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A New Statistical Toolbox for Studying Variability in Fast Transients

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The research in this thesis details ways to characterise and understand variability in short magnetar bursts. Magnetars, neutron stars with exceptionally strong magnetic fields, show variability on many different time scales. Particularly at high X-ray energies, they show bright bursts that are believed to be created by what we call starquakes: a sudden release of energy that triggers global oscillations of the star?s solid crust and possibly the interior. These oscillations, observed in the X-ray light curves of the bright giant flares, are of particular interest, because they have to potential to probe the stellar composition and constrain related nuclear physics.

Because standard statistical methods fail when applied to magnetar bursts, the research in this thesis aims at developing new methods to search for and characterise oscillations in the light curves of short magnetar bursts, and at un- derstanding variability in these sources as well as the underlying physical processes in general. With this new methodology, several oscillations were found in short bursts from two different magnetars, indicating that similar processes are active in both the short recurrent bursts and the longer, brighter giant flares. Additionally, a new model was developed for the underlying aperiodic variability, which, for the first time, allows a comparison of the X-ray variability in magnetar bursts with toy models of the underlying physics.