X-RAY OBSERVATIONS OF ORION OBIB ASSOCIATION

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1. Introduction

The signs of the active star formation in the Orion region are mainly found in the direction of the two giant molecular clouds - Ori A and Ori B - . Recent objective prism survey in the Orion region shows large number of Hα emission-line stars distributed outside of the giant molecular clouds (Nakano *et al.*, 1995). Many weak-lined T Tauri star candidates are also discovered by the discrimination analysis of the X-ray sources found in the ROSAT all sky survey (RASS) (Sterzik *et al.*, 1995). Although such huge number of pre-main sequence stars outside of the molecular cloud was not expected, their nature is still in controversial (Neuhäuser, 1997). To know the X-ray properties of these sources in the Orion region, we have carried out the ASCA observations.

2. Observations

We have obtained the broad-band X-ray images of the Orion OB1b association by ASCA. The obscuration effects are less important for detector with high sensitivity at high energies. We observed three areas in the OBIb association. A-region is between ε Ori and δ Ori, where relatively many emission-line stars were found. B-region is the east of ε Ori where no known young stars or emission-line stars. C-region is the interface region between Orion B giant molecular cloud (L1630) and HII region IC 434 excited by σ Ori, and where the horsehead nebula (B33) lies.

In total, more than forty faint X-ray sources were detected in three fields, and about half of them have likely optical counterparts in the Hubble Guide Star Catalog.

K. Koyama et al. (eds.), The Hot Universe, 230-231.

3. Results

In the C-region, several X-ray sources were identified with known possible low mass pre-main sequence stars. Some X-ray sources were also found in the chain of small reflection nebulosity in the A-region, which appears to be illuminated by OB association members.

Including the source with marginal detection, eight pre-main sequence stars were detected with ASCA observations - V469 Ori (marginal), V607 Ori, V615 Ori, Haro 5-36, NGC2023/S105, and #101, #105, #110 in our emission-line star survey (Wiramihardja *et al.*, 1989). As a detailed analysis of the spectral properties of all sources is not feasible, we used the count ratio to estimate the X-ray temperature. We simulated a hot, optically thin plasma with interstellar absorption and calculated model count ratios for a grid of hydrogen absorption column densities in the range $N(H)=3\times10^{20}-1\times10^{22}cm^{-2}$ and X-ray temperature kT = 1-10 keV. All of pre-main sequence stars with X-ray emission are rather X-ray luminous in our source list ($> 2\times10^{30}$ ergs/s) and count ratio for most sources are around 0.9 - 1.0, which mean the X-ray temperature kT = 1-2 keV.

New X-ray source in the Horsehead nebula is identified as B33-10 (Reipurth and Bouchet, 1984). Its NIR colors on the two-color diagram indicates that it has no NIR excess emission. The spectrum of the bright classical T-Tauri star V615 Ori is fitted by a Raymond-Smith model with a 0.3 solar abundance, kT=2.8 keV, and $N(H)=0.29\times10^{22}cm^{-2}$.

There are five high tempearture sources in the B-region. One of them is identified with a small nebulous object on the Palomar Sky Survey Print. Its position is RA=$5^h38^m36^s$, Dec=$-1°38'33''$ (2000). We tried to model the spectra with simple combination of absorbed thin hot plasma. Exteremely high X-ray temperature is needed to fit one temperature hot plasma model (kT > 10 keV) for the spectrum. We suggest that it might be an extra-galactic source.

References

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