THE DEEP RHO OPHIUCHI XMM-NEWTON OBSERVATION (DROXO).

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ABSTRACT

We present the X-ray data and the analysis status of the DROXO (Deep Rho Oph XMM-Newton Observation) project, aimed to mainly characterize the spectro-variability properties of YSOs in the nearby and very young ρ Oph star forming region. We focus on a few selected initial scientific results for few interesting YSOs, such as Elias 29 and YLW16A. In Elias 29 we see the 6.4 keV fluorescent Fe line as already reported in literature, whereas in YLW16A we do not detect the fluorescent line at odd with previous findings. Hence we conclude that the line intensity does change with time (and/or physical conditions).

Key words: Stars: formation; X-rays: stars; Stars: individual: ρ Ophiuchi.

1. THE DROXO PROJECT

The DROXO project has collected top quality EPIC spectra and light curves of the ρ Ophiuchi YSOs with the aim to address key issues related to their X-ray emission: Can we distinguish between "pure" solar-like coronal and star-disk interaction activity ? What is the interplay between accretion and X-ray emission in YSOs ? How is the accretion channelled and regulated? There is any feedback at work ? What is the effects of X-rays on small (planetary) and large (molecular cloud) scale evolution ? What is the effect of X-rays on the chemistry of protoplanetary disks ?

DROXO consists of six observations over a timespan of about 10 days starting on March 8, 2005. The total observing time was about 500 ksec (i.e. ~8 days), about 1/5 is affected by very high background and only 1/2 of the observing time has a really low background level.

Summing all Mos-1, Mos-2 and pn data during the low background segments and using the Pwxdetect (the XMM-Newton version of Wdetect, see Damiani et al. 1997a,b), we have found 130 sources down to $f_X \sim 3 \cdot 10^{-15}$ erg s^{-1} cm^{-2}; 30 out of 130 are new X-ray sources; 32 of the X-ray sources have X-ray spectra with more than 2000 counts.

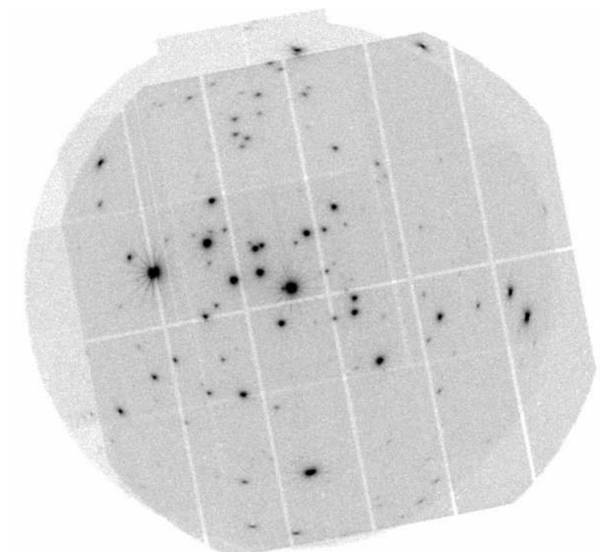

Figure 1. DROXO EPIC X-ray image of ρ Ophiuchi region.

1.1. Light Curves

Examples of X-ray light curves of ρ Oph members are shown in Fig. 2. Times are counted in ks from the start of the first pn observation, thick line is the background subtracted light curve. We observe variability due to flares (as in the bottom panel, WL2/GY218, class II) which may last up to 35-40 ks. In other cases we see a smooth

