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Newly discovered candidate weak-line T Tauri stars in the surrounding area of the Taurus-Auriga region*,**

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Abstract. We present results of an extensive search for weak-line T Tauri stars (WTTS) in the outskirts of the Taurus-Auriga molecular cloud on the basis of the ROSAT All-Sky Survey Bright Source Catalog. Our surveyed region extends from $2^{\rm h}40^{\rm m}$ to $5^{\rm h}40^{\rm m}$ in right ascension and from 10° to 40° in declination, with the central part of Taurus-Auriga ($4^{\rm h} < \alpha < 5^{\rm h}$, $15° < \delta < 34°$), accomplished by Wichmann et al. (1996), excluded. Within a sky coverage of about 10^3 square degrees, 219 X-ray sources fulfil the criteria for selecting program sources suggested by Neuhäuser et al. (1995a), and 164 of these X-ray sources were found to have at least one optical counterpart with E magnitude brighter than 16. Low-resolution spectroscopic observation has been carried out in order to discard early type stars and galaxies from the sample, additional intermediate-resolution spectra of a sub-sample of 156 late type optical counterparts were obtained for spectral classification and for the calculation of the equivalent width of H_α emission and LiI line absorption at 6707 Å. Excluding 2 previously identified WTTS, a total of 75 new candidate WTTS and one possible classical T Tauri star have been discovered in our study. The majority of the newly found Li-rich optical counterparts are believed to be PMS stars rather than ZAMS stars as those of the Pleiades.

Key words: stars: formation — stars: pre-main sequence — X-ray: stars — surveys

1. Introduction

T Tauri stars (TTS) can be defined as low-mass (up to 3 $M_\odot$), late spectral type (later than mid-F) and variable pre-main sequence stars with relatively young age (from 10^5 yrs to a few 10^7 yrs). Weak-line T Tauri stars (WTTS), unlike classical T Tauri stars (CTTS) which are characterized by strong optical emission lines, ultraviolet and infrared excesses, are believed to be relatively devoid of circumstellar matter. Taurus-Auriga is one of the best studied ongoing low-mass Star Forming Regions (SFR) with a distance of ~140 pc. About 150 TTS were known prior to the ROSAT mission in the surrounding area of the T association, most of which are listed in the Herbig-Bell catalog (Herbig & Bell 1988), and nearly all CTTS have been previously discovered by their conspicuous optical characteristics. Since WTTS are intrinsically more X-ray luminous than CTTS (Neuhäuser et al. 1995a) and thus are much easier detected by the spatially unbiased ROSAT All Sky Survey (RASS), the advent of the RASS offers for the first time the opportunity to extend the search for X-ray active WTTS in nearby SFRs, with a flux limit comparable with typical EO pointed observations. So far, ~70 previously unknown WTTS candidates have been uncovered in the central part of the Taurus-Auriga SFR (Wichmann et al. 1996). Furthermore, 15 WTTS candidates (Neuhäuser et al. 1995c) and later 30 more WTTS candidates (Magazzú et al. 1997) have been identified to the south of the Taurus molecular clouds on the basis of RASS data and follow-up optical observations. A few TTS candidates have also been discovered sporadically in deep ROSAT pointed observations in Taurus-Auriga (Strom & Strom 1994; Carkner et al. 1996; Wichmann et al. 1996).

The release of the RASS Bright Source Catalog (RASS-BSC) (Voges et al. 1996) has enabled us to study the surroundings of Taurus-Auriga to reveal more WTTS. A complete sample of X-ray sources selected from RASS-BSC were identified using ground-based optical follow-up observations. Low-resolution spectroscopic observations

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* Tables 2-5 are also available in electronic form at the CDS via anonymous ftp 130.79.128.5 or via http://cdsweb.u-strasbg.fr/Abstract.html

** Figures 1 and 2 are only available in the electronic version of the paper (http://www.edpsciences.com).

have been carried out to discriminate late type optical counterparts from early type stars and galaxies in the error box of the RASS, and to estimate their visual magnitudes at the time of observation. Intermediate-resolution spectroscopy of the late type stars then followed to investigate their proper spectral types and to measure H_α and LiI equivalent widths. The identification of the RASS sources and the discovery of new WTTS candidates in the Taurus-Auriga SFR are concerned in this paper.

