The NuSTAR serendipitous survey: the 40-month catalog and the properties of the distant high-energy X-ray source population

We present the first full catalog and science results for the Nuclear Spectroscopic Telescope Array (NuSTAR) serendipitous survey. The catalog incorporates data taken during the first 40 months of NuSTAR operation, which provide \( \approx 20 \) Ms of effective exposure time over 331 fields, with an areal coverage of 13 deg\(^2\), and 497 sources detected in total over the 3–24 keV energy range. There are 276 sources with spectroscopic redshifts and classifications, largely resulting from our extensive campaign of ground-based spectroscopic follow-up. We characterize the overall sample in terms of the X-ray, optical, and infrared source properties. The sample is primarily composed of active galactic nuclei (AGNs), detected over a large range in redshift from \( z = 0.002 \) to 3.4 (median of), but also includes 16 spectroscopically confirmed Galactic sources. There is a large range in X-ray flux, from to \( -11 \), and in rest-frame 10–40 keV luminosity, from to 46, with a median of 44.1. Approximately 79% of the NuSTAR sources have lower-energy (<10 keV) X-ray counterparts from XMM-Newton, Chandra, and Swift XRT. The mid-infrared (MIR) analysis, using WISE all-sky survey data, shows that MIR AGN color selections miss a large fraction of the NuSTAR-selected AGN population, from \( \approx 15\% \) at the highest luminosities (erg s\(^{-1}\)) to \( \approx 80\% \) at the lowest luminosities (erg s\(^{-1}\)). Our optical spectroscopic analysis finds that the observed fraction of optically obscured AGNs (i.e., the type 2 fraction) is, for a well-defined subset of the 8–24 keV selected sample. This is higher, albeit at a low significance level, than the type 2 fraction measured for redshift- and luminosity-matched AGNs selected by <10 keV X-ray missions.

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