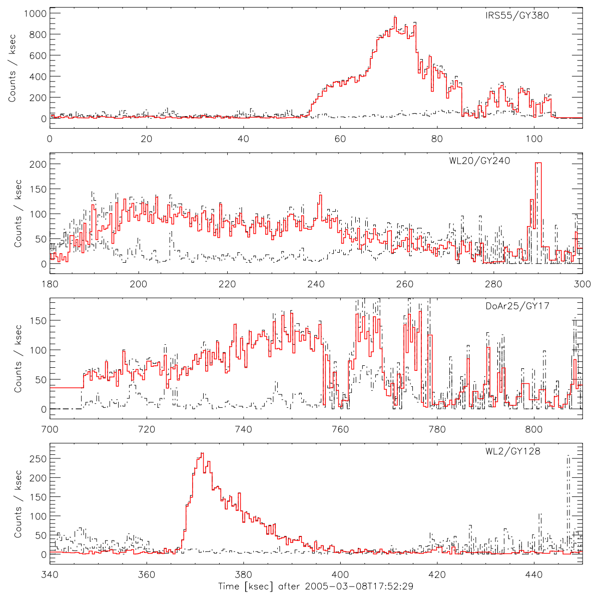

Figure 2. Examples of time variability in X-ray light curves of ρ Ophiuchi YSOs. Thick line marks the background subtracted count rates.

modulation, as in DoAr25/GY17 and WL20/GY240, two class II YSOs. We observe also more complex behaviour such as a "modulated" flare (top panel, IRS55/GY380, a class III YSOs).

1.2. X-ray Spectra

DROXO allows us to get significant insight into the spectral properties of X-ray emission from very young and deeply embedded stars.

Elias 29, a class I YSO. Other than the Fe XXV complex at 6.7 keV, we clearly distinguish the 6.4 keV fluorescent Fe line as already found by Favata et al. (2005) and Imanishi et al. (2001) (Fig. 3). While the 6.7 keV Fe XXV line is due to emission from a very hot plasma, the 6.4 keV line is likely due to emission from a circumstellar disk, X-ray illuminated by the star at the center (cf. Tsujimoto et al. 2005 and Favata et al. 2005).

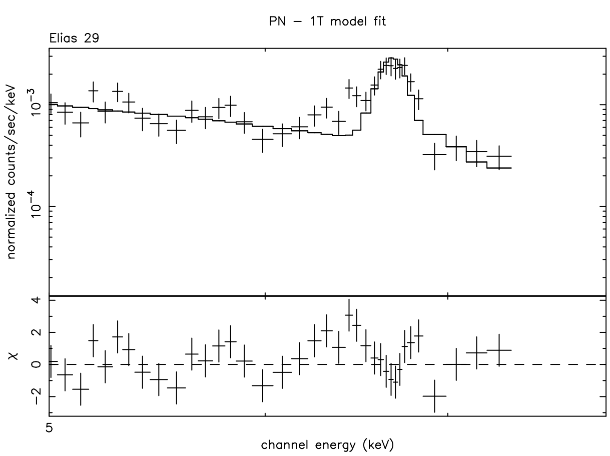

Figure 3. Fe 6.7 keV region in the X-ray spectrum of Elias29.

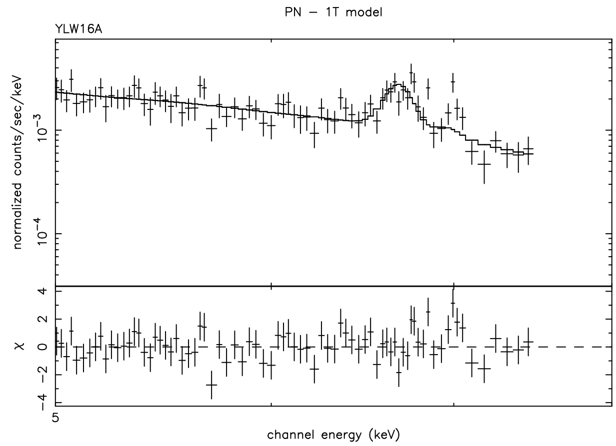

Figure 4. Fe 6.7keV spectral region of YLW16A. While it is not evident any neutral Fe fluorescence line at 6.4 keV, we observe a line feature at ~7 keV hinting the presence of very hot plasma.

YLW16A, a class I YSO. Contrary to previous finding (Imanishi et al. 2001) we do not detect the 6.4 keV fluorescent Fe line (Fig. 4). While the Imanishi report was associated to an intense X-ray flare, we do not detect this feature in the spectra in the entire exposure as well as in the first orbit alone, when the star is quiescent. In any case, we conclude that the 6.4 keV fluorescent Fe line does change with time. In the spectrum of YLW16A, as well as in other spectra, we observe also a feature at 6.9 keV, which hints the presence of plasma hotter than 50 MK.

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