2. Observed sample

Our study includes the surrounding area of the Taurus-Auriga SFR, which extends from 2^h40^m to 5^h40^m in right ascension and from 10° to 40° in declination, with the central core area($4^h < \alpha < 5^h$, $15° < \delta < 34°$, previously studied by Wichmann et al. 1996) excluded. Within our sample area of about 10^3 square degrees, 219 X-ray sources were selected based on the RASS-BSC and the selection criteria developed by Neuhäuser et al. (1995a), $-0.15 \leq$ HR1 ≤ 1 and $-0.3 \leq$ HR2 ≤ 0.5 where the HRs represent hardness ratios computed with count rates of five different energy bands of the ROSAT detection. The X-ray sources thus selected all, except one, have optical counterparts in the Digital Sky Survey(DSS) within the RASS error box of 20″; their E magnitudes have been estimated from the DSS with a routine developed by Cao et al. (1997) with an accuracy of 0.5 mag, and a sample of 164 X-ray sources with at least one counterpart brighter than $E = 16$ was obtained. Two X-ray sources, IRXS J033310.7+103613 and 1RXS J053434.7+100710, though previously identified to be WTTS candidates by Neuhäuser et al. (1995c) and Alcalá et al. (1996) respectively, have been included in our study. Low-resolution spectroscopy of a list of 175 optical counterparts to 164 ROSAT sources was performed, the V magnitude of each object was estimated at 5570 Å (accurate to 0.2 V) and the spectral type was determined visually. As a result, 19 early type stars and galaxies were omitted and a subsample of 156 optical counterparts, associated with 147 X-ray sources that have spectral type later than mid-F and $V_{5570} \leq 16$ (with one exception of $V_{5570} = 16.3$) have been followed up with intermediate-resolution spectroscopic observations.

3. Observation and data analysis

Spectroscopic observations were undertaken on the 2.16 m optical telescope at the Xing-Long station of the Beijing Astronomical Observatory (BAO). The OMR (Optomechanics Research Inc.) spectrograph and the detector TEK1024 CCD were used in both runs of observations. The low-resolution spectroscopy (with dispersion of 400 Å/mm, 9.6- Å per pixel) centered at 6500 Å has been carried out on 4 observing nights from 1996 Nov. 28 to Dec. 1 under good sky conditions, whereas the intermediate-resolution spectroscopic observation (with dispersion of 50 Å/mm, 1.2- Å per pixel) centered at 6300 Å has been performed on 1996 Dec. 22, 23, 27 and 28, with usually two spectrophotometric standard stars observed each night for flux calibration. Furthermore, a grid of spectral standards was acquired during the second run by observing stars of spectral types F5 to M0 and of luminosity classes IV and V, which were selected from the Bright Star Catalog (1991).

All the observational spectral data were reduced with standard procedures in the NOAO Interactive Reduction and Analysis Facility (IRAF, version 2.10.4) software packages, and a relative flux calibration of each spectrum was performed using a mean response function. The low-resolution spectra were used to classify spectral types and to derive V_{5570}. The intermediate-resolution spectra were normalized for further study. A custom routine programmed with the command language (CL) of IRAF, namely ASCLTS (Automatic Spectral Classification of Late Type Stars, Li & Hu 1997) was applied to determine the spectral types of the late type stars, the accuracy of which is expected to be ± one sub-class in most cases. Cross-correlation of each intermediate-resolution spectrum with the grid of spectral standards was carried out with ASCLTS to obtain the best fit spectral type. Then, the residual spectrum derived from the target spectrum and the standard spectrum of the same spectral type was used to calculate the equivalent width of H_α and LiI absorption with corresponding tasks and commands in IRAF.

4. Results and discussion

19 objects (including 17 early type stars and 2 Seyfert galaxies) were identified on the basis of the low-resolution spectroscopy and are presented in Table 1.

All spectra of the sub-sample of late type stars were examined and the following criteria were applied to confirm the optical counterparts' candidate nature as WTTS:

- apparent LiI absorption with equivalent width $W_\lambda \geq$ 0.1 Å, treated as an indicator of youth,
- with spectral type later than mid-F,
- equivalent width of H_α less than 10 Å.

