

OPTICAL FOLLOW-UP OBSERVATIONS OF ASCA LYNX DEEP SURVEY

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1. Introduction

Since the bulk of the energy density of the Cosmic X-ray Background (CXB) resides in the harder energy band than that of the ROSAT band (0.5-2 keV) and since the X-ray sources identified in the ROSAT band have X-ray spectra softer than that of the CXB, investigation of nature of the X-ray sources at the harder energy band is indispensable to solve the origin of the CXB. However, only 2-3% of the CXB in the hard band (2-10 keV) had been resolved into discrete sources (Piccinotti et al. 1982, ApJ 253, 485). We present our preliminary results of optical follow-up observations of the ASCA Lynx deep survey.

2. X-ray observations

The X-ray observations were made with the ASCA with an exposure time of about 80 ksec. The flux limit in the 2-10 keV band is more than 100 times deeper than that of the previous survey. The observed field is Lynx

3A and the field of view of SIS is about $20'$ by $20'$. Details of the X-ray observations are presented in Ogasaka (1997, in this proceedings). We define an X-ray source sample containing 8 sources by selecting X-ray sources detected above 5.5σ confidence. The fluxes of the sources range from 3×10^{-14} to 12×10^{-14} erg s $^{-1}$ cm $^{-2}$ in 0.7 - 7 keV band and from 5×10^{-14} to 10×10^{-14} erg s $^{-1}$ cm $^{-2}$ in 2 - 7 keV band.

3. Optical follow-up observations

Optical imaging observations were made in R-band with the Kiso Schmidt (1.05m) in Japan and in I-band with the University of Hawaii 2.2m and 0.6m telescopes. We picked up candidates of optical counterpart in an error circle (radius $\sim 30''$) of an ASCA source. In this process, we also used the ROSAT SRC catalogue, in which X-ray sources are cataloged with a typical error radius of about $10''$. Note that all the sources identified below are also ROSAT sources. Optical spectroscopic observations were carried out for these candidates using the KPNO 2.1m with the Gold Camera and the KPNO 4m with the Cryo Cam.

4. Results

Two sources are identified with type-1 (broad emission line) AGNs with redshifts of 0.46 and 0.57. One type 1.5 AGN is also identified at $z = 0.56$. These objects have X-ray luminosities of $(1 - 7) \times 10^{44}$ erg s $^{-1}$ (2-10 keV). We have two more type-1 AGN counterparts, but only one broad emission line is seen in the spectra; possible redshifts of these objects are 4.2, 3.2, and 1.3, if the emission is Ly α , CIV, and MgII, respectively. Other 3 X-ray sources have not yet optically identified. However since one of them shows an excess number density of faint galaxies, it may be a cluster of galaxies.

Our 5.5σ sample has total flux of 3.95×10^{-13} erg s $^{-1}$ cm $^{-2}$ in the 2 - 7 keV band which corresponds to about 27 % of the CXB in this band. Type-1 AGNs/QSOs including type-1.5 and the objects without the certain redshift contribute 19 % of the CXB in this band. The possible cluster has about 4 % contribution.

It should be worth noting that in course of the follow-up program, we obtained optical spectra for less significant X-ray sources. One of which is AX J08494+4454. This object was identified with a type-2 QSO at $z = 0.9$ (Ohta et al. 1996, ApJ 458, L57) and contributes about 7 % of the CXB in the 2 - 7 keV band.