Long-term spectroscopic survey of T Tauri stars in the Taurus-Auriga star-forming region

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Abstract:
Long-term spectroscopic monitoring of 22 T Tauri stars located in the Taurus-Auriga star-forming region (SFR) is presented. The medium and high-dispersion échelle spectroscopy obtained at the Stará Lesná, Skalnaté Pleso and Tautenburg observatory (TLS) was obtained from 2015 till 2018. The broadening function technique was used to determine the radial and projected rotational velocities and to study multiplicity of the objects. The analysis was also focused on the determination of atmospheric parameters such as log g, $T_{\rm eff}$ and metallicity. The nature of the objects was assessed by measuring the equivalent with of the H_α and Li I 6708 lines. Their membership was checked using the *Gaia* DR2 parallaxes and estimated model distances.

TARGET SELECTION

We have found many bona fide T Tauri stars (originally designated as members of Tau-Aur SFR – the nearest known SFR) in literature without much information, or contradicting physical parameters. We have exclude any known Classical T Tauri stars and visual binaries. We have picked stars with V < 11 mag (for the observation limit).

	Evo. tracks & *Gaia*		Calibrations based on *ubvyβ* photometry				Spectroscopic modelling with `iSpec` and BF extraction				
Star	Age	Distance	[Fe/H]	$T_{\rm eff}$ range	log g range	Sp. type	Sp. type	EW H_α	EW Li 6708	BF strength	$v \sin i$
	[Myr]	[pc]	[dex]	[K]	(cgs)			[mÅ]	[mÅ]	[km.s^{-1}]	[km.s^{-1}]
HD 285281	1-8	135.3(1.2)	-0.111	4260-5375	3.87-4.88	G2-K6	K1		423	0.91	80
BD +19 0656	7-12	108.5(7)	0.01	5020-5322	4.29-4.85	G9-K1	K1	254	376	1.08	31
HD 284135			-0.555	5465-5936	3.69-4.47	G2-G8	G3V	824	193	0.96	74
HD 284149	15-25	118.2(7)	-0.65	5905-6239	3.95-4.37	F8-G2	G1	720	169	0.91	30
HD 281691	8-18	110.3(5)	0.191	4947-5368	4.35-4.87	G9-K2	G8III	145	342	1.04	25
HD 284266	15-30	119.9(1.0)	-0.134	5619-6088	3.99-4.77	F9-G6	K0V	408	239	0.91	34
HD 284503	10-20	111.6(7)	-0.232	5161-5692	3.75-4.54	G6-K0	G8	125	274	0.90	44
HD 284496	12-20	125.8(6)	-0.23	5337-5526	3.76-5.09	G7-G9	K0	297	288	0.87	28
HD 285840	20-70	90.5(3)		5596-5684	4.45	G6-G7	K1		214	1.13	25
HD 285957	3-13	139.2(1.1)	0.059	4688-5202	4.54-5.04	K0-K3	K1	155	411	1.09	28
HD 283798	17-21	110.8(6)	0.595	5630-5887	4.33-5.05	G3-G6	G7	380	243	0.89	29
HD 283782	< 3	168.0(6.5)	0.082	4277-5596	4.43-5.01	G7-K6	K1	-3937	237	0.83	77
HD 30171	2-4	184.9(3.8)	-0.353	5133-5648	3.53-4.54	G6-K1	G5	706	273	0.90	112
HD 31281	8-12	122.4(6)	-0.558	5131-5840	3.49-4.45	G3-K1	G1	970	167	0.98	83
HD 286179	10-35	123.7(1.0)	-0.153	5495-6100	4.19-5.07	F9-G8	G3	1316		0.99	22
HD 286178		74.3(3.4)		4403-4576	4.64	K4-K5	K1	211	166	1.07	46
HD 283447	2-4	128.1(2.3)		3994-4104	4.71	K7-K8	K3V	-1397	500	1.09	47
HD 283572	2-5	130.3(9)		5277-5402	4.51	G8-K0	G5	899	274	0.86	82
HD 285778	8-15	120.1(8)	-0.352	5051-5558	3.54-4.56	G7-K1	K1	510	269	0.98	21
HD 283518	< 2	130.4(9)		3770	4.78	M0	K3V		517	1.22	74