H_α emission, an indicator of deep chromosphere or large surface coverage of plage, seems to be not so important in the identification of WTTS, because it might show up as significant emission, filled-in or even absorption due to different spectral types of stars. 75 optical counterparts to the X-ray sources could be identified as new candidate WTTS, two others, previously discovered by Neuhäuser et al. (1995c) and Alcala et al. (1996) respectively, were confirmed to be Li-rich stars in our program, and their

Table 1. Optical counterparts to X-ray sources excluded from the sample. Objects with sequential number of the sample, RASS source designation, position, type of stars or galaxies, and catalog identifier

No.	RASS designation	$\alpha(2000)$	$\delta(2000)$	Type	Catalog iden.
085	1RXS J034308.0+185836	3 43 08.0	18 58 36.5	Seyfert	
100	1RXS J034724.3+243513	3 47 24.3	24 35 13.0	A4	HD 23628
101	1RXS J034839.3+215538	3 48 39.3	21 55 38.0	A3	
105	1RXS J034958.2+235109	3 49 58.2	23 51 9.0	A1	
121	1RXS J035857.8+354737	3 58 57.8	35 47 37.5	O7	HR 1228
144	1RXS J044003.6+121149	4 40 03.6	12 11 49.5	B7IV	HR 1484
152	1RXS J050702.2+170726	5 07 02.2	17 07 26.0	B6	
153	1RXS J045915.4+375330	4 59 15.4	37 53 30.0	A0V	HR 1592
162	1RXS J050258.5+225949	5 02 58.5	22 59 49.5	Seyfert	IRAS 04599+2255
163	1RXS J050547.7+355018	5 05 47.7	35 50 18.0	B4	
164	1RXS J050559.4+280717	5 05 59.4	28 07 17.5	B4	
166	1RXS J050702.8+332444	5 07 02.8	33 24 44.5	B8	
166s				B4	
180	1RXS J051602.1+255728	5 16 02.1	25 57 28.5	A0	HD 34096
185	1RXS J052250.8+191423	5 22 50.8	19 14 23.0	A3	
198	1RXS J052916.9+250853	5 29 16.9	25 08 53.0	B8	
210	1RXS J053527.4+240226	5 35 27.4	24 02 26.5	B3V	HR 1875
215	1RXS J053732.3+370513	5 37 32.3	37 05 13.5	B0	
216	1RXS J053842.2+322811	5 38 42.2	32 28 11.0	B0	

* nnns means the second object of a pair corresponding to source No.nnn, which is defined according to its comparably larger distance to the X-ray source position in most cases, and so forth.

Table 2. Optical data of the newly discovered candidate WTTS

No.	RASS designation	$\alpha(2000)$	$\delta(2000)$	$V_{\rm mag}$	H_α	LiI	S.T.	Catalog iden.	comments
001	1RXS J024029.7+200602	2 40 29.7	20 06 02.5	12.3V	−0.21	−0.19	G8V		
017	1RXS J025216.9+361658	2 52 16.9	36 16 58.0	9.9V	3.18	−0.22	K2IV		
018	1RXS J025223.5+372914	2 52 23.5	37 29 14.5	10.0V	0.50	−0.22	G5IV		
028	1RXS J025751.8+115759	2 57 51.8	11 57 59.5	10.4V	1.18	−0.32	G7V	BD+11 414	
029	1RXS J025828.0+294805	2 58 28.0	29 48 05.5	10.9V	1.23	−0.18	K0IV		
037	1RXS J030356.9+373904	3 03 56.9	37 39 04.5	11.7V	1.01	−0.24	K0IV		
040	1RXS J030443.2+143740	3 04 43.2	14 37 40.5	10.8V	0.81	−0.27	G5IV		
042	1RXS J030759.1+302032	3 07 59.1	30 20 32.0	9.2V	0.48	−0.18	G5IV	BD+29 525	
044	1RXS J031113.0+222518	3 11 13.0	22 25 18.5	8.5V	0.34	−0.15	G0V	SAO 75775	
047	1RXS J031347.9+290729	3 13 47.9	29 07 29.5	13.4V	3.00	−0.14	K4V		
049	1RXS J031537.5+372424	3 15 37.5	37 24 24.5	13.1V	7.17	−0.14	K4V		
053	1RXS J031644.0+192259	3 16 44.0	19 22 59.5	11.1V	0.76	−0.23	G2IV		
056	1RXS J031907.4+393418	3 19 07.4	39 34 18.0	11.6V	0.68	−0.30	K0V		
061	1RXS J032355.5+233947	3 23 55.5	23 39 47.0	13.1V	4.13	−0.29	K4V		
062	1RXS J032406.6+234714	3 24 06.6	23 47 14.5	10.4V	1.31	−0.19	K4V	L 1307 -15	
063	1RXS J032409.7+123745	3 24 09.7	12 37 45.5	6.0V	−0.17	−0.33	K2IV	HR 1028	
065	1RXS J032547.5+365147	3 25 47.5	36 51 47.5	13.1V	0.94	−0.27	K0IV		
067	1RXS J032733.2+255405	3 27 33.2	25 54 05.0	9.2V	0.22	−0.11	G5IV		
073	1RXS J033530.2+311336	3 35 30.2	31 13 36.0	9.2V	0.40	−0.19	G5IV	HD 22179	
080	1RXS J034106.7+283644	3 41 06.7	28 36 44.0	15.0V	7.40	−0.26	>M0V		
084	1RXS J034241.8+233017	3 42 41.8	23 30 17.0	12.4V	2.20	−0.16	G7IV	Melotte 22 HCG 85	
087	1RXS J034327.4+252330	3 43 27.4	25 23 30.0	11.6V	1.73	−0.32	G2IV	Melotte 22 PELS 56	

