XMM–NEWTON OBSERVATION OF THE SEYFERT 2 GALAXY NGC4138

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The XMM–Newton data presented here are the first X–ray observation of the Seyfert 2 galaxy NGC4138. Although the galaxy has been pointed by ROSAT–HRI, it was not detected, with a flux upper limit of about $1.1 \times 10^{-13}$ erg cm$^{-2}$ s$^{-1}$ in the 0.2–2.4 keV energy band. XMM–Newton performed the observation on 26 November 2001. The source is detected for the first time in X–rays with $F_{0.2-2.4} = 1.0 \times 10^{-13}$ erg cm$^{-2}$ s$^{-1}$, in agreement with the upper limit of ROSAT. The source spectrum is typical of Seyfert 2 galaxies. We find heavy obscuration ($N_H \approx 8 \times 10^{22}$ cm$^{-2}$) and a flat photon index ($\approx 1.6$). The source intrinsic luminosity is about $5 \times 10^{41}$ erg/s in the 0.5–10 keV energy band.

1 Introduction

NGC4138 is a spiral galaxy of Hubble type SA(r)0+ distant 17 Mpc, with a $D_{25} = 2.57'$. Its morphology appears undisturbed, although the galaxy has a dust lane in the southeastern side. The nucleus is classified as Seyfert 1.9. Optical observations have shown evidence for a counterrotating disk, with a velocity dispersion systematically lower than that of the primary disk. The counterrotating disk may be either the result of a recent merger (it appears to be still forming) or the continuum infall of material with opposite spin vector into NGC4138. ROSAT–HRI observed the galaxy for 5.8 ks without detecting it. Halderson et al. gave an upper limit to the 0.1–2.4 keV flux of $1.15 \times 10^{-13}$ erg cm$^{-2}$ s$^{-1}$. XMM–Newton EPIC instrument detected the source at a flux level of about $1.0 - 1.1 \times 10^{-13}$ erg cm$^{-2}$ s$^{-1}$ in the same band.

2 XMM–Newton data analysis

In Fig. 1, it is shown the Digitized Sky Survey (DSS) image of NGC4138, with EPIC–MOS2 contours superimposed. Although optical observations indicate the presence of a counterrotating disk, thus suggesting the possibility of a mild

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heating of the interstellar gas, the *XMM–Newton* data show no clear evidence of such process, in addition to that of the active nucleus. The source appears to be point-like (Fig. 2). There is a marginal evidence of a diffuse component beyond about 20\arcsec from the nucleus. A more detailed analysis will be performed soon.

The source spectrum is shown in Fig. 3 and it is typical of a Seyfert 2 galaxy\(^4\). Indeed, its best fit model consists of an intrinsic absorbed power law component (with $\Gamma = 1.6 \pm 0.1$ and $N_H = (8.3 \pm 0.7) \times 10^{22} \text{ cm}^{-2}$), plus a soft component dominating the emission below about 1.34 keV.

An Fe K\alpha line at $E = 6.37 \pm 0.04$ keV with $\sigma < 84$ eV and $EW \approx 100$ eV is also present. This line is consistent with being produced by the transmission of X-rays through the measured absorption column\(^5\). It is hard to disentangle on the basis of the present data, if this absorber is the putative torus of AGN or the dust lane visible in the optical observations\(^3\).

The soft component is most likely due to the scattered primary radiation. In this case, it would account for about 1% of the direct emission. In this energy band, it is also present a broad line, or a blending of non-resolved
Figure 2: Radial profile of NGC4138. Solid line: PSF at 5 keV; Points: source counts in the energy range 0.5 – 10 keV from EPIC–MOS2.

lines, at $0.79 \pm 0.07$ keV (equivalent width $\approx 670$ eV). This feature suggests the presence of either thermal and photoionization processes associated to a galactic hot gas. It is possible to substitute the scattered power law and the emission line with the Mekal model of Xspec for a hot plasma with emission lines. In this case, the temperature is $0.60 \pm 0.09$ keV.

The relationships $^6$ between the soft–X luminosity and the blue and the FIR luminosity applied to the present case$^b$ suggest that the thermal emission may be due to hot gas derived from a star formation activity. However, the optical observations of NGC4138$^3$ showed that the star formation activity in the primary disk ceased about 100 Myr ago. The only star formation activity present in NGC4138 is in the counterrotating disk, especially in the area of a HII ring (with 22″ radius).

More detailed observations with higher spatial resolution (e.g., Chandra) are necessary to put stronger constraints on the nature of this hot gas and on the structure of NGC4138.

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$^b$With the following values: observed $L_{X,0.5-2 \text{ keV}} = 1.9 \times 10^{39}$ erg/s, $L_B = 1.5 \times 10^{43}$ erg/s, $L_{FIR} = 1.5 \times 10^{41}$ erg/s.
Figure 3: Best fit model for NGC4138: it consists of a power law plus scattered component, and two gaussian emission lines at about 0.8 keV and 6.4 keV. See text for more details.

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References

1. Halderson E.L. et al., *The Astrophysical Journal* 122, 637 (2001)
2. Ho L.C. et al., *The Astrophysical Journal Supplement Series* 112, 315 (1997)
3. Jore K.P. et al., *The Astronomical Journal* 112, 438 (1996)
4. Turner T.J. et al., *The Astrophysical Journal Supplement Series* 113, 23 (1997)
5. Leahy D. A. and Creighton J., *Monthly Notices of the Royal Astronomical Society* 263, 314 (1993)
6. David L.P. et al., *The Astrophysical Journal* 388, 82 (1992)