X-RAY STUDY OF THE STAR-FORMING REGION L1495E IN TAURUS WITH *XMM-NEWTON*

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ABSTRACT

We report the results of two consecutive XMM-Newton observations (74.4 and 45.1 ks) pointing at the star-forming cloud L1495E in the Taurus region. The target is V410 Tau system. We were able to detect 30 sources, being 12 new X-ray detections without optical counterpart. From the remaining X-ray sources, 12 show X-ray lightcurve variations. We also report a preliminary analysis of the peculiar variation seen on V410 Tau.

Key words: ISM: individual objects: L1495E; stars: pre-main sequence: V410 Tau; X-rays: stars.

1. OBSERVATION

The XMM-Newton observations here reported consist of two consecutive exposures of 74.4 and 45.1 ks nominal; the first started on March 11 2001 at 12:40:22 UT and the second on March 12 2001 at 10:23:10 UT. The PI of the observations is F.Walter and the main target was the WTTS V410 Tau triple system. The data was retrieved from the XMM-Newton public archive and processed using the standard SAS V6.0.0 pipeline system. Data from the three EPIC cameras was extracted.

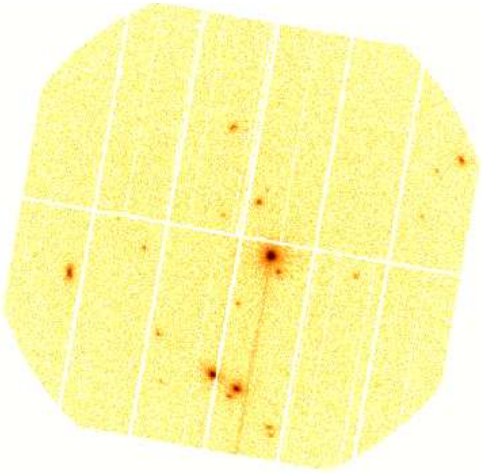

Figure 1. EPIC-pn image of L1495E in the Taurus region.

2. DETECTED SOURCES

From the detection process we were able to detect 30 X-ray sources and 12 corresponding to new X-ray detections (Figure 2). From the analysis of the remaining sources, 12 show X-ray lightcurve variations. From the

X-ray source	Coordinates J2000		[SS94]	ID
	RA	*DEC*		
1	04 17 39.04	+28 32 57.46	LkCa 5	HBC 371
2	04 17 45.47	+28 32 20.82	-	-
3	04 17 49.50	+28 29 31.31	-	[BCG93] 3
4	04 17 58.85	+28 28 40.30	-	-
5	04 18 07.84	+28 26 00.43	V410 X-ray 3	-
6	04 18 18.26	+28 31 41.35	-	-
7	04 18 28.69	+28 36 27.81	-	-
8	04 18 28.95	+28 26 16.61	-	-
9	04 18 29.08	+28 16 55.01	-	-
10	04 18 31.02	+28 16 24.62	DD Tau	HBC 30
11	04 18 31.13	+28 27 14.22	V410 Tau	HBC 29
12	04 18 31.63	+28 16 56.62	CZ Tau	HBC 31
13	04 18 31.98	+28 31 14.22	PSC04154+2823	[BBM92] 17
14	04 18 34.41	+28 30 27.82	V410 X-ray 2	-
15	04 18 37.81	+28 34 48.62	-	-
16	04 18 38.05	+28 26 51.82	-	-
17	04 18 38.05	+28 31 11.02	-	-
18	04 18 40.23	+28 24 21.42	V410 X-ray 4	-
19	04 18 40.59	+28 19 14.22	V892 Tau	HBC 373
20	04 18 41.45	+28 34 59.82	-	-
21	04 18 42.29	+28 18 47.02	V410 X-ray 7	MHO 11
22	04 18 43.87	+28 29 41.41	-	-
23	04 18 44.35	+28 24 21.41	-	-
24	04 18 47.02	+28 20 07.00	Hubble I 4	V1023 Tau
25	04 19 00.95	+28 19 38.09	V410 X-ray 6	-
26	04 19 01.81	+28 22 32.48	V410 X-ray 5a	MHO 12
27	04 19 05.83	+28 27 42.83	-	-
28	04 19 12.88	+28 29 29.92	FQ Tau	HBC 377
29	04 19 26.33	+28 26 11.26	V819 Tau	TAP 27
30	04 19 35.56	+28 27 21.03	-	FR Tau

Figure 2. XMM-Newton detected sources in the star forming region L1495E. SS94 ROSAT detection (Strom et al. 1994). ID - Name of optical counterpart from SIMBAD and USNO B1 catalogs. The search was within a radius of 10 arcsec from the X-ray source position.

sources with no optical counterparts, we identify 2 as members of the star forming region L1495E;

3. V410 TAU

V410 Tau is a well known K7 WTTS with a rotational period of 1.871970 days (Stelzer et al. 2003, Fernndez et al. 2004). In this observation, V410 Tau displays a peculiar lightcurve (Fig 3). The X-ray emission rises linearly by a factor of 1.8 in 30 ks (from 20 ks to 50 ks) and then decrease back to the original level.