Table 2. continued

No.	RASS designation	α(2000)	δ(2000)	$V_{\rm mag}$	H_α	LiI	S.T.	Catalog iden.	comments
088	1RXS J034403.8+243013	3 44 03.8	24 30 13.5	10.9V	0.73	−0.24	G0V	CL Melotte 22 253	
089	1RXS J034412.1+240200	3 44 12.1	24 01 60.0	12.4V	1.83	−0.36	K0V	BD+23 501B	southeast
089s				11.6V	0.31	−0.12	G7IV	BD+23 501A	northwest
090	1RXS J034414.1+240623	3 44 14.1	24 06 23.0	10.7V	0.41	−0.23	G5IV	BD+23 502	
091	1RXS J034420.7+244719	3 44 20.7	24 47 19.0	10.9V	0.42	−0.22	G0V		
092	1RXS J034423.3+281224	3 44 23.3	28 12 24.5	9.1V	0.28	−0.27	G7V	SAO 76116	
093	1RXS J034426.3+243524	3 44 26.3	24 35 24.5	11.7V	1.44	−0.21	G7IV	CL Melotte 22 345	
097	1RXS J034542.4+245421	3 45 42.4	24 54 21.5	9.7V	0.46	−0.22	G5IV		
099	1RXS J034629.2+242605	3 46 29.2	24 26 05.0	11.4V	0.71	−0.19	K0V	CL Melotte 22 1032	
102	1RXS J034850.1+235844	3 48 50.1	23 58 44.5	12.8V	1.83	−0.24	G7IV	UBV M 41137	
103	1RXS J034905.9+234653	3 49 05.9	23 46 53.5	11.0V	2.05	−0.24	G7IV	CL Melotte 22 2147	
107	1RXS J035024.5+130424	3 50 24.5	13 04 24.5	11.0V	0.75	−0.19	G7IV		
108	1RXS J035028.0+163121	3 50 28.0	16 31 21.0	10.8V	0.66	−0.14	G5IV		
110	1RXS J035055.0+235016	3 50 55.0	23 50 16.0	11.7V	1.41	−0.22	G7IV	CL Melotte 22 2881	
117	1RXS J035330.5+263152	3 53 30.5	26 31 52.5	12.1V	2.95	−0.31	G7IV	Melotte 22 PELS 75	
119	1RXS J035423.8+242146	3 54 23.8	24 21 46.5	11.4V	0.94	−0.30	G5IV		
131	1RXS J041004.9+363901	4 10 04.9	36 39 01.0	9.0V	1.00	−0.14	G0V	HD 26182	
136	1RXS J042638.5+384458	4 26 38.5	38 44 58.0	10.5V	1.00	−0.31	G5V		
137	1RXS J043119.5+375143	4 31 19.5	37 51 43.5	10.9V	0.72	−0.27	G7V	HD 279935	
143	1RXS J043931.0+340737	4 39 31.0	34 07 37.0	9.4V	0.96	−0.24	G8V	HD 282346	
145	1RXS J044101.8+392904	4 41 01.8	39 29 04.0	10.5V	2.09	−0.18	K0V		
149	1RXS J044758.7+363936	4 47 58.7	36 39 36.0	11.7V	2.15	−0.26	G2V		
150	1RXS J044852.7+103028	4 48 52.7	10 30 28.5	13.3V	3.94	−0.24	K5V		
155	1RXS J050024.8+150519	5 00 24.8	15 05 19.5	9.8V	0.60	−0.16	F5V	HD 31950	
157	1RXS J050029.8+172400	5 00 29.8	17 24 00.5	12.4V	2.31	−0.23	G5IV		
158	1RXS J050049.1+152658	5 00 49.1	15 26 58.5	11.0V	1.80	−0.42	K2IV	HD 286264	
165	1RXS J050702.2+170726	5 07 02.2	17 07 26.0	11.4V	0.62	−0.24	G7IV		
168	1RXS J050808.7+242714	5 08 08.7	24 27 14.5	13.7V	6.69	−0.41	K5V		
172	1RXS J050926.3+185405	5 09 26.3	18 54 05.5	12.3V	1.28	−0.16	K0IV		
173	1RXS J051023.1+312648	5 10 23.1	31 26 48.5	7.9V	2.02	−0.29	K2IV		
175	1RXS J051111.1+281353	5 11 11.1	28 13 53.5	6.8V	1.95	−0.36	K0V		
184	1RXS J052146.7+240036	5 21 46.7	24 00 36.5	10.9V	2.14	−0.39	G7IV		
185	1RXS J052250.8+191423	5 22 50.8	19 14 23.0	14.5V	6.82	−0.13	M0V		
188	1RXS J052355.2+253052	5 23 55.2	25 30 52.0	11.3V	1.76	−0.43	G4V		
190	1RXS J052425.5+192204	5 24 25.5	19 22 04.0	14.9V	15.25	−0.27	>M0V		
192	1RXS J052638.7+223151	5 26 38.7	22 31 51.0	12.4V	2.32	−0.33	K2IV		north
192s				12.0V	1.88	−0.30	K0IV		south
194	1RXS J052706.4+213525	5 27 06.4	21 35 25.5	11.3V	2.80	−0.19	G7IV		
196	1RXS J052856.6+170307	5 28 56.6	17 03 07.0	14.3V	9.50	−0.27	M0V		south
196s				?	−0.68	−0.30	G7IV		north
199	1RXS J052924.2+144836	5 29 24.2	14 48 36.5	9.9V	2.28	−0.12	K0IV	HD 244162	north
199s				9.9V	−0.23	−0.18	G2IV		south
200	1RXS J052940.9+291058	5 29 40.9	29 10 58.0	6.2V	−0.84	−0.14	F7V	HR 1822	
201	1RXS J052943.1+233412	5 29 43.1	23 34 12.5	13.3V	7.38	−0.46	K4V		
202	1RXS J053055.8+101506	5 30 55.8	10 15 06.0	7.2V	1.46	−0.42	G7V		
204	1RXS J053103.9+231232	5 31 03.9	23 12 32.5	9.3V	1.78	−0.35	G2IV	HD 244354	
211	1RXS J053636.6+213927	5 36 36.6	21 39 27.0	12.9V	7.17	−0.48	K4V		
212	1RXS J053650.0+133756	5 36 50.0	13 37 56.5	10.9V	1.63	−0.36	K0V		
213	1RXS J053652.7+232600	5 36 52.7	23 25 60.0	8.8V	1.24	−0.30	G5V	HD 245358	
214	1RXS J053718.4+133453	5 37 18.4	13 34 53.0	9.9V	0.80	−0.25	G0V	HD 245567	
217	1RXS J053902.6+100244	5 39 02.6	10 02 44.5	12.9V	1.55	−0.42	G8V		northwest
217s				13.2V	2.56	−0.46	K0V		southeast
219	1RXS J053931.0+230628	5 39 31.0	23 6 28.0	9.7V	1.30	−0.24	K0IV		

* >M0V in section S.T. represents spectral type later than M0V, and so forth.

Table 3. Optical data of the possible CTTS discovered and the two previously found WTTS candidates

No.	RASS designation	$\alpha(2000)$	$\delta(2000)$	V_{mag}	H_α	LiI	S.T.	Catalog iden.
197	1RXS J052908.4+115207	5 29 08.4	11 52 07.0	10.1V	24.47	−0.45	G2IV	HD 244138
074	1RXS J033609.2+311853	3 36 09.2	31 18 53.0	11.2V	1.07	−0.29	K3	
208	1RXS J053434.7+100710	5 34 34.7	10 07 10.5	10.2V	2.28	−0.30	K0V	HD 245059

