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Particle acceleration in the X-ray knots of Centaurus A

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Centaurus A (Cen A) is our cosmic neighborhood's closest jetted radio galaxy (1). It has been explored across the entire electromagnetic spectrum, from radio to gamma rays, providing evidence for the particle acceleration to very high energies in this object. The direction of Cen A is also associated with an excess of ultra-high-energy cosmic rays, which make it an important candidate to accelerate these particles. Due to the proximity, high power, and the detected emission of high-energy γ-rays, Cen A is a unique target to explore particle acceleration with the Cherenkov Telescope Array Observatory (CTAO), which will be built in the coming years. The CTAO measurements will take our knowledge of particle acceleration in astrophysical sources to a new level. It requires reliable models of particle acceleration. In this work, we develop models of particle acceleration in the knots of Cen A using a multi-wavelength approach. Knots are bright substructures detected in radio and X-ray along the jet and potential sites for particle acceleration and gamma-ray production (2). The most accepted hypothesis for the knot's origin is the collision of the jet material with obstacles, commonly assumed a stellar wind. Combining the data measured for Cen A with relativistic hydrodynamics simulations performed in the PLUTO software (3), we solve the plasma properties in the knot. The results are used in association with theoretical arguments to define the non-thermal electron population in the knot. Using the Naima package, we show that our model are able to describe the radio and X-ray data for the bright knots and we predict the gamma-ray signal of these regions. The possibility of measurement by the CTAO is then explored.

Palavras-chave: Gamma rays; Centaurus A; Particle acceleration

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