We present a comprehensive study of the northern disk of M31 using the strengths of three missions: the multi-band optical photometry from the Hubble Space Telescope (Panchromatic Hubble Andromeda Treasury, PHAT, Dalcanton et al., 2012, ApJS, 195, 937). Top-right: dust seen at 250 keV with the footprints of the Chandra and the PHAT surveys shown by solid green northern disk in the energy band 0.2–1.0 keV with classified sources: cyan for XRBs and candidates identified based on comparisons with Hubble and Chandra data, we associated an X-ray source with an optical source, and the X-ray spectral information from XMM-Newton.

The northern disk of M31 was observed with XMM-Newton in a large program (LP, Sasaki et al., 2018, A&A, 620, 28). After sources were identified based on comparisons with Hubble and Chandra data, we determined the spectral properties of all detected XMM-Newt sources by using hardness ratios and, if the statistics were sufficient, by analyzing the spectrum for each source. We also checked for variability. We identified 43 foreground stars and candidates and 50 background sources. Based on the hardness ratios, variability, luminosities, and comparison with the results of the Chandra/PHAT survey, we classify 24 hard X-ray sources as new candidates for X-ray binaries (XRBs). In total, we identified 34 XRBs and candidates as well as 18 supernova remnants (SNRs) and candidates and compiled a complete list of X-ray sources down to a flux limit of 7 × 10^{-17} erg/s (0.5–2.0 keV).

We used all existing XMM-Newton data to create a source-excised mosaic, which gives the most detailed view of the hot interstellar medium (ISM) in a grand-design spiral galaxy such as our own to date. We performed a spectral analysis of the extended X-ray emission using our deep LP observations. The temperature of the hot ISM varies from kT = 0.2–0.3 keV in the ring up to kT = 0.6 keV in a superbubble. We show that the massive stars in the northern disk, in particular, in the 10 kpc star-forming dust ring,  supply sufficient energy to heat the ISM to X-ray emitting temperatures via stellar winds and supernovae (Kavanagh et al., arXiv:1910.12754).

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