Table 4. Optical data of the probable cloud members of Taurus-Auriga

No.	RASS designation	$\alpha(2000)$	$\delta(2000)$	V_{mag}	H_α	LiI	S.T.	Catalog iden.
006	1RXS J024524.3+143518	2 45 24.3	14 35 18.5	9.2V	1.35	−0.08	G4V	
013	1RXS J025020.0+372909	2 50 20.0	37 29 09.0	11.5V	3.60	−0.08	K4V	
014	1RXS J025029.9+115206	2 50 29.9	11 52 06.5	7.8V	0.56	−0.02	G7V	HD 17662
019	1RXS J025233.7+221924	2 52 33.7	22 19 24.5	11.8V	1.80	−0.05	K4V	
035	1RXS J030122.7+112345	3 01 22.7	11 23 45.5	10.6V	1.84	−0.06	K4V	StKM 1- 328
050	1RXS J031545.0+355704	3 15 45.0	35 57 04.0	11.0V	1.33	−0.02	K0V	HD 278455
053s	1RXS J031644.0+192259	3 16 44.0	19 22 59.5	11.1V	−1.15	−0.02	G0V	
054	1RXS J031723.1+261908	3 17 23.1	26 19 08.0	11.1V	0.69	−0.04	K4V	
057	1RXS J031924.8+124740	3 19 24.8	12 47 40.5	10.2V	2.59	−0.05	G2IV	
066	1RXS J032635.1+284302	3 26 35.1	28 43 02.0	6.3V	2.16	−0.06	K0V	GJ 141.1
082	1RXS J034145.2+271855	3 41 45.2	27 18 55.5	11.8V	2.11	−0.08	K2IV	
104	1RXS J034926.6+110837	3 49 26.6	11 08 37.5	7.7V	0.23	−0.05	G0V	HD 23952
125	1RXS J040408.0+393023	4 04 08.0	39 30 23.0	6.5V	0.10	−0.03	G7V	HD 25444
128	1RXS J040753.8+352730	4 07 53.8	35 27 30.5	10.5V	1.46	−0.09	G7IV	
130	1RXS J040849.2+102754	4 08 49.2	10 27 54.0	8.4V	0.50	−0.03	G2IV	HD 26172
133	1RXS J041434.7+104209	4 14 34.7	10 42 09.0	7.0V	−1.15	−0.07	G2V	HD 26784
139	1RXS J043224.8+384804	4 32 24.8	38 48 04.5	8.4V	0.23	−0.02	G0V	
170	1RXS J050903.6+125744	5 09 03.6	12 57 44.5	9.6V	1.52	−0.04	G2IV	SAO 33053
174	1RXS J051110.9+154857	5 11 10.9	15 48 57.0	12.2V	1.49	−0.06	K4V	StKM 1- 549
182s	1RXS J052054.8+240206	5 20 54.8	24 02 06.0	9.7V	0.29	−0.05	F5V	BD+23 902B
187	1RXS J052350.4+145510	5 23 50.4	14 55 10.5	16.3V	1.45	−0.03	G5V	
191	1RXS J052425.7+172301	5 24 25.7	17 23 01.0	5.6V	0.12	−0.04	G0V	HR 1780
193	1RXS J052652.5+283425	5 26 52.5	28 34 25.0	6.0V	2.10	−0.03	K2IV	HD 243628
206	1RXS J053323.5+201951	5 33 23.5	20 19 51.5	10.5V	0.81	−0.05	G5V	

