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Investigating Energy Release in Eleven NuSTAR Microflares

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This work examines eleven solar microflares observed in hard x-rays (HXRs) by the Nuclear Spectroscopic Telescope ARray (NuSTAR). HXR emission in solar flares originates from both hot (millions of Kelvin) plasma and nonthermal accelerated particles, both of which are diagnostic of flare energy release. NuSTAR's direct focusing optics give it a dramatic increase in sensitivity over indirect imagers in the HXR range, allowing for unique insight into the energetics of faint microflares. We discuss the temporal, spatial, and energetic properties of all eleven microflares in context with other published HXR brightenings. They are seen to display several 'large-flare' properties, such as impulsive time profiles and earlier peaktimes in higher energy HXRs. For two events where active region background could be removed, microflare emission did not display spatial complexity: differing NuSTAR energy ranges had equivalent emission centroids. Finally, spectral fitting showed a high energy excess over a single thermal model in all events. This excess was found to most likely originate from additional higher-temperature plasma volumes in 10/11 microflares, and from a nonthermal accelerated particle distribution in the last. These spectral results motivate a more general discussion of the incidence of nonthermal emission across these and other similar-magnitude microflares observed by NuSTAR and other HXR instruments.

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