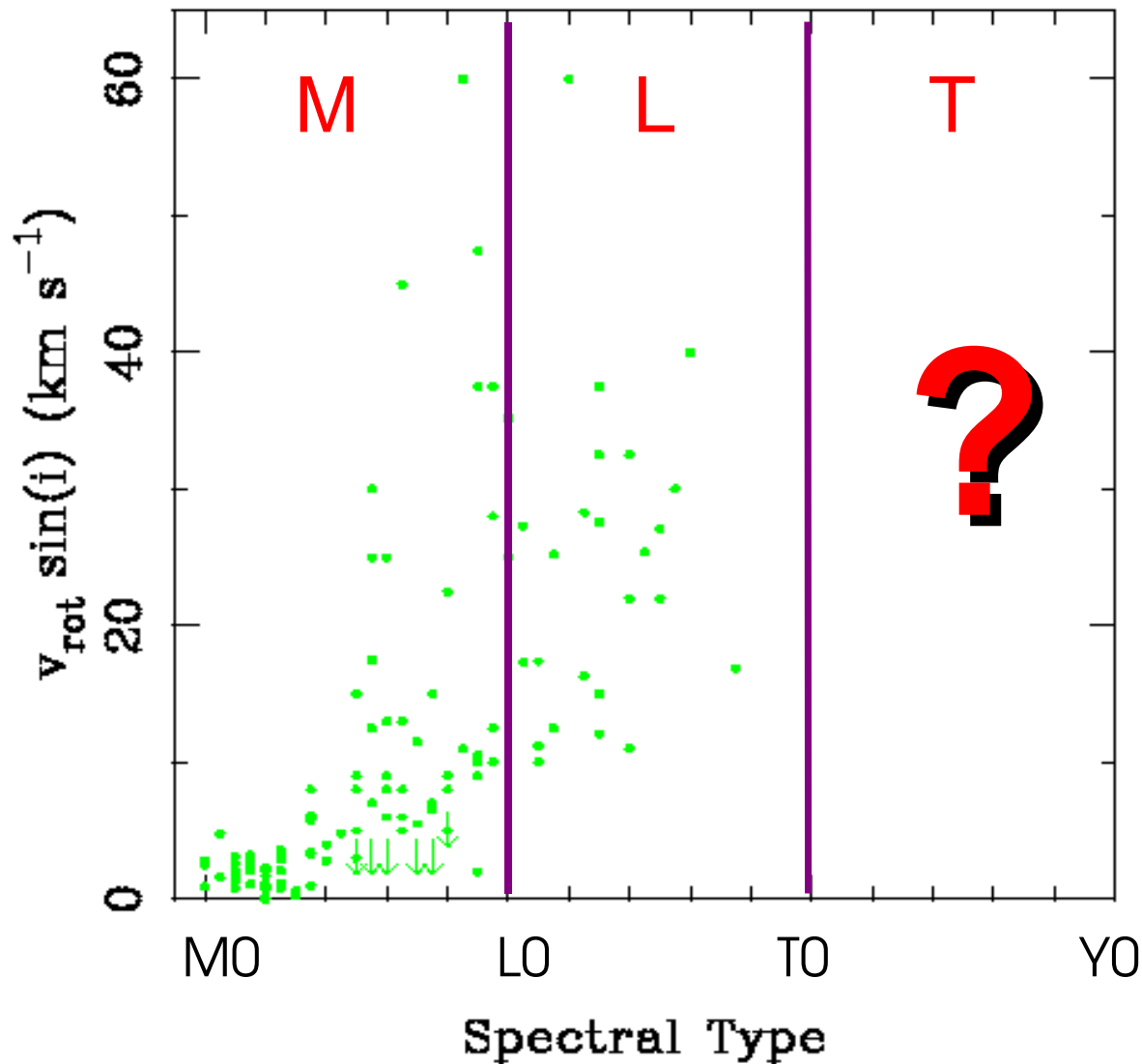
HR diagram of the coolest objects in the solar vicinity



Evolution of stars, brown dwarfs and planets



Spectroscopic velocities of M and L-type field dwarfs



M0-M4 dwarfs are the slowest rotators on the main sequence. They lose about 98% of their angular momentum during their main sequence lifetime.

Late-M and L dwarfs rotate faster, indicating less angular momentum loss.

What are the equatorial velocities of the T-type brown dwarfs?

Our sample

3 late-M field dwarfs.

6 L field dwarfs (1900 - 1300 K).

9 T field dwarfs (1300 - 770 K).

The L and T samples cover the mass range 30-75 M_{jup} (for an age interval 1-10 Gyr).

The observations

NIRSPEC/KECKII

High-resolution, $R=40000$

J-band: KI

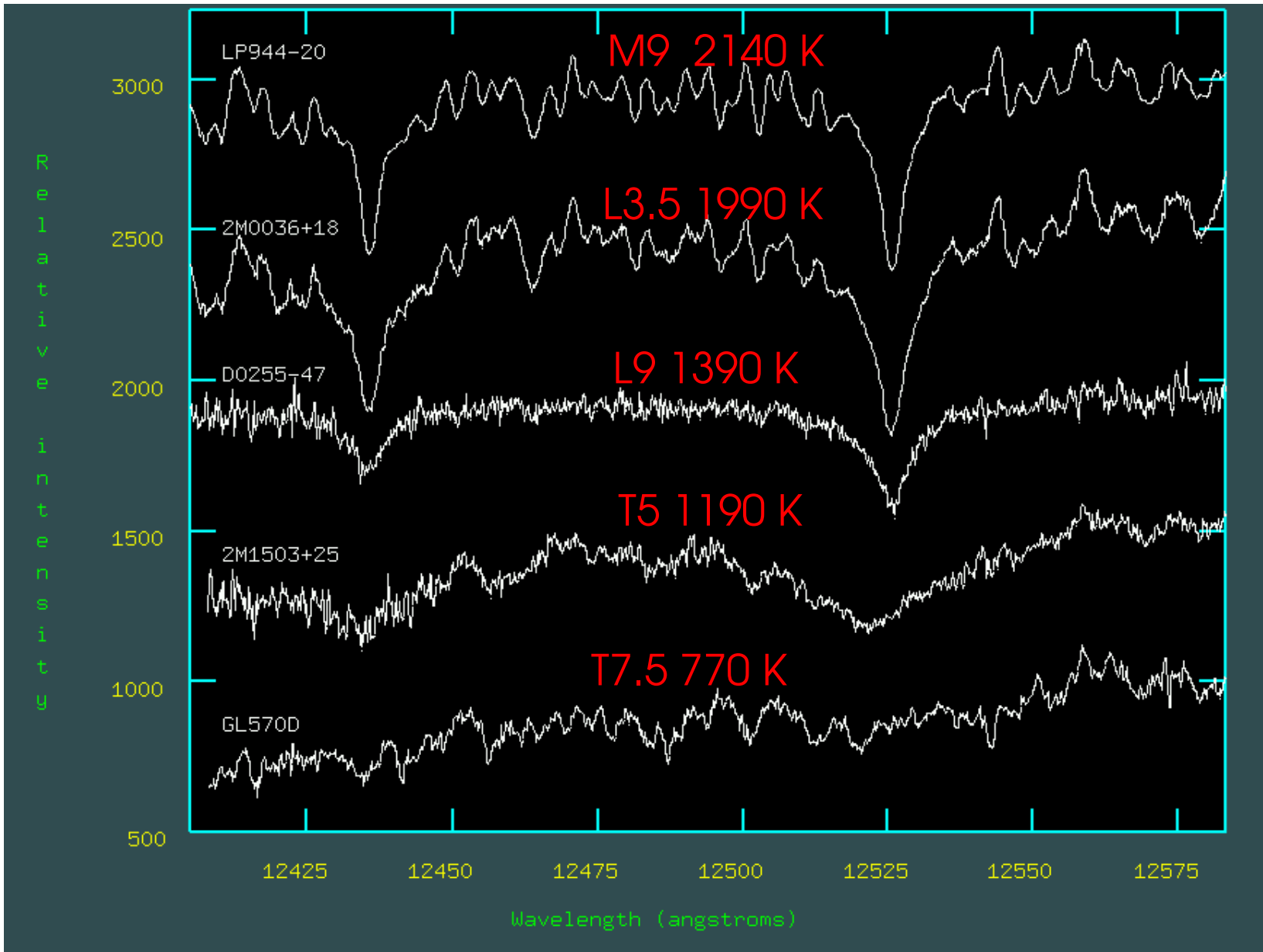
oxides

hydrides

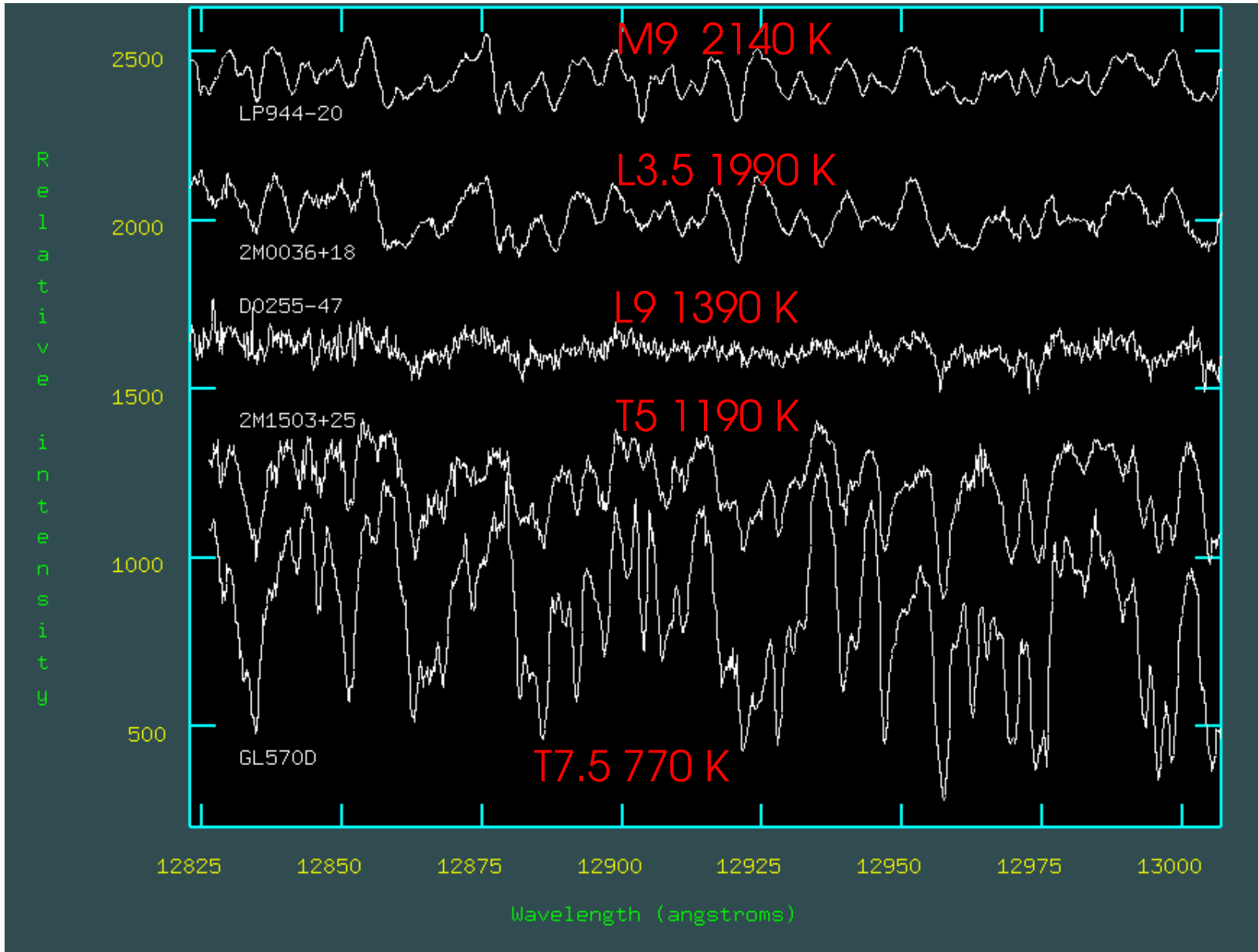
water vapor

methane

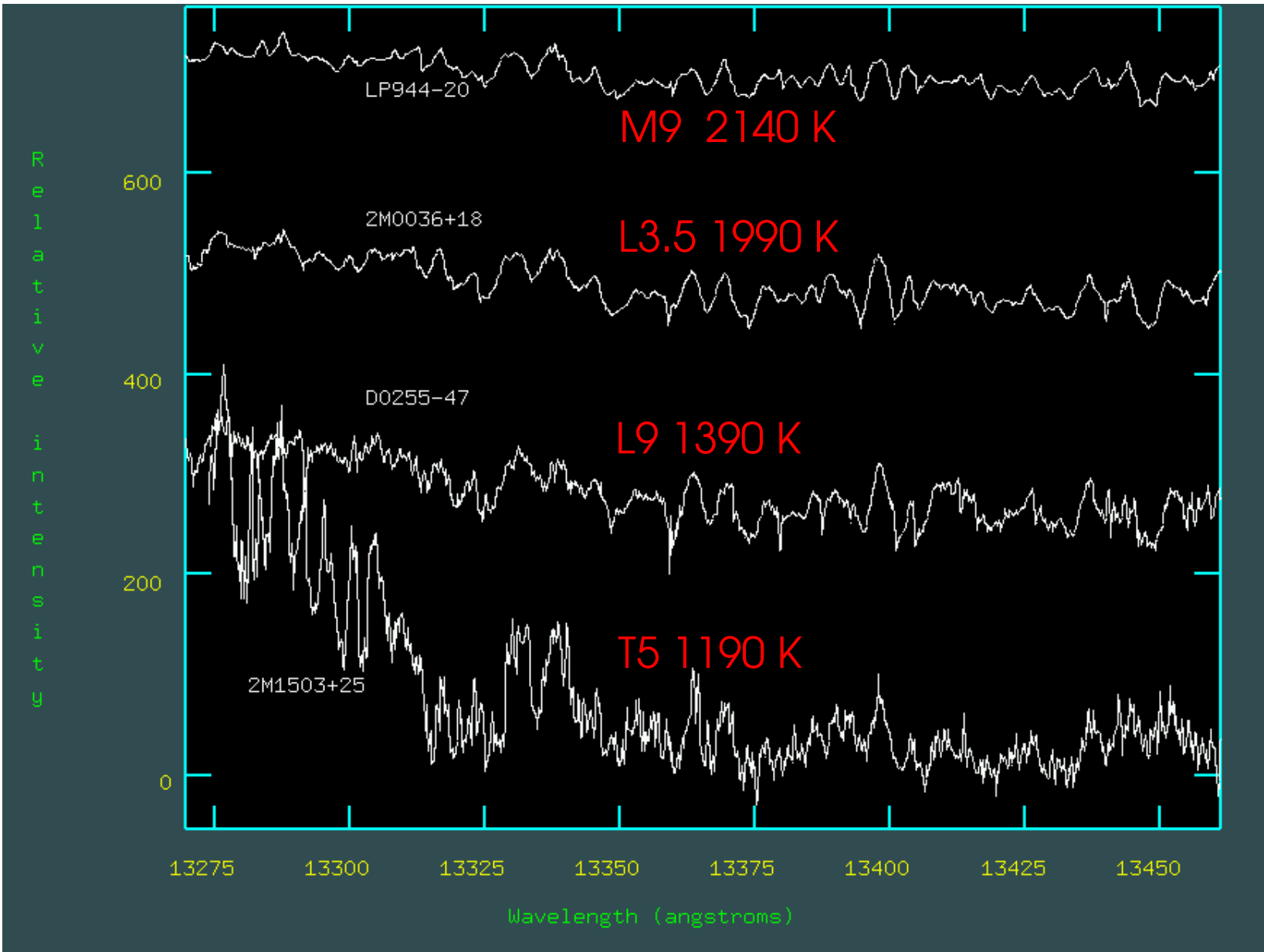
Some of our spectra ...



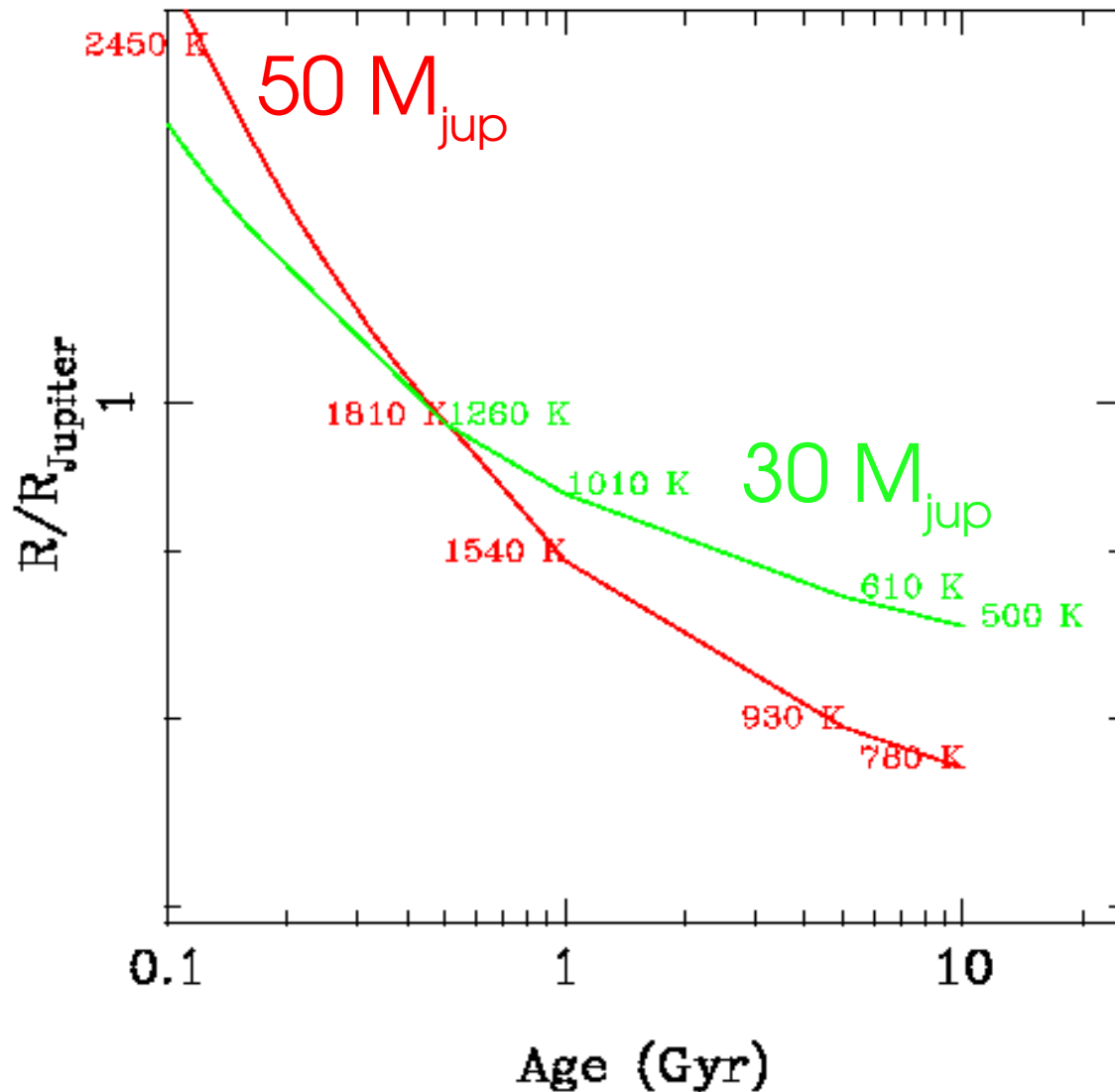
Some of our spectra ...



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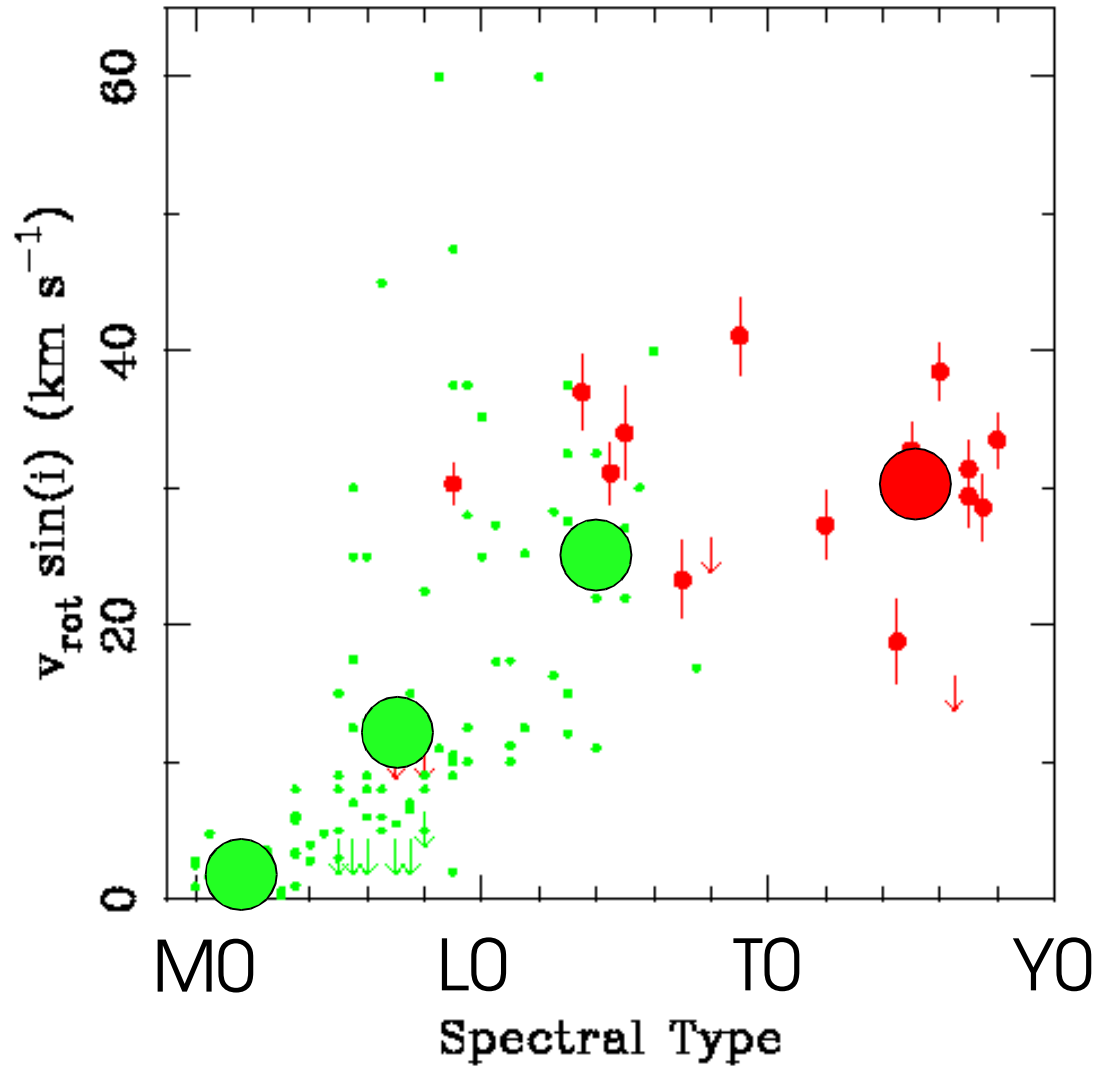


Predicted radii of brown dwarfs



Brown dwarfs *are not* on the main sequence. They reach the size of Jupiter at the age of ~ 500 Myr, and later on, shrink very smoothly down to about $0.8 R_{\text{jup}}$.

The results ...



T-type brown dwarfs are fast rotators. Their equatorial velocities span a range similar to that of L dwarfs.

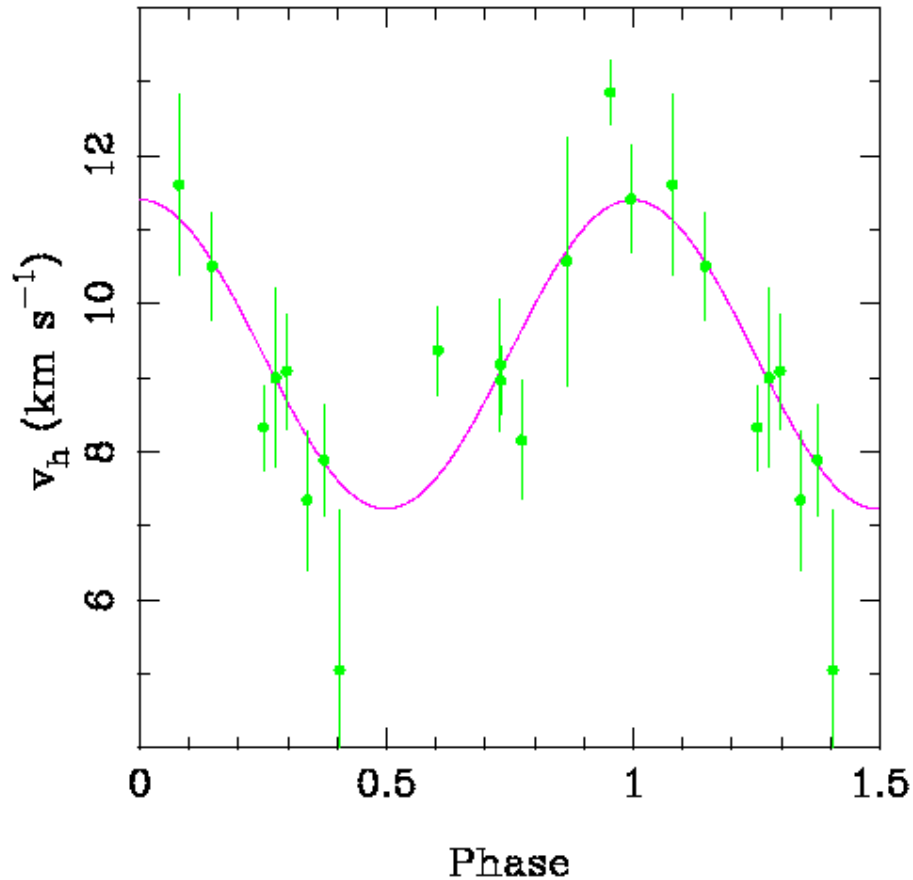
Indeed, very little, if any, angular momentum loss is observed.

Final remarks

- T-type, field brown dwarfs do rotate very fast with typical $v \sin i$ values ranging from 15 to 40 km/s.
- According to state-of-the-art evolutionary models, the size of these objects is similar to that of Jupiter. Then, typical rotational periods should be shorter than about 10 hours.
- In contrast to low-mass stars, brown dwarfs seem to preserve a significant amount of their original angular momentum. No efficient braking mechanism is apparently working.

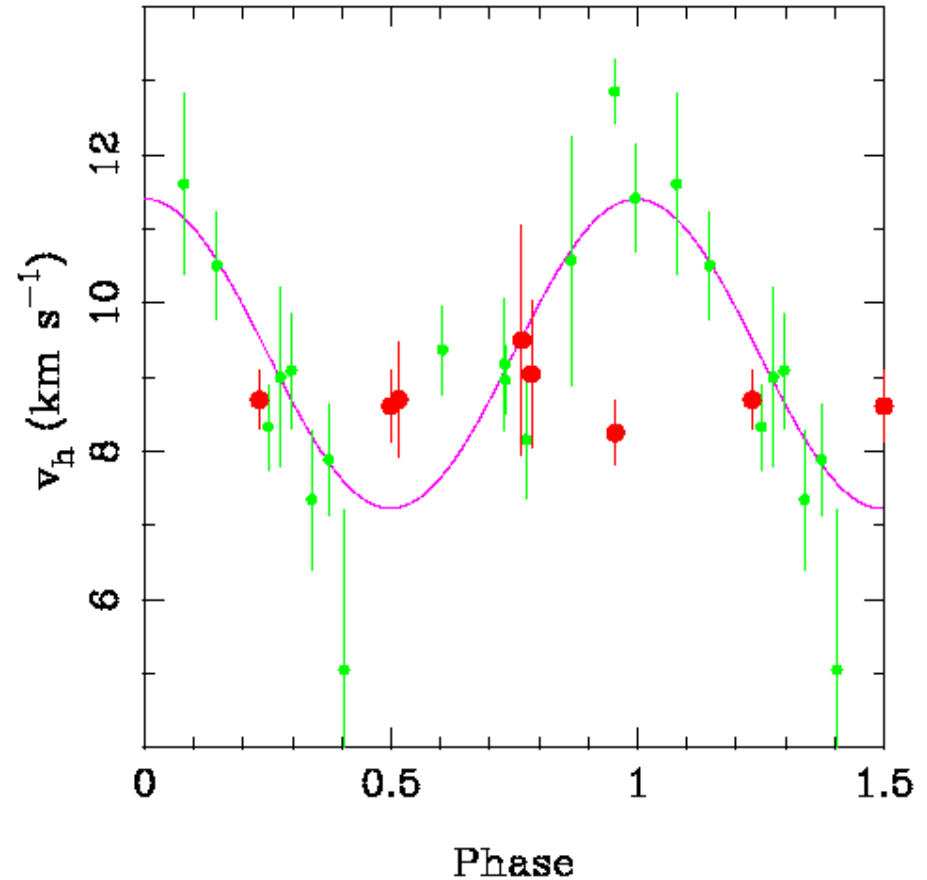
LP944-20 (M9V): a very young brown dwarf. Optical vs near-infrared data

VLT optical data



Amplitude: 2.1 km/s
Period = 3.7 d (?)
 $M \sin i = 3.4 M_{\text{jup}}$ (?)

NIRSPEC/Keck data



Dispersion: 0.43 km/s

In collaboration with E. Guenther