The XMM-Newton View of the Northern Disk of M31

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The XMM-Newton survey of M31 revealed extended diffuse emission in the northern disk of M31, which is well correlated with the star-forming ring of the galaxy. The stellar population of this part of M31 has been extensively studied in the optical in the Panchromatic Hubble Andromeda Treasury (PHAT) survey. We have observed the northern disk of M31 in areas within the PHAT footprint in an XMM-Newton Large Programme (LP, see Fig. 1, Table 1). We have thus obtained a map of the X-ray emission of the hot interstellar medium (ISM) in a spiral galaxy like our own on arcmin scales and a complete list of X-ray sources down to the confusion limit of a few 10^{34} erg/s, with variability and spectral information.

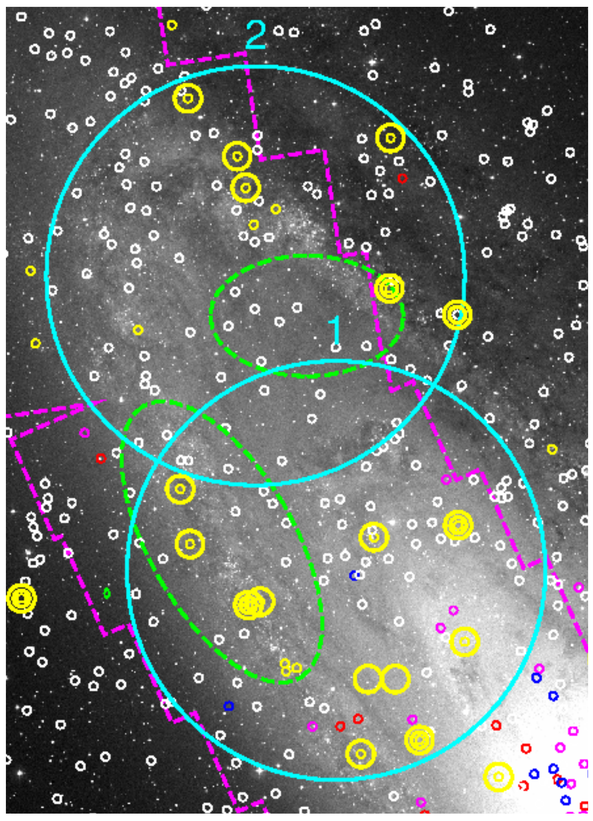

Fig. 1 *Left*: DSS image of the northern disk of M31. Large cyan circles: FOVs of the new XMM LP observations. Larger yellow circles: SNRs (single circle) and candidates (double) confirmed by Sasaki et al. (2012, A&A, 544, 144). Dashed magenta line: PHAT footprint. Small white circles: XMM-Newton sources detected by Stiele et al. (2011), most of which are still unidentified (white). Green dashed ellipses: regions, in which Williams (2003, AJ, 126, 1312) reported enhanced star-formation ~32 – 63 Myr ago. *Right*: Mosaic of all four XMM LP observations of the northern disk of M31 (red: 0.2 - 1.0 keV, green: 1.0 - 2.0 keV, blue: 2.0 - 12.0 keV).

