Comprehensive magnetar burst analysis using NICER data

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Abstract

We present a systematic search for short bursts in all available magnetar observations obtained with NICER. A total of 1130 bursts are identified from 14 magnetars, the majority of which occurred during outburst episodes. Among these, we discover two bursts with microsecond-scale durations, representing the first detection of X-ray bursts on such short timescales. We perform a comprehensive timing and spectral analysis of the burst sample. Bursts from SGR 1935+2154 exhibit significantly longer durations than those from other magnetars. Spectral analysis shows that higher-fluence bursts generally have harder spectra. The waiting-time distributions within intervals of approximately constant burst rate are broadly consistent with Poisson statistics, while little or no correlation is found between burst fluence and waiting time for most sources. Different outbursts exhibit distinct burst rates and, in some cases, departures from a simple Poisson process, suggesting that the burst activity evolves during the course of an outburst. This analysis represents one of the most comprehensive studies of magnetar short bursts with NICER and provides a valuable resource for future investigations of burst physics, population studies, and theoretical models of magnetar activity.

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