X-RAY PROPERTIES OF THE POINT SOURCES DETECTED INSIDE THE GALAXY NGC 300

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ABSTRACT

We present properties of the X-ray point sources detected in the nearby spiral galaxy NGC 300. The galaxy was observed with *XMM-Newton* in 2000 December/2001 January for a total of 66 ksec. A total of 163 sources were detected in the energy range of 0.3–6 keV, 86 sources of which are within the D_{25} optical disk. We report on the global properties of these sources, such as their hardness ratio and X-ray fluxes. We combine this information with the optical counterparts found in B, V, and R images from the 2.2 m MPG/ESO telescope and we cross-correlate the X-ray sources found inside the disk with SIMBAD, the USNO-A2.0 catalog, and radio catalogues. A full description of our results can be found in Carpano et al. (2005).

Key words: Galaxies: individual: NGC 300 – X-rays: galaxies.

1. INTRODUCTION

NGC 300 is a normal dwarf galaxy of type SA(s)d belonging to the Sculptor galaxy group. Due to its small distance (∼1.88 Mpc; Gieren et al., 2005), its low Galactic column density ($N_\mathrm{H} = 3.6 \times 10^{20}\,\mathrm{cm}^{-2}$; Dickey & Lockman, 1990) and its face-on orientation, this galaxy is an ideal target for the study of the entire X-ray population of a typical normal quiescent spiral galaxy. The major axes of the D_{25} optical disk are 13.3 kpc and 9.4 kpc ($22' \times 15'$; de Vaucouleurs et al., 1991).

2. SOURCE CATALOG

NGC 300 has been observed by *XMM-Newton* during orbit 192 and orbit 195 for 37 ksec and 47 ksec respectively. Event and attitude files of each instrument were merged for both orbits using the `merge` task. Point source detection was then performed on the three cameras using the maximum likelihood approach of the `edetect_chain` task.

After removing sources associated with the galaxy cluster CL 0053−37, a total of 163 sources were found above a maximum likelihood threshold of 10 in the 0.3–6.0 keV band, 86 sources of which are within the D_{25} optical disk.

3. COLORS

We define the X-ray colors with:

$$\mathrm{HR}_\mathrm{hard} = \frac{H - M}{H + M + S}, \quad \text{and} \quad \mathrm{HR}_\mathrm{soft} = \frac{M - S}{H + M + S}$$

where S, M, and H are the total count rates in the soft (0.3–1.0 keV), medium (1.0–2.0 keV), and hard (2.0–6.0 keV) energy bands. Comparing the color-color diagram for sources inside the D_{25} optical disk and having more than 20 net counts with empirical color-color diagrams (see Carpano et al., 2005), we were able to characterize the shape of the X-ray spectrum for each source individually and to estimate source fluxes. These are between $\sim 3.5 \times 10^{-13}\,\mathrm{erg\,cm^{-2}\,s^{-1}}$ and $\sim 7 \times 10^{-16}\,\mathrm{erg\,cm^{-2}\,s^{-1}}$.

4. OPTICAL COUNTERPARTS AND CATALOGS

In addition to the X-ray data, observations with the 2.2 m MPG/ESO telescope on La Silla were performed. We searched for all possible optical counterparts in the merged BVR optical image and then calculated their fluxes in each of these three optical bands. Results are tabulated by Carpano et al. (2005). We also cross-correlated the X-ray sources with SIMBAD, the USNO-A2.0 catalog, and radio catalogues, finding

- 14 sources already observed in the X-rays,
- 9 (suspected) supernova remnants (SNR),
- 11 radio sources (3 associated with SNR, 8 possible AGN),

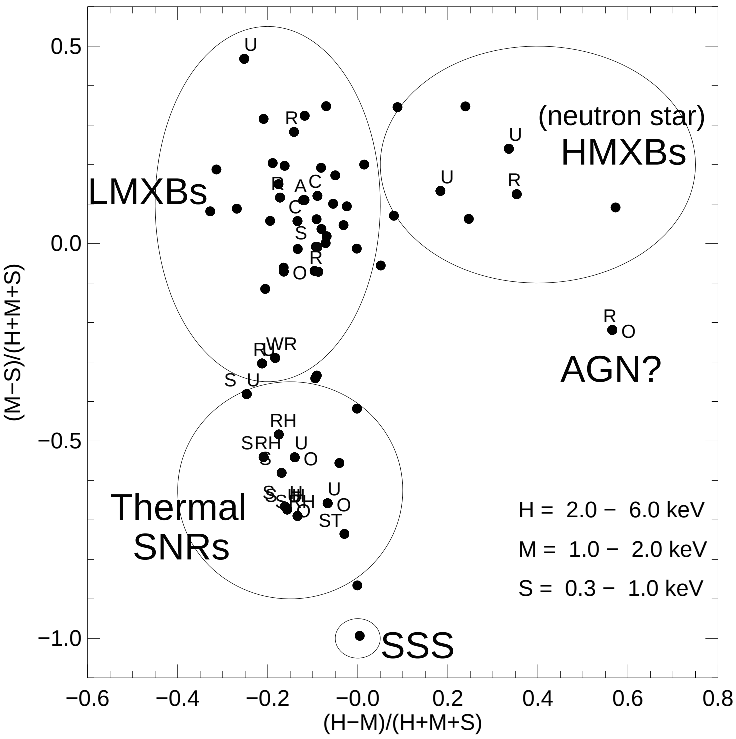

Figure 1. Color-color diagram for sources inside the optical disk. Supernova remnants are labeled with an 'S', radio sources with a 'R', H II *regions with an 'H', Cepheid stars with a 'C', association of stars with an 'A', stars in NGC 300 with an 'ST', Wolf-Rayet stars with a 'WR' and sources from the USNO catalog with an 'U'. Sources with* $\log(F_X/F_{vis}) < -1$ *(Maccacaro et al., 2005) are labeled with 'O'.*

- 2 associations of stars, 8 H II (ionized) regions, 2 Cepheid variable stars, 3 foreground stars/stars in NGC 300, 10 USNO-A2.0 counterparts.

5. SOURCE CLASSIFICATION

Using the source identification from catalogs, we classify the sources according to their X-ray colors (Fig. 1). SSSs are at the very bottom of the color-color diagram and soft sources are expected to be thermal SNR. SNR dominated by non-thermal emission (Crab-like objects) are expected to have harder spectra. Hard sources are likely X-ray binaries (XRB), which we classify into X-ray soft low-mass and harder high-mass XRB following Prestwich et al. (2005). Black-hole HMXB and LMXB are assumed to have similar spectral shape. Foreground stars are expected to have a $\log(F_{\rm X}/F_{\rm vis}) < -1$ (Maccacaro et al., 2005) and to be soft (therefore being prone to be confused with 'Thermal SNRs').

Note that there are overlaps from the different categories in the color-color diagram due to similar spectra and/or absorption. Strongly absorbed SSSs, e.g., can fall into the SNR group, whilst strongly absorbed or non-thermal SNRs can be confused with LMXBs.

Six sources in the thermal SNR group have SIMBAD counterparts (some of them have also radio and/or H II region counterparts), and one known SNR (lying in the LMXB group) has be found to be a non-thermal X-ray spectrum. One source, having a radio and a bright optical counterpart, is likely identified as a background AGN. The brightest source is associated with a Wolf-Rayet star.

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