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NuSTAR Surveys of M31 and M33: Identifying Black Holes and Neutron Stars in the X-ray Binary Populations of our Nearest Neighbors

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X-ray binaries (XRBs) trace old and new stellar populations in galaxies, and thus star formation history and star formation rate. X-ray emission from XRBs may be responsible for significant amounts of heating of the early Intergalactic Medium (IGM) at Cosmic Dawn and may also play a significant role in reionization. Until recently, the hard emission from these populations could only be studied for XRBs in our own galaxy, where it is often difficult to measure accurate distances and thus luminosities. The launch of NuSTAR, the first focusing hard X-ray observatory, has allowed us to resolve the brightest XRBs (down to L_X ~ few times 10^{38} erg/s) in galaxies like NGC 253, M83, and M82 up to 4 Mpc away. To reach much lower X-ray luminosities that are more typical of XRBs in the Milky Way ($L_X < 10^{37}$ erg/s), we have observed multiple fields in M31 and M33. In M31, 4 deep fields and 7 shallow fields, totaling roughly 2 Ms, have been executed, while M33 is covered by 3 moderate exposure fields totaling 600 ks. We detect 120 sources in the 4-25 keV band in M31 and over 40 hard band (12-25 keV) accreting black holes and neutron stars, distinguished by their spectral shape in this band. The luminosity function (LF) of the hard band detected sources are compared to INTEGRAL- and Swift/BAT-derived LFs of the Milky Way population, which reveals a possible excess of luminous sources in M31 when correcting for star formation rate and stellar mass. In M33, we find a potentially higher fraction of black hole accreting sources, perhaps related to its higher specific star formation rate. The populations in both galaxies are compared to the total XRB population thus far detected in all the galaxies observed by NuSTAR.

Topic

Compact and diffuse sources in galaxies and in the Galactic Center

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