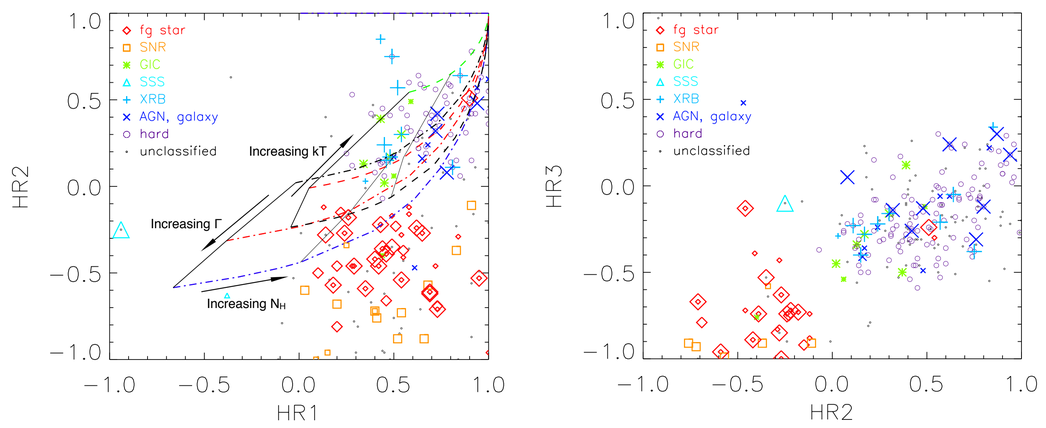

Fig. 3 Hardness ratio diagrams of XMM LP sources (Sasaki et al., in prep.). Used bands are: 0.2 - 0.5 keV, 0.5 - 1.0 keV, 1.0 - 2.0 keV, and 2.0 - 4.5 keV. Symbol sizes indicate: medium for sources classified by Stiele et al. (2011, A&A, 534, 55), small for candidates, and large for new classifications. Lines in the HR1-HR2 hardness ratio diagram show the predicted position for sources with a power-law spectrum (dash-dotted) for Γ = 1 (black), 2 (red), 3 (blue) and a disc black-body spectrum (dashed) for kT = 0.5 keV (black), 1.0 keV (red), and 2.0 keV (green) for different absorbing foreground N_H (thick for 10^{20} cm^{-2}, thin for 10^{21} cm^{-2}).

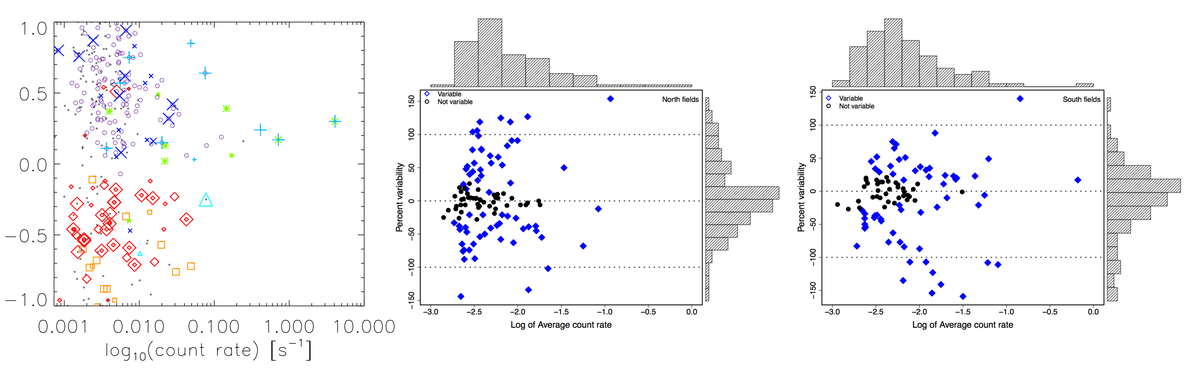

Fig. 4 *Left*: Count rate vs hardness ratio HR2. Same symbols as in Fig. 2 are used. Globular cluster sources are brighter than other types of sources and are neither soft nor hard. *Right*: Average count rate vs fractional normalised variability for all sources detected in each of the two epochs of the north (left) and south (right) XMM-Newton LP fields. Sources with significant variability are marked with blue diamonds. Dashed grey lines mark the zero and 100% variability levels (Henze et al., in prep.).

