Three-dimensional Models of the Interstellar Medium for the Propagation of Cosmic Rays and their Non-Thermal Interstellar Emissions

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Abstract

High-energy gamma rays of interstