High time-resolution analysis of X-ray data from Proxima Centauri

Andrea Damonte

CEA Saclay - INAF Palermo

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Abstract

The Ariel mission will be studying the characteristics and the evolution of around one thousand exoplanetary atmospheres. Investigating the XUV emission from their hosting stars is required to assess its effects on their atmospheres and their evolution. Among the systems presented in the target list approximately 100 M-type stars are included. These stars are the most promising to detect and characterize Earth-like, potentially habitable planets. M dwarfs are known for their long-term activity. Although their flares are typically weaker (in terms of released energy) than those usually found in our Sun, the small distances that define the habitable zone (HZ) for these stars imply that HZ planets around them may experience significantly stronger XUV fluxes. The combination of long-term activity and high XUV fluxes makes variability at these energies a main concern to establish whether these planets retain their atmospheres. As a first case sample we have analyzed archival data of Proxima Centauri from the XMM-Newton and Chandra telescopes with special attention to calibration and time-resolution. We propose an original pile-up correction at the level of the data calibration, and compare its performance with respect to more traditional approaches. We find out that, during the brightest flares, fluxes between 0.15 and 10.0 keV may vary by up to 30% when comparing the corrected and uncorrected data. We propose a time binning algorithm that allows the extraction of high-resolution time series in the stellar fluxes and spectra. We use empirical laws to estimate the length of the loop of two bright, time-resolved, flares and compare our result with analogous analyses in the literature. Flux upper-limits for extreme events are extrapolated from the flux distribution under different assumptions. Time-resolved spectra are compared to the average quiescent and flaring literature spectra of the same star.