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

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The study of X-ray and extreme ultraviolet (together, XUV) emission from stars has experienced a renewed interest in recent years. The focus has shifted from the study of stellar physics towards the effects of these emissions on exoplanet atmospheres, and is now part of a bigger field concerned with star-planet interactions. Particular attention is given to M dwarfs, low-mass, cool stars that are the most common in our galaxy. Their systems 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 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 more XUV fluxes. The combination of long-term activity and high XUV fluxes makes variability, in terms of dynamic range and frequency, a main concern to establish whether these planets retain their atmospheres. Stellar XUV radiation is extremely difficult to measure, as it is easily absorbed by the interstellar medium. For this reason, Proxima Centauri, the closest neighbor to us and classified as a flaring M dwarf, represents one of the best candidates for in-depth studies of XUV radiation. We have analyzed archival data of Proxima Centauri from the XMM-Newton and Chandra telescopes, and produced temporal series of its X-ray emission. We have paid special attention to calibration and time-binning.

We propose an original pile-up correction and find that, depending on the treatment of this instrumental effect, fluxes of radiation with energy between 0.3 and 5.0 keV may vary by up to 30%. Pile-up-induced flux-loss is a function of energy and, during the brightest flares, it can reach up to 200% for emissions between 2.5 and 5.0 keV. It reaches 350% when extrapolating the spectra to 10 keV. The quiescent and the flaring emissions from Proxima Centauri are characterized both in energies and in frequencies using nearly 6 days of observations spanning 19 years. Luminosities in the 0.3 - 5.0 keV energy range are presented with uncertainties less than 6% and average time-resolution of 10 minutes. Rates for extreme events are extrapolated from the distributions under different assumptions.

Astrophysics Field

X-rays, M-dwarves, Exoplanets

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