X-ray emission from brown dwarf candidates in Cha I

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ABSTRACT

The physical process producing X-ray emission in brown dwarfs (BDs) is still not well understood. In young BDs, X-ray emission is though to be produced by some kind of magnetic activity and/or accretion (as in T Tauri stars), but the low frequency of detections does not permit to achieve robust conclusions. Only a small fraction of the BDs in some star-forming regions has been detected in X-rays. Investigating the characteristics of the X-ray emission of a larger sample of BDs is needed to the understanding of the process producing high-energy emission in these objects. We have taken advantage of the high sensitivity of the EPIC on-board the XMM-Newton satellite to study the X-ray properties of brown dwarf candidates of the Chamaleon I molecular cloud selected from the literature. Our sample increases the number of BDs detected in X-rays in Cha I by a factor of two. Our aim is to investigate whether the X-ray emission coming from these objects is similar or not to that of T Tauri stars of the same region.

OBSERVATIONS

The study is based on XXM-*Newton* data of the Chamaleon I molecular cloud. Observations were taken using the three European Photon Imaging Cameras (EPIC) operated simultaneously in full frame mode for different fields. For the reduction, we used the *XMM-Newton Science Analysis System software* (SAS) to derive a table of calibrated events. Then, different filters were applied to eliminate bad events and noise. Source detection for each dataset was performed in three different energy bands: soft (0.3–2.0 keV), medium (2.0–4.5 keV), and hard (4.5–7.5 keV). Cleaned event-file images (corrected for bad pixels and noise) were used at this stage. We ignored the energy channels below 0.3 keV because of the strong noise affecting the EPIC detectors below this value, and those above 7.5 keV, since merely only background is present at high energies.

RESULTS

To identify brown dwarfs we cross-correlated the detected X-ray sources with the data in López-Martí et al. (2004) and Luhman et al. (2004) which provide a spectral classification of stars in the Chamaleon I molecular cloud based on their IR colours and long-slit optical spectra, respectively. We found X-ray counterparts for eleven objects classified as brown dwarfs in the latter works.

For nine of those objects, the amount of counts was enough to obtain an spectrum. In those cases, we used the XSPEC software to analyse the X-ray spectrum. Results for the fitting using the Astrophysical Plasma Emission Code (APEC) model are shown in the table and in the figures below. We used a fixed value of Z=0.3$Z_{\odot}$ for the abundances motivated by previous works on this region (Stelzer et al. 2004, Robrade & Schmitt 2007). With the exception of one object, we used a one-temperature (1*T*) model to fit the data toobtain general properties of the emitting plasma.

			X-ray analysis							López-Martí et al. 2004[1] Luhman et al. 2004[2]		
BD	RA	DEC	N_H (10^{22})	kT	$Z/Z_{\odot}$	Norm. (10^{-5})	χ^2_{red} (d.o.f.)	f_X (10^{-14})	# Counts	name	SpT	class
field 1 (13)	11:05:43.60	-77:26:52.3	$0.04^{+0.08}_{-0.04}$	$0.99^{+0.08}_{-0.09}$	=0.3	$8.11^{+2.05}_{-1.55}$	1.28 (31)	7.16	233	ChaI 449[1]	M6	trans. ob.
field 1 (16)	11:06:28.77	-77:37:33.1	$0.89^{+1.10}_{-0.39}$	$1.18^{+1.05}_{-0.33}$	=0.3	$7.94^{+7.62}_{-4.42}$	0.53 (53)	0.11	50	CHXR 73B[2]	M9	
				$0.22^{+2.10}_{-0.15}$	=0.3	$0.66^{+8.93}_{-5.61}$						
field 1 (25)	11:09:45.60	-77:40:34.0	$0.05^{+0.62}_{-0.05}$	$0.95^{+0.46}_{-0.49}$	=0.3	$1.20^{+5.30}_{-0.45}$	0.51 (19)	1.02	76	ChaI 434[1]	M7[1]/M5.75[2]	BD
field 1 (27)	11:07:16.68	-77:35:53.2	$0.03^{+4.27}_{-0.03}$	$1.09^{+0.72}_{-0.28}$	=0.3	$0.51^{+0.65}_{-0.22}$	0.98 (16)	0.11	70	2M J11071668-7735532[2]	M7.75	
field (34)	11:07:37.75	-77:35:30.8	$0.23^{+1.26}_{-0.23}$	$0.77^{+0.27}_{-0.77}$	=0.3	0.88	1.09 (12)	0.08	54	2M J11073775-7735308[2]	M7.75	
field 3 (8)	11:01:19.44	-77:32:37.4	$0.38^{+0.47}_{-0.17}$	$1.52^{+3.77}_{-0.30}$	=0.3	$2.50^{+1.05}_{-1.52}$	0.73 (64)	1.50	172	Cha J11011944-7732374[2]	M8.25	
				$0.42^{+0.42}_{-0.19}$	=0.3	$1.52^{+1.67}_{-1.41}$						
field 3 (51)	11:02:42.50	-77:24:25.2	Not possible to fit the spectrum						57	ChaI 423[1]	M6	trans. ob.
field 4 (36)	11:10:22.30	-76:25:14.2	$0.07^{+0.25}_{-0.07}$	$0.94^{+0.35}_{-0.26}$	=0.3	$0.73^{+1.01}_{-0.36}$	0.40 (8)	0.59	44	ChaI 710[1]	M9[1]/M8[2]	BD
field 4 (78)	11:12:03.40	-76:37:03.7	Detected just in MOS1. Not possible to fit the spectrum						26	ChaI 742[1]	M6	trans. ob.
field 5 (5)	11:03:48.30	-77:19:57.4	$0.24^{+0.09}_{-0.05}$	$1.75^{+0.30}_{-0.31}$	=0.3	$15.05^{+2.59}_{-1.81}$	1.02 (48)	9.19	367	ChaI 425[1]	M7.5	BD
field 5 (22)	11:08:00.50	-77:15:32.4	$0.47^{+0.93}_{-0.35}$	$0.83^{+0.38}_{-0.82}$	=0.3	$1.41^{+indef}_{-1.41}$	0.67 (24)	0.46	58	ChaI 610[1]	M7	BD