ASCA OBSERVATIONS OF CLASS I PROTOSTARS IN THE RHO OPH DARK CLOUD

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1. Introduction

On 1993 August 20, we observed the Rho-Oph dark cloud and detected hard X-rays from Class I sources (Koyama *et al.*(1994), Kamata *et al.*(1997)). One of the sources (EL29) showed a flare-like variability, while another (WL6) exhibited sinusoidal variation with no large spectral change. The later would be due to a spin of the protostar. The sinusoidal period of about 1 day is shorter than spin periods of TTSs of ~3–7 day.

From these X-ray emitting YSOs, we found bipolar flows with radio observations (Sekimoto *et al.*(1997)). This places the sources to be protostars at the dynamical mass accretion phase. The common feature of these out-flows is that the blue and red lobes are largely overlapped, suggesting nearly pole-on geometry. On the other hand, no significant X-ray has been reported from out-flow sources, VLA 1623 (Kamata *et al.*(1997)), L1551 IRS5 and L1551 NE, HL Tau (Carkner *et al.*(1996)), all these would be edge-on systems (André *et al.*(1990), Ohashi *et al.*(1996)). Consequently, we proposed a unified picture of protostars; every protostar emits X-rays, but the X-rays can only be detected from pole-on viewing angle, where X-rays are less absorbed by dense circumstellar disks.

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To study the time variability of the X-ray emitting Class I sources, we re-observed this region deeply.

2. Observations & Results

On 1997 Mar 2–3, we observed the central region of the cloud with 100 ksec exposure, and found that WL6 and EL29 became very faint. Instead, new hard X-ray (> 2 keV) objects appeared at the positions of other Class I stars. The brightest was YLW15, on which a large flare had been detected with the ROSAT deep pointing observation (Grosso *et al.*(1997)). The outflow map of YLW15 (Bontemps *et al.*(1996)) has also a signature of pole-on configuration, confirming our unified picture.

In the hard band (> 2 keV), we detected three flares on the YLW15 with about 20 hours interval. The time interval is comparable to the spin period of the protostar WL6, which we suggested from the sinusoidal X-ray light curve. It is also comparable to the period of the inner-most Keplarian orbit (r = several $\times 10^{-2}$ AU). Accordingly, the quasi-periodicity of the flares would be related to the spin of the central star or/and rotation of the circumstellar disk.

References

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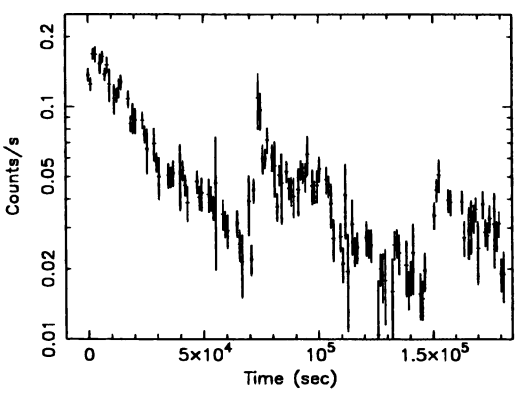

Figure 1. Lightcurve of YLW15 in 2–10 keV band (GIS 2 + 3). Each time bin width is 1024 sec.