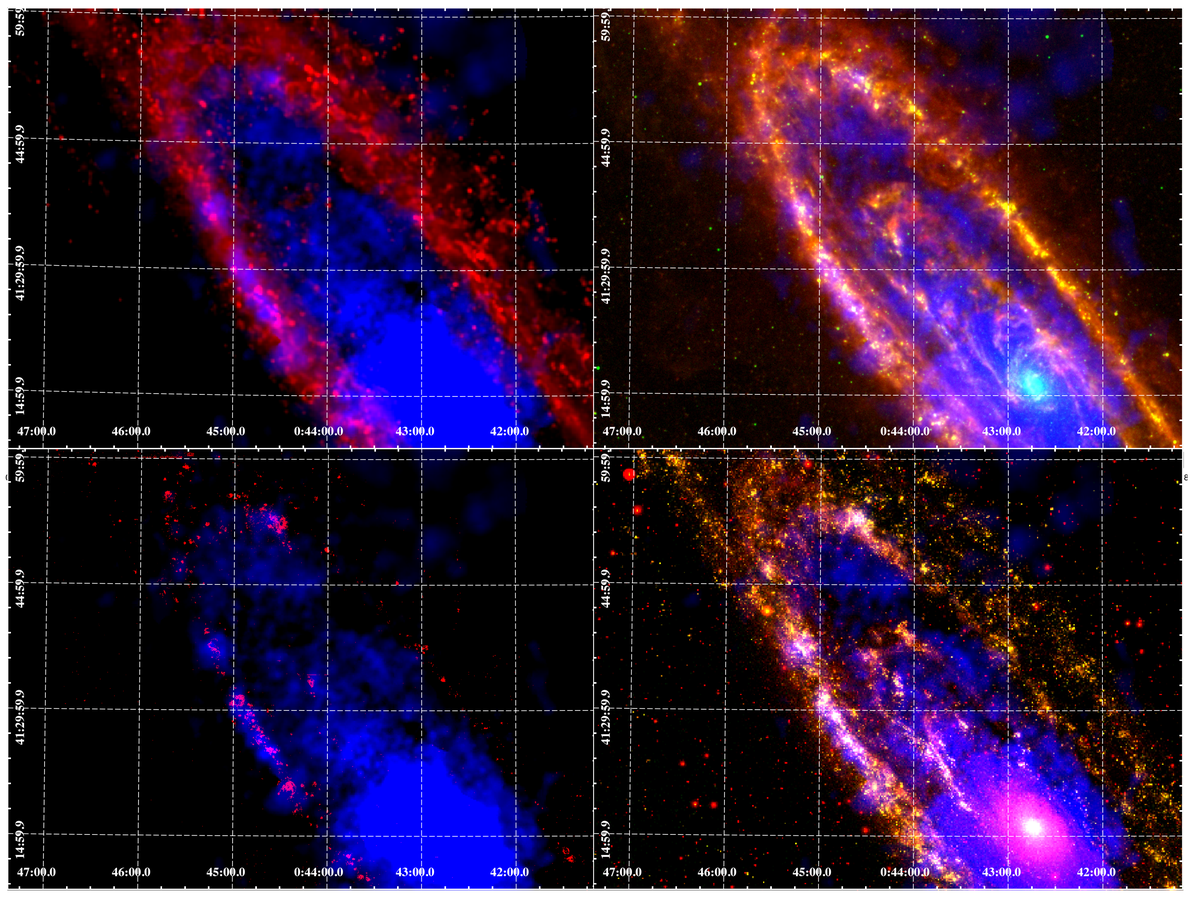

Fig. 2 Multi-wavelength comparison of the ISM in the northern disk of M31. The 0.3 - 0.7 keV XMM-Newton image of the diffuse emission is given in blue. All X-ray sources have been excised and filled. Top-left: HI (red). Top-right: dust seen at 250 µm (red) by Herschel SPIRE and at 24 µm (green) by Spitzer MIPS. Bottom-left: Continuum-subtracted Hα (red) from the Local Group Galaxy Survey. Bottom-right: population of massive stars, seen in NUV (red) and in FUV (green) by Galex.

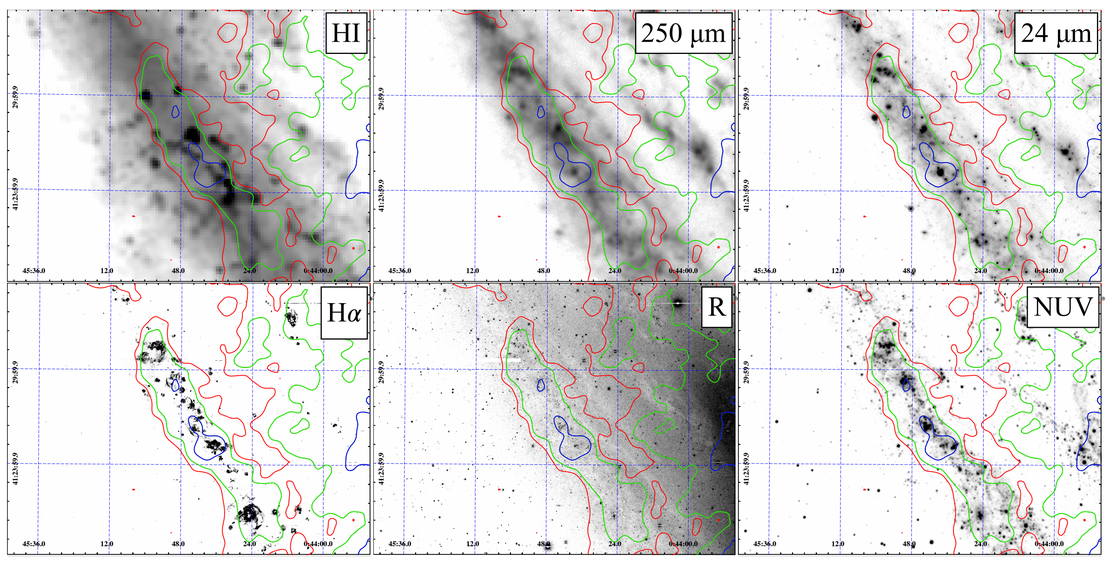

Fig. 5 Multi-wavelength view of the inner dust ring with contours for the X-ray emission (red: 5σ, green: 10σ, blue: 20σ above the average background level, Kavanagh, et al., in prep.).

ObsID	Field	Net Exposure Time
763120101	South (1)	95 ks
763120201	South (1)	51 ks
763120301	North (2)	100 ks
763120401	North (2)	68 ks

Table 1 List of XMM LP observations

Heisenberg-Programm
Deutsche Forschungsgemeinschaft DFG
Bundesministerium für Wirtschaft und Energie
DLR