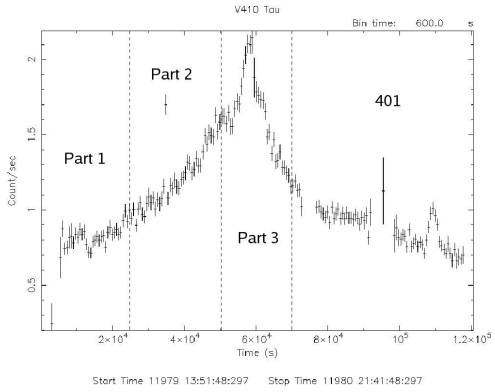

Figure 3. X-ray background subtracted lightcurve of V410 Tau during the two consecutive observations of L1495E.

We performed a time-resolved spectral analysis, dividing the first observation in 3 segments of 25 ks (part 1), 25 ks (part 2) and 18 ks (part 3) as indicated in Fig 3. 401 represents the full second observation. The spectral analysis was done with XSPEC package and the best fit corresponds to a 3-Temperature Mekal model.

Although the lightcurve of V410 Tau is variable, the spectral parameters from the various segments are not quite different. The 3 temperatures components show small changes, increasing a little in part 2 and 3. The lightcurve of part 3 is likely to be explained by a flare superimposed into some kind of basal X-ray modulated emission; temperatures from part 2 are hotter, but more material (EM) is involved in the X-ray emission of part 3. From Fig 3 we can see that part 3 corresponds to the brightest phase of V410 Tau in the V band photometry. Rotational modulation is one interpretation for the X-ray emission behaviour, but we should be careful because the X-ray data do not cover a complete stellar period.

Time Interval Ks	kT_1 keV	kT_2 keV	kT_3 keV	EM_1 10^{53}	EM_2 10^{53}	EM_3 10^{53}	Z	χ^2
0-25	0.26±0.01	0.88±0.02	2.30±0.19	1.60±0.73	2.36±0.84	1.74±0.38	0.18±0.03	1.19
25-50	0.28±0.01	0.99±0.03	2.95±0.29	2.07±0.72	3.34±1.12	2.78±0.63	0.21±0.03	1.00
50-69	0.33±0.01	0.97±0.03	2.67±0.22	2.10±0.67	3.99±1.24	3.48±0.71	0.22±0.03	1.14
401	0.27±0.01	0.96±0.02	2.23±0.22	1.67±0.56	2.23± 0.91	1.89±0.63	0.22±0.03	1.01

Figure 4. X-Ray best-fit spectral parameters with 3-T Mekal model.

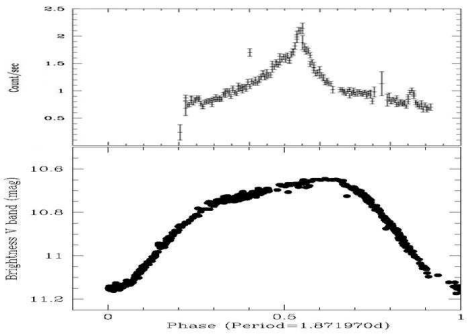

Figure 5. Multi-wavelength phase plot for the 1.87 optical period of V410 Tau. From top to bottom: x-ray count rate, V band photometry (adapted from Stelzer et al. 2003).

4. CONCLUSIONS

The main results are:

- The detection of 12 new X-ray sources with no optical counterpart.
- The identification of 2 X-ray sources with no optical counterpart as members of L1495E.
- The peculiar V410 Taus lightcurve can not be explained just by a flare like event. The almost linear increase in X-ray emission (Part 2) followed by a decrease lasts for a large fraction of time of the optical stellar period. Part 3 has a flare which is likely superimposed into some kind of basal X-ray modulated emission.
- Further studies of this X-ray survey of L1495E will be carried out and the results will be published in forthcoming paper. RGS data will also be analyzed in order to try to unveil the mystery behind V410 Tau peculiar x-ray emission.

REFERENCES

[1] Fernandez et al. 2004, A&A 427, 263

[2] Stelzer et al. 2003, A&A 411, 517

[3] Strom et al. 1994, ApJ 424, 237