optical data are provided in Table 3. Since ZAMS stars at the age of the Pleiades ($\sim 10^8$ yrs) still show significant Li with W_λ(Li) depending on spectral type (Soderblom et al. 1993), at a given spectral type WTTS should show a higher value of W_λ(Li) than the Pleiades. Most of the newly discovered WTTS candidates were found to have W_λ(Li) significantly higher than the Pleiades stars of the same spectral class (Soderblom et al. 1993), while the remaining ones have comparable W_λ(Li). Furthermore, a limited comparison conducted by Neuhäuser et al. (1997), between the detection of LiI absorption at high resolution ($\sim$0.25 Å) and relatively high resolution (0.7 $\sim$ 1.5 Å), conclude that $\sim$1 Å resolution (the resolution of our study is 1.2 Å/pixel) is sufficient to obtain accurate W_λ(Li) values despite of the possible overestimation due to blending. Therefore, the majority of the WTTS candidates found are probably PMS stars rather than ZAMS stars as those of the Pleiades. ROSAT source name, position, estimated V magnitude, equivalent width of H_α and LiI absorption, spectral type and comments on pairs are given in Table 2, where positive values of equivalent width indicate line emission and negative means absorption. If available, the catalog identifier of a star is also provided. However, no radial velocity of these new candidate WTTS has been measured until now, thus membership to the T association could not be confirmed and subsequent analysis such as the distribution of WTTS all around the Taurus-Auriga region will be reported later (Li & Hu 1998). Notably, the object IRXS J052908.4+115207, observed on 1996 Dec. 27 was discovered to have rather strong H_α emission (with $W_\lambda(H_\alpha)$ of at least 24.5 Å) and significant LiI absorption (W_λ(Li) = 0.45 Å), though the low-resolution spectrum obtained in the first run showed similar H_α but fairly weak H_β emission. Additional intermediate-resolution spectroscopy (with dispersion of 50 Å/mm, 1.2 Å/pixel, centered at 3900 Å) carried out on 1997 Jan. 18 found no CaII H and K emission, which are regarded as characteristics of CTTS. Another low-resolution spectroscopic

Table 5. Optical data of the possible optical counterparts to the RASS sources

No.	RASS designation	α(2000)	δ(2000)	$V_{\rm mag}$	S.T.	Catalog iden.
003	1RXS J024333.1+170831	2 43 33.1	17 08 31.0	9.6V	F7V	
009	1RXS J024751.2+361157	2 47 51.2	36 11 57.0	11.1V	K0IV	
010	1RXS J024843.0+310701	2 48 43.0	31 07 01.5	6.3V	K0V	GJ 113.1
012	1RXS J024955.0+334515	2 49 55.0	33 45 15.5	13.3V	>M0V	
015	1RXS J025153.2+222735	2 51 53.2	22 27 35.0	12.6V	>M0V	
020	1RXS J025351.3+152118	2 53 51.3	15 21 18.0	9.6V	G0V	
025	1RXS J025659.9+101912	2 56 59.9	10 19 12.5	12.0V	>M0V	G 76-43
026	1RXS J025740.5+235755	2 57 40.5	23 57 55.0	9.8V	K0V	BD+23 390
