in memoriam
in memory of Yakiv Pavlenko

Truly great mentors are hard to find, difficult to leave, and impossible to forget.

(adapted from Anonymous)

María Rosa Zapatero Osorio
CAB, CSIC-INTA

"Brown Dwarfs come of age"
international meeting hold in Fuerteventura, May 2013

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international meeting hold in Fuerteventura, May 2013

- When will scientists obtain the first image of an Earth-mass planet in the habitable zone of its parent star/ brown dwarf?

Astron. Astrophys. 355, 245–255 (2000)

ASTRONOMY AND ASTROPHYSICS

On the interpretation of the optical spectra of L-type dwarfs⋆

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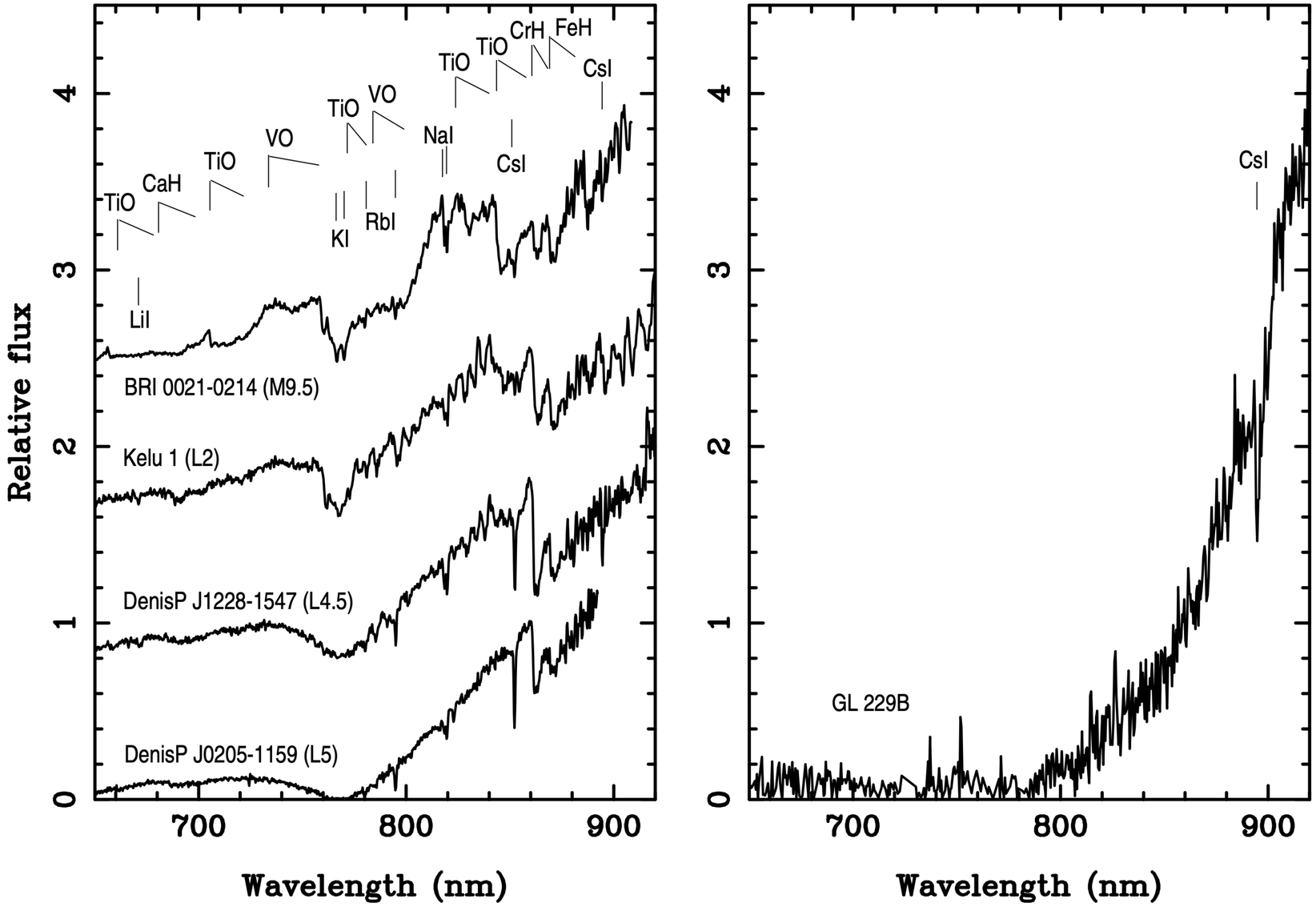
On the interpretation of the optical spectra of L-type dwarfs

Pavlenko, Zapatero Osorio, Rebolo (2000)



On the interpretation of the optical spectra of L-type dwarfs

Pavlenko, Zapatero Osorio, Rebolo (2020)

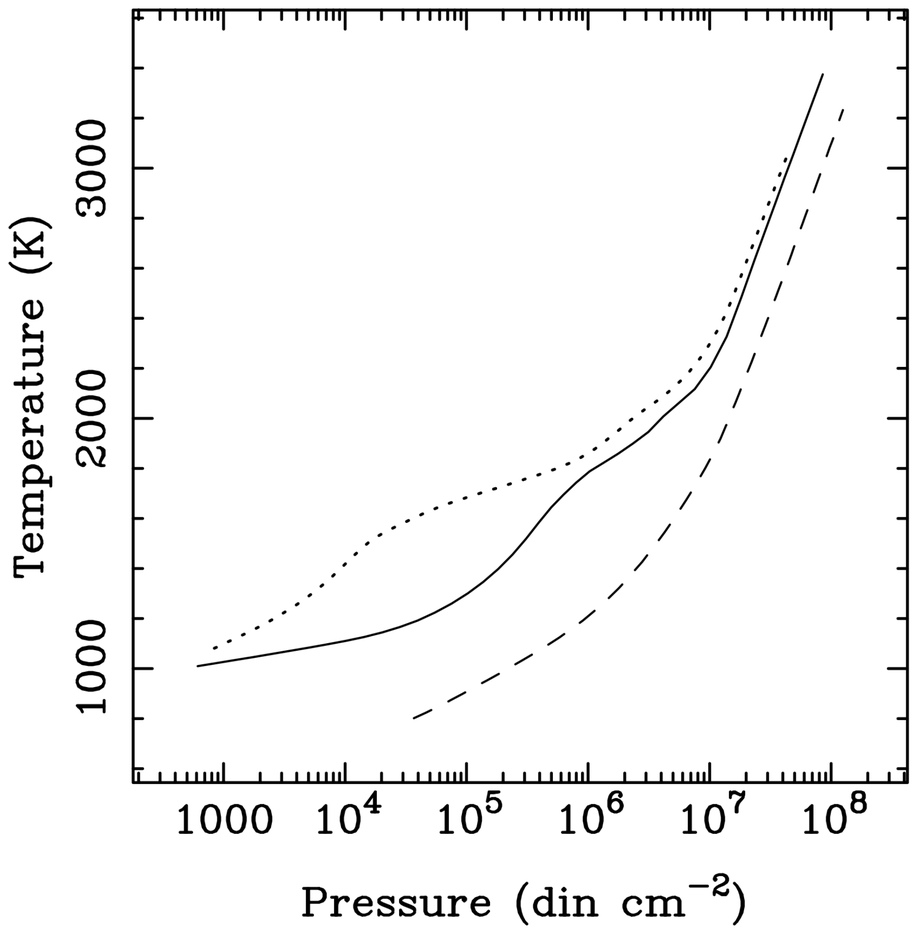


Fig. 2. Temperature structures for the model atmospheres of $T_{\rm eff} = 1400$ K and $\log g = 5.0$ given by Tsuji (2000, C-type, dashed line; B-type, dotted line) and by Allard (1999, full line).

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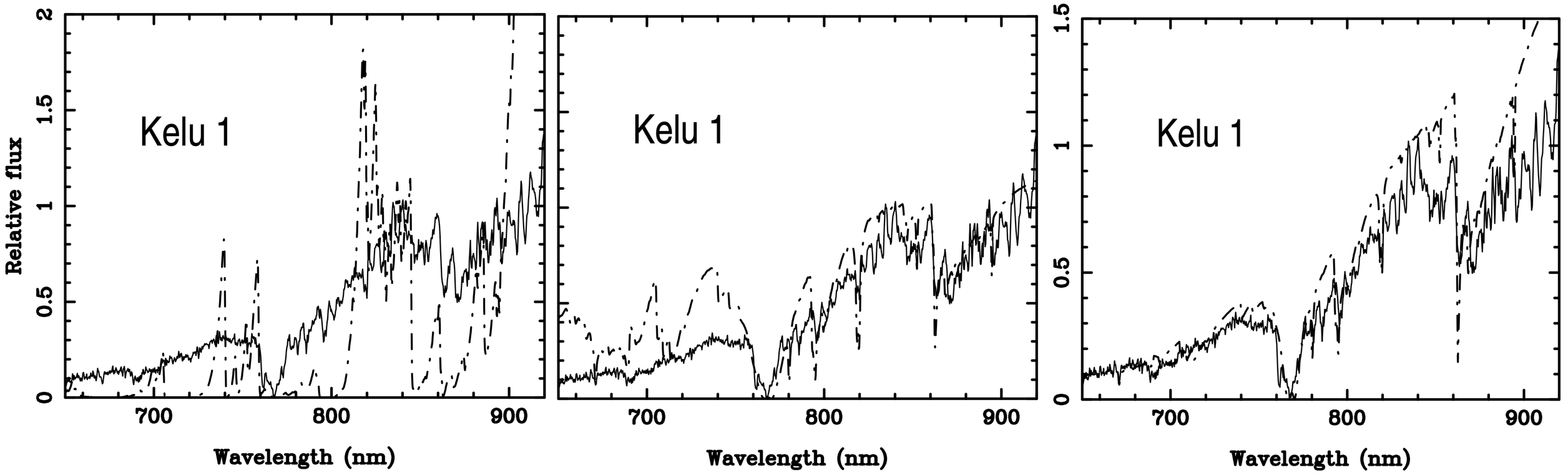

- T_{eff} = 2000 K, log g = 5.0 (cgs).
- Natural depletion of TiO and VO due to chemical equilibrium.

- Extra depletion of TiO, VO, CaH, CrH.

- Additional dust opacity, a_o = 0.03

$$a_\circ \left(\nu/\nu_\circ\right)^N, \text{with } N = 4.$$

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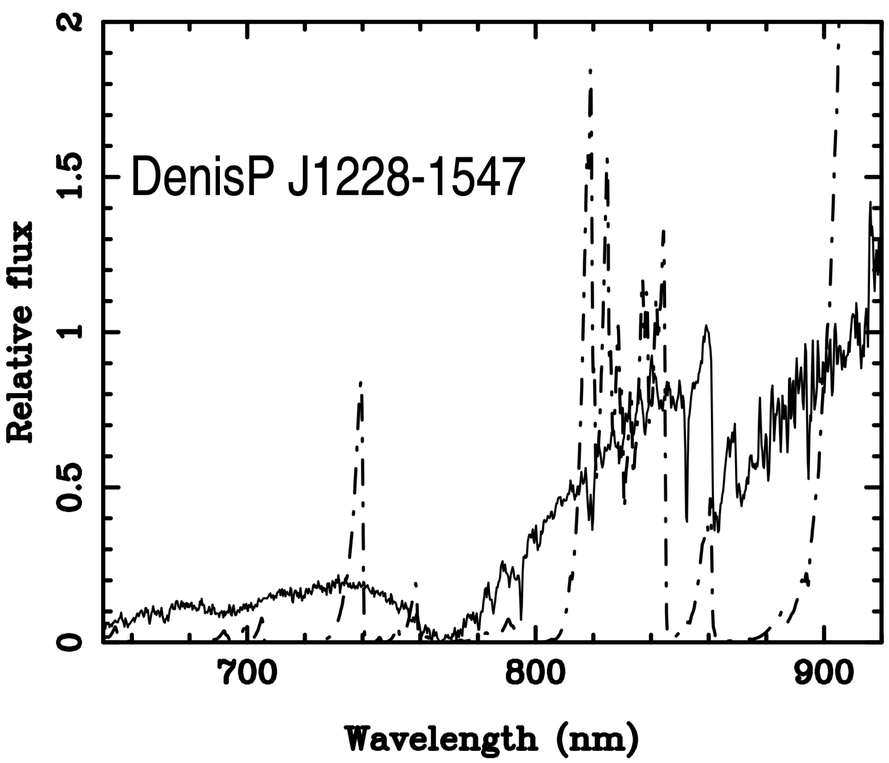

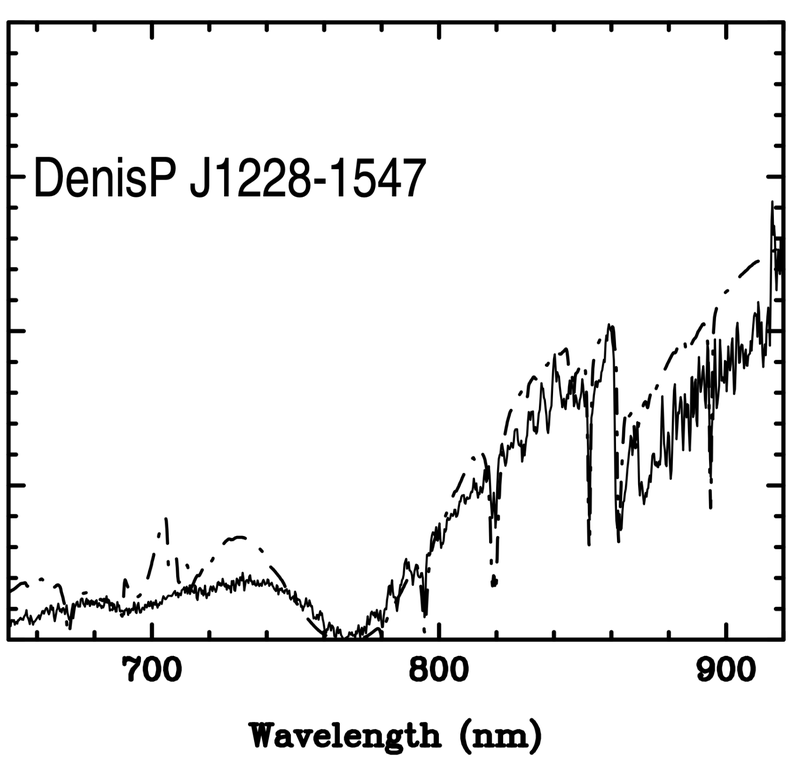

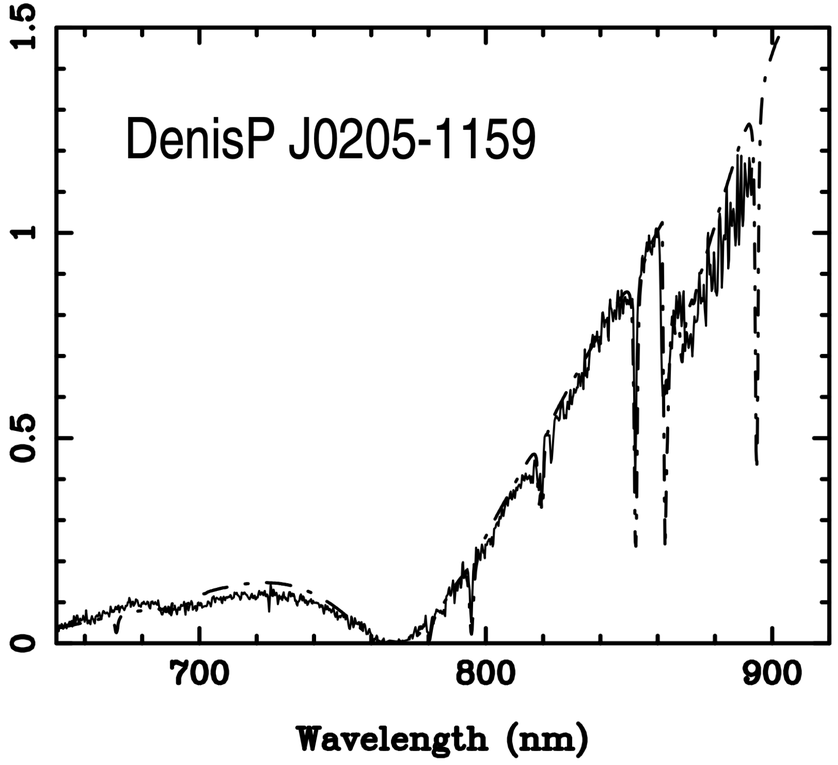

- T_{eff} = 1600 K, log g = 5.0 (cgs).
- Natural depletion of TiO and VO due to chemical equilibrium.

- Extra depletion of TiO, VO, CaH, CrH.

- Additional dust opacity, a_o = 0.006

$$a_\circ \left(\nu/\nu_\circ\right)^N, \text{with } N = 4$$

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Table 4. $T_{\rm eff}$ estimations for our sample adopting Tsuji's (2000) C-type models and $\log g = 5.0$.

T_{eff} scale

Object	Sp. Type	$I-J$	$T_{\rm eff}$ ($\pm$200 K)	Other measures	Source
BRI 0021–0214	M9.5	3.30	2200	1980, 2300	TMR93, LAH98
Kelu 1	L2 (L2)	3.50	2000	2000, 1900	B99, RLA97
DenisP J1228–1547	L4.5 (L5)	3.81	1600	1800	B99
DenisP J0205–1159	L5 (L7)	3.82	1200	1700, 1800	B99, TK99

NOTES. Spectral types are given in Martín et al. (1999). Those spectral types in brackets come from Kirkpatrick et al. (1999a).
$(I-J)$ colors have been taken from Leggett et al. (1998).
References: TMR93 = Tinney et al. (1993); LAH98 = Leggett et al. (1998); B99 = Basri et al. (1999); RLA97 = Ruiz et al. (1997); TK99 = Tokunaga & Kobayashi (1999).

- Kirkpatrick et al. (2021)

SpT	T_{eff} (K)
L2	1960
L5	1610
L7	1400

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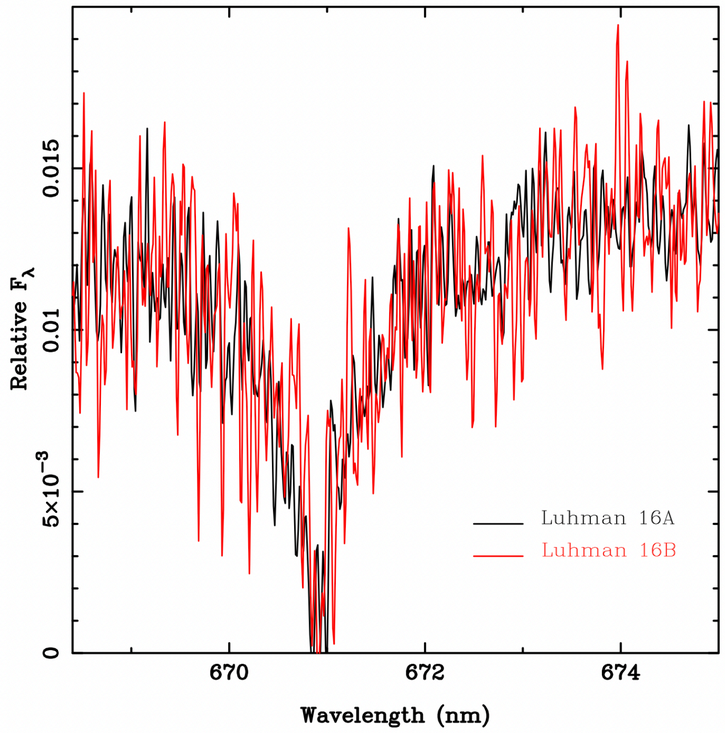
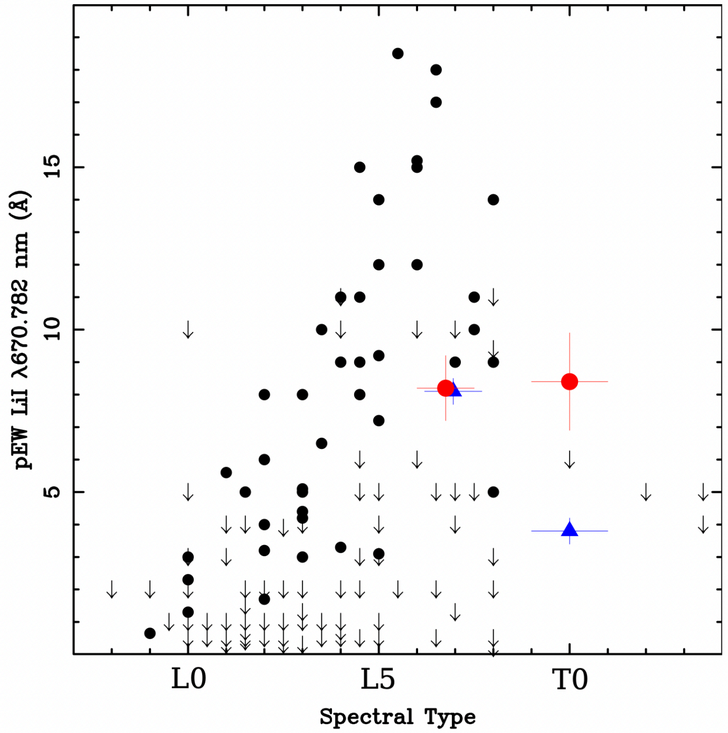
LITHIUM predictions

Table 5. Equivalent widths (Å) of the Li I resonance doublet at 670.8 nm computed for the C-type Tsuji's (2000) model atmospheres, cosmic Li abundance (log N(Li) = 3.2) and gravity log g = 5.0.

	$T_{\rm eff}$		$a_{\rm o}$		
			0.00	0.01	0.10
	(K)		EW (Å)		
T-dwarfs	1000	T5.5	17	8	0.6
	1200	T2	30	12	0.7
L-dwarfs	1400	L7	42	21	0.9
	1600	L5	40	24	1.6
	2000		23	16	3.6

- Atomic lithium would be detectable in early-to-mid T dwarfs.





From Lodieu et al. (2015), including Ya. Pavlenko

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DYNAMICAL MASSES OF THE BINARY BROWN DWARF GJ 569 Bab

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ABSTRACT

We have obtained new images and high-resolution ($R \sim 22{,}400$) near-infrared (1.2400–1.2575 μm) spectra of each component of the brown dwarf binary GJ 569 Bab using the adaptive optics facility of the Keck II telescope and the NIRSPEC spectrometer. These data have allowed us to improve the determination of the astrometric orbit and to measure radial velocities of the components. We have used the astrometric and spectroscopic measurements to derive the dynamical mass of each brown dwarf and the systemic velocity of the pair by means of a χ^2 fitting technique. From various considerations, the mass of each component is likely in the range 0.034–0.070 $M_\odot$ (GJ 569 Bb) and 0.055–0.087 $M_\odot$ (GJ 569 Ba). This implies that the mass ratio q of the binary is greater than 0.4, the most likely value being $q = 0.75$–0.85. Adopting 0.072 $M_\odot$ as the most conservative location of the substellar limit for solar metallicity, our analysis confirms GJ 569 Bb as the *first genuine brown dwarf known without any theoretical assumptions*. We have compared the dynamical masses of GJ 569 Ba and Bb, and their effective temperatures and luminosities, to the predictions of state-of-the-art theoretical evolutionary isochrones, finding that models exhibit good performance in the regime of high substellar masses if the binary is about a few hundred million years old. However, the surface gravities of GJ 569 Ba (M8.5 V) and Bb (M9 V) derived from our spectral analysis (the observed data have been compared to the latest synthetic spectra) appear to be smaller than the values provided by the evolutionary models.

Subject headings: binaries: visual — stars: fundamental parameters — stars: individual (GJ 569B) — stars: low-mass, brown dwarfs

Dynamical masses of a binary brown dwarf GJ 569 Bab
Zapatero Osorio, Lane, Pavlenko, Martín, et al. (2004)

