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Constraining the cosmic ray spectrum in the vicinity of the supernova remnant W28: from sub-GeV to multi-TeV energies (Poster during the break)

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Supernova remnants interacting with molecular clouds are ideal laboratories to study the acceleration of particles at shock waves and their transport and interactions in the surrounding interstellar medium. In this paper, we focus on the supernova remnant W28, which over the years has been observed in all energy domains from radio waves to very-high-energy gamma rays. The bright gamma-ray emission detected from molecular clouds located in its vicinity revealed the presence of accelerated GeV and TeV particles in the region. An enhanced ionization rate has also been measured by means of millimetre observations, but such observations alone cannot tell us whether the enhancement is due to low energy (MeV) cosmic rays (either protons or electrons) or the X-ray photons emitted by the shocked gas. The goal of this study is to determine the origin of the enhanced ionization rate and to infer from multiwavelength observations the spectrum of cosmic rays accelerated at the supernova remnant shock in the unprecedented range spanning from MeV to multi-TeV particle energies. We developed a model to describe the transport of X-ray photons into the molecular cloud, and we fitted the radio, millimeter, and gamma-ray data to derive the spectrum of the radiating particles. The contribution from X-ray photons to the enhanced ionization rate is negligible, and therefore the ionization must be due to cosmic rays. Even though we cannot exclude a contribution to the ionization rate coming from cosmic-ray electrons, we show that a scenario where cosmic-ray protons explain both the gamma-ray flux and the enhanced ionization rate provides the most natural fit to multiwavelength data. This strongly suggests that the intensity of CR protons is enhanced in the region for particle energies in a very broad range covering almost 6 orders of magnitude: from roughly below 100 MeV up to several tens of TeV.

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Cosmic rays

Primary author: PHAN, Vo Hong Minh (TTK, RWTH Aachen University)

Co-authors: Dr MORLINO, Giovanni (Osservatorio astrofisico di Arcetri); Dr VINK, Jacco (GRAPPA, University of Amsterdam); Dr KRAUSE, Julian (APC, Université de Paris); Dr MENU, Mélissa (Laboratoire de Physique des Plasmas, Université Paris-Saclay); Dr TERRIER, Regis (APC, Université de Paris); Dr GABICI, Stefano (APC, Université de Paris)

Presenter: PHAN, Vo Hong Minh (TTK, RWTH Aachen University)

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