X-ray survey of the Chamaleon I star forming region

INTRODUCTION + ABSTRACT

The Chamaleon I dark molecular cloud, hereafter Cha I, is an active site of recent star formation located at high galactic latitude (b ~ -15°). It belongs to the Chamaleon complex which is one of the nearest SFR (d ~ 160 pc). These two characteristics result in low foreground extinction and poor contamination with background objects, which makes it of special interest for the unbiased determination of the true population of young stars. Cha I has been the target of a large number of studies, including spectroscopy by Malhotra (Comeron et al. 1999, 2000), monitoring of photometric variability (Carpenter et al. 2002), and IR photometry (Luhman et al. 2000; Luhman 2004; Manoj et al. 2011), who carried out a thorough spectroscopic study to obtain precise spectral types and membership census of Cha I stars. The sub stellar limit in Cha I, based on the members of median age (Steiner & Micela 2007), corresponds to the spectral type M6-MS.5 (Baraffe et al. 1998).

Finally, X-ray studies using Einstein Observatory (Fiegelson & Kriem 1989), ROSAT (Fiegelson et al. 1992; Micela & Alcalá 1995, 1997), Chandra (Fiegelson & Lawson 2004; Steiner & Micela 2007) and XMM-Newton observations (Steiner et al. 2004; Robrade & Schmitt 2007) have partially revealed the Cha I X-ray stellar population, but leaving a large part of it unexplored in the X-rays.

We present preliminary study of the Cha I X-ray stellar content and describe the nature of 484 X-ray sources detected in the analysis of 8 XMM-Newton X-ray observations. We correlate them with optical, mid- and near- infrared Spitzer and 2MASS counterparts. One third of the X-ray sources shows 2MASS counterparts and 14 X-ray sources out of 54 Spitzer sources, exhibit mid-IR colors, indicative of stars with circumstellar discs. The range of Av absorption is between 0.1 to 0.5 mag. We perform X-ray spectral analysis of X-ray sources with more than 100 X-ray photons in the spectra. High energy emission is highly variable over the entire stellar field. We estimate X-ray plasma temperature, abundances and fluxes of stars. Typical X-ray spectral parameters are log(NH) = -21.45 (cm^-2) with 1 sigma dispersion of 0.4 dex, and a normal temperature kT=0.71 keV, with a hard tail temperature distribution between 1.5 keV. We test the X-ray Luminosity Function (XLF) approaches as it was computed from spectral fits or via conversion factor (CF). It is biased by the effect of the NH absorption correction to the X-ray luminosity. The XLF of known SFRs could be biased if the Lx of stars were obtained via CF, rather than the spectral fits.

X-ray abundances: Stellar abundances is one major key in the study of low-mass stars in SFRs. In low resolution spectra, elemental abundances are usually fixed at Z = 0.3 Zsun. While these fits are usually statistically successful, the chemistry is not homogeneous because of the different star components in a cloud. Several studies of magnitudes of massive active stars show that many plasma components with a wide range of temperatures may be present, and that the chemical fractionation associated to magnetic reconnection flaring can produce strongly non-solar elemental abundances (Kastner et al. 2003). Non-solar values were fitted for sources with more than 1000 X-ray photons (20 sources). The distribution of non-solar abundances peaks at 0.2 Zsun, with a large spread of values from 0.1 to 0.8, and even 1.2 Zsun. Ten sources (i.e. 5% of the X-ray sample) displays values larger than 0.5 Zsun, indicating the effect proposed by Kastner et al. 2003.

Bias on the X-ray luminosity function: The most important parameter that characterize the X-ray activity of stars is the un-absorbed X-ray luminosity, which is an indicator of the activity. The X-ray absorbed flux histogram for the sample shows that many plasma components with a wide range of temperatures may be present, and that the chemical fractionation associated to magnetic reconnection flaring can produce strongly non-solar elemental abundances (Kastner et al. 2003). Non-solar values were fitted for sources with more than 1000 X-ray photons (20 sources). The distribution of non-solar abundances peaks at 0.2 Zsun, with a large spread of values from 0.1 to 0.8, and even 1.2 Zsun. Ten sources (i.e. 5% of the X-ray sample) displays values larger than 0.5 Zsun, indicating the effect proposed by Kastner et al. 2003.

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