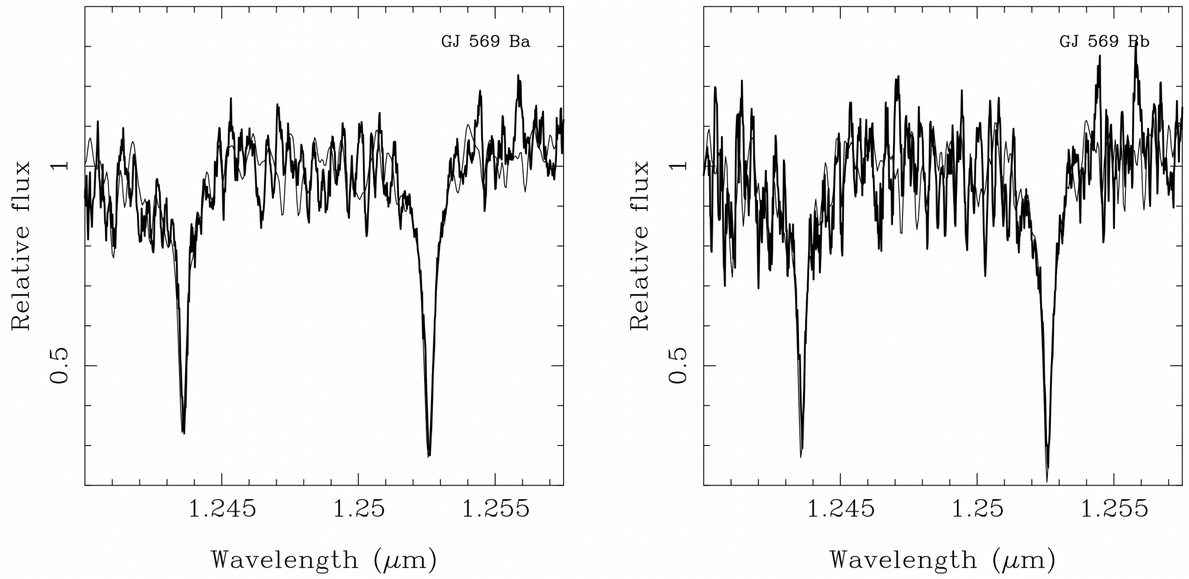

FIG. 7.—Spectral data of GJ 569 Ba and Bb (*thick lines*) and the best-fit DUSTY theoretical spectrum (2400 K, $\log g = 4.5$; *thin lines*). Note that while the alkali lines are nicely reproduced by the theoretical data, the molecular absorptions are not well matched by the computations.

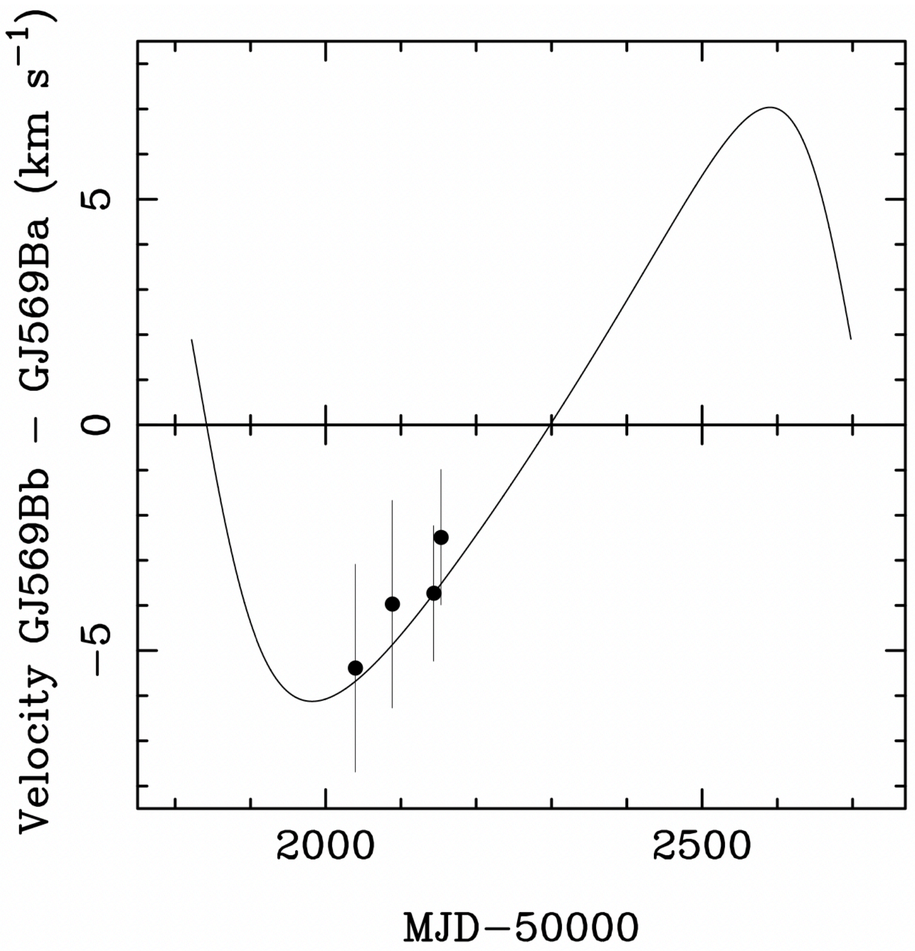

FIG. 8.—Relative velocity of GJ 569 Bb with respect GJ 569 Ba plotted as a function of the epoch of the observations. Overplotted onto the data is the predicted velocity curve for the known orbital parameters and total mass of the pair.

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in memory of Yakiv Pavlenko

May your laughter, kindness, and strength live on forever.