030	1RXS J025939.0+140253	2 59 39.0	14 02 53.0	9.3V	K0V	HD 18580
032	1RXS J025952.4+380149	2 59 52.4	38 01 49.0	10.1V	K0IV	
036	1RXS J030226.6+222225	3 02 26.6	22 22 25.5	8.1V	G0V	HD 18831
039	1RXS J030405.0+300312	3 04 05.0	30 03 12.0	5.9V	K0V	
044s	1RXS J031113.0+222518	3 11 13.0	22 25 18.5	9.8V	G5V	BD+21 418B
051	1RXS J031634.9+321115	3 16 34.9	32 11 15.0	6.2V	K0V	HR 978
060	1RXS J032311.1+330455	3 23 11.1	33 04 55.5	8.0V	G0V	HD 20891
069	1RXS J033041.2+313712	3 30 41.2	31 37 12.5	11.8V	K2IV	VSS IX-17
071	1RXS J033501.2+320104	3 35 01.2	32 01 04.5	6.7V	F7V	HD 22124
074	1RXS J033609.2+311853	3 36 09.2	31 18 53.0	14.4V	>M0V	
075	1RXS J033711.0+255934	3 37 11.0	25 59 34.0	7.4V	K0V	HD 22403
076	1RXS J033733.9+175105	3 37 33.9	17 51 05.5	13.4V	>M0V	LP 413-19
076s				12.7V	>M0V	
077	1RXS J033933.3+182316	3 39 33.3	18 23 16.0	8.4V	F5V	HD 22694
078	1RXS J033947.7+332833	3 39 47.7	33 28 33.5	13.1V	>M0V	
078s				9.1V	K2IV	
079	1RXS J034019.2+122029	3 40 19.2	12 20 29.0	12.6V	K0V	
086	1RXS J034327.2+293546	3 43 27.2	29 35 46.5	10.0V	G5IV	
094	1RXS J034432.1+395937	3 44 32.1	39 59 37.5	12.7V	K4V	
095	1RXS J034526.5+174702	3 45 26.5	17 47 02.5	12.7V	K2IV	
096	1RXS J034533.8+241821	3 45 33.8	24 18 21.0	13.6V	K2IV	V* OU Tau
098	1RXS J034613.8+170929	3 46 13.8	17 09 29.0	12.9V	K2IV	StKM 1- 406
098s				11.4V	K2IV	
106	1RXS J035003.1+223539	3 50 03.1	22 35 39.0	7.7V	G0V	HD 23965
127	1RXS J040734.6+380415	4 07 34.6	38 04 15.0	6.7V	G5V	IRAS 04042+3756
129	1RXS J040836.4+380213	4 08 36.4	38 02 13.5	5.4V	F7V	HR 1278
134	1RXS J042147.7+114011	4 21 47.7	11 40 11.0	10.5V	K0V	HD 286704
138	1RXS J043156.9+364440	4 31 56.9	36 44 40.5	6.1V	G7V	HD 28591
140	1RXS J043225.9+130648	4 32 25.9	13 06 48.5	10.9V	K4V	HD 286839
141	1RXS J043412.1+113353	4 34 12.1	11 33 53.5	11.4V	K4V	Cl Melotte 25 294
146	1RXS J044107.1+113213	4 41 07.1	11 32 13.0	11.4V	G0IV	
147	1RXS J044240.9+101746	4 42 40.9	10 17 46.5	9.0V	K2IV	
151	1RXS J045149.5+133918	4 51 49.5	13 39 18.0	6.4V	G4V	HD 30869
154	1RXS J045923.7+122940	4 59 23.7	12 29 40.0	11.6V	G7IV	
159	1RXS J050131.1+230630	5 01 31.1	23 06 30.0	8.8V	K0V	
167	1RXS J050806.9+143155	5 08 06.9	14 31 55.0	8.3V	G5IV	HD 33053
171	1RXS J050909.9+152740	5 09 09.9	15 27 40.0	12.8V	>M0V	G 85-44
176	1RXS J051153.5+164432	5 11 53.5	16 44 32.5	9.1V	F7V	HD 33572
177	1RXS J051153.6+370749	5 11 53.6	37 07 49.0	6.0V	G5IV	
178	1RXS J051521.6+122118	5 15 21.6	12 21 18.0	12.1V	G5V	
179	1RXS J051548.9+184419	5 15 48.9	18 44 19.0	10.7V	G7IV	
181	1RXS J051908.2+340529	5 19 08.2	34 05 29.5	8.6V	K2IV	
182	1RXS J052054.8+240206	5 20 54.8	24 02 06.0	14.5V	F7V	HD 34772
189	1RXS J052403.2+192241	5 24 03.2	19 22 41.0	13.9V	>M0V	
195	1RXS J052737.7+395525	5 27 37.7	39 55 25.0	9.3V	K2IV	
209	1RXS J053506.4+394644	5 35 06.4	39 46 44.5	10.4V	K0V	

