The Hard X-ray Emission of the Milky Way's Nuclear Stellar Disk

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Abstract

One of the key results of the INTEGRAL observatory is characterising the morphology and spectral shape of the Galactic ridge X-ray emission (GRXE) at energies above 20 keV. Our current understanding of GRXE is that this extended background is produced by the combined flux of numerous faint compact objects, as shown by the strong correlation between X-ray luminosity and stellar mass distribution. However, in the central degree of the Milky Way, the emission structure becomes more complex due to the Nuclear Stellar Disk (NSD) - a massive, axisymmetric component that contains most of the old stellar population in the Galactic Center. Large-scale studies of this region with SRG/ART-XC and XMM-Newton show a spatial variation: the mass-normalized X-ray emissivity of the NSD is about 1.5 to 3 times higher than the typical values of the Galactic ridge. To compare the NSD properties with the broader Galactic background and check if this excess is caused by changes in the local stellar population, we combine 3D luminosity density modeling from SRG/ART-XC with a detailed point-source analysis using deep Chandra observations with an exposure of about 800 ks targeting the molecular cloud regions near the Galactic Center. Within a 165 arcminˆ2 area, where the NSD contributes about 63% of the total stellar mass, we detect 734 sources at a significance level above 4 sigma down to a flux limit of 2e-15 erg sˆ-1 cmˆ-2. This flux corresponds to a luminosity of approximately 1.6e31 erg sˆ-1 at a Galactic Center distance of 8.18 kpc. Taking into account local spectral estimates of interstellar absorption, the derived log N - log S distribution shows good agreement with models of the Solar neighborhood and the Norma spiral arm. This indicates that the resolved source population consists mainly of typical cataclysmic variables and shows no unexpected deviations. Meanwhile, the most numerous part of the stellar population - including active binaries and fainter accreting systems - remains below our detection threshold. Our joint analysis shows that the observed emissivity excess of the NSD cannot be explained by the already resolved sources, meaning that studying the ultra-faint population below the current threshold is required to fully understand the nature of the X-ray emission from the central parts of the Galaxy.

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