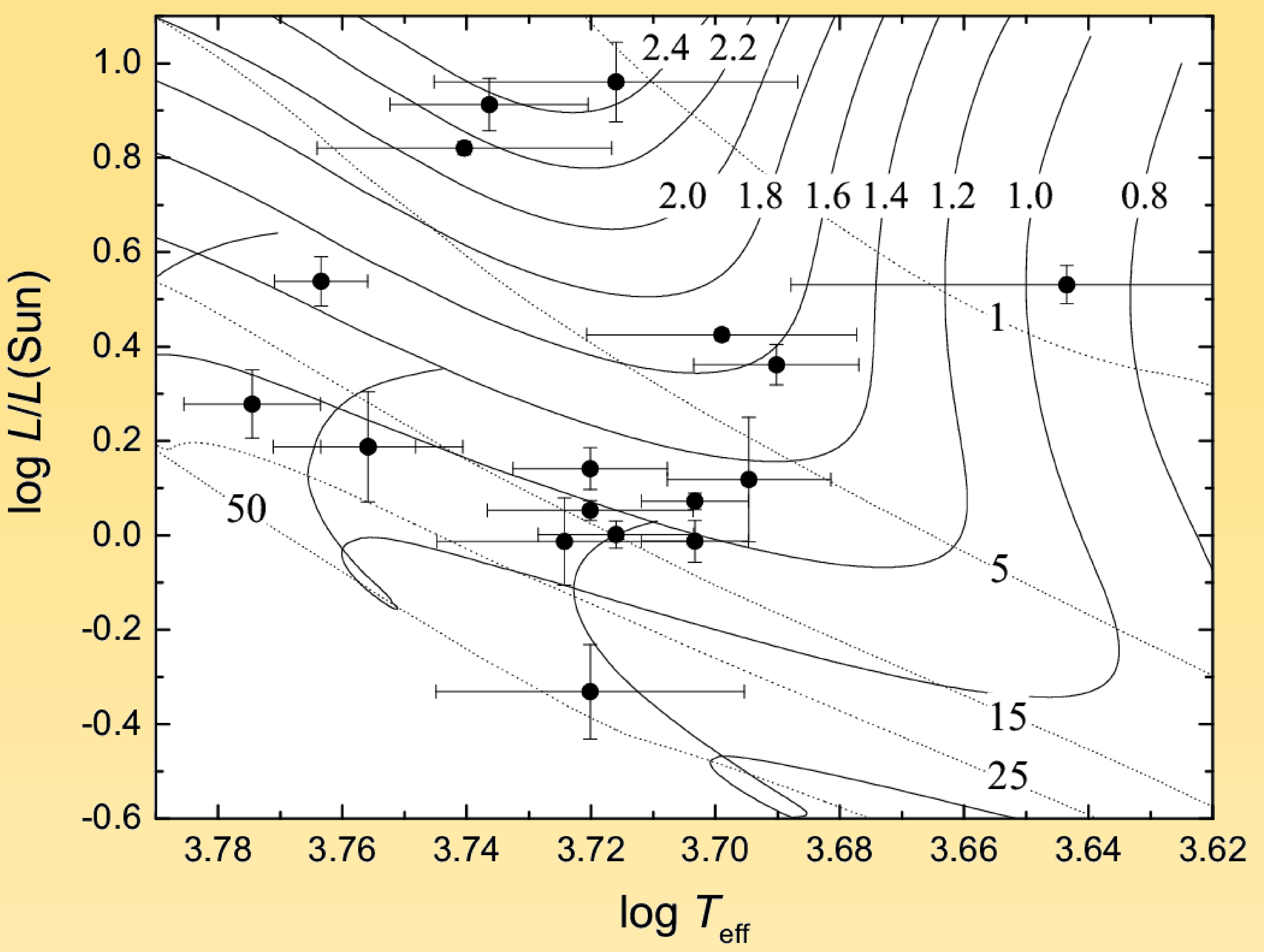
OBSERVATION AND DATA REDUCTION

Medium and high-dispersion spectroscopy of stars was obtained with three spectrographs:

1) At Stará Lesná observatory with a 60cm, f/12.5 Zeiss Cassegrain telescope equipped with a fiber-fed échelle spectrograph eShel (see Thizy & Cochard 2011, Pribulla et al. 2015). 4150-7600 Å spectral range, $R = 11{,}000$. ThAr calibration unit provides about 100 m.s^{-1} radial-velocity accuracy.
2) At Skalnaté Pleso with 1.3m, f/8.36, Nasmyth-Cassegrain telescope equipped with a fiber-fed echelle spectrograph similar to the MUSICOS design (see Baudrand & Bohm 1992). The spectral range of the instrument is 4250-7375 Å, $R = 38{,}000$.
3) At TLS Tautenburg with the Alfred Jensch 2m telescope and f/46 Coudé échelle spectrograph. These spectra cover 4510-7610 Å with $R = 31{,}500$.

Altogether **168** spectra have been obtained.

The raw data obtained with 60cm and 1.3m telescopes were reduced using **IRAF** package tasks, Linux shell scripts and **FORTRAN** programs as described in Pribulla et al. (2015). Data were reduced with standard dark and flat-field frames. Bad pixels were cleaned using a bad pixel mask, cosmic hits were removed using the program of Pych (2004). Order positions were defined by fitting Chebyshev polynomials to tungsten-lamp and blue LED spectrum. In the following step, scattered light was modeled and subtracted. Aperture spectra were then extracted for both object and ThAr lamp and then the resulting 2D spectra were dispersion solved. The spectra obtained at TLS were reduced under the **IRAF** environment (see Hatzes et al. 2005; Guenther et al. 2009; Hartmann et al. 2010).



EVOLUTION STAGE

We have used the $T_{\rm eff}$ values from available literature, derived luminosities from available *Gaia* DR2 parallax (Lindegren et al. 2018) or TGAS catalogue (Michalik et al. 2015). We have used the reddening estimate from the literature (Meištas & Straišys 1981; Chavarría-K et al. 2000; Grankin 2013; Herczeg & Hillenbrand 2014) and the dereddening method based on the Strömgren-Crawford *ubvyβ* photometric system (Crawford 1975; Schuster & Nissen 1989). The *ubvyβ* photometry data was taken from Paunzen (2015). Then we used the PMS evolutionary tracks for solar metallicity [X=0.609, Y=0.2533, Z=0.1377] based on the Pisa Stellar Models (Tognelli et al. 2011) to deduce the age of targets. We have found that ***all stars in our sample*** should be ***younger than 70 Myr.*** This is close or inclusive to the 10–100 Myr interval for the post T Tauri stars defined by Jensen (2001). The errors, mainly due to the effective temperature, allow estimating the masses of stars within ± 0.2 $M_\odot$. Stellar atmospheric parameters were calculated using the **iSpec** software (Blanco-Cuaresma et al. 2013). Radial velocities were extracted using the broadening function technique by Rucinski (1992).

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