observation based on the same set-up as described in Sect. 3 has been undertaken 60 days later. The spectrum reduced with similar procedure shows significant increase both in H_α and the continuum emission, and the estimated V magnitude increased by about 0.4 mag. However, no other broad optical line emission was found on any of the nights. Although this needs to be confirmed, IRXS J052908.4+115207 was classified as a possible CTTS and optical information is presented in Table 3. Table 4 is a list of 19 optical counterparts having significant but weak LiI absorption, these were classified as probable cloud members of the Taurus-Auriga SFR which might have reached the ZAMS. The remaining 53 objects studied, showing no obvious LiI absorption in the spectra, were regarded as likely optical counterparts to the related X-ray sources, but not as WTTS, no statements could be made concerning the distance or their possible associations with the Taurus-Auriga region. These objects are listed in Table 5.

Normalized spectra of the newly discovered candidate WTTS are shown in Fig. 1, covering both H_α emission and LiI absorption. Finding charts for all new candidate WTTS are presented in Fig. 2, each having a coverage of $5' \times 5'$. Spectrum and finding chart of IRXS J052908.4+115207 are also provided at the end of Fig. 1 and Fig. 2, respectively.

With 75 new candidate WTTS, 5 thereof are pairs, 1 possible CTTS discovered and 2 previously identified Li-rich stars (Neuhäuser et al. 1995c; Alcalá et al. 1996) confirmed by our program out of the sample of 164 RASS sources, a discovery rate of about 47% was obtained as compared to 42% achieved by Wichmann et al. (1996). Thus, the selection criteria based on hardness ratios established by Neuhäuser et al. (1995a) turned out to be reliable, though possibly biased by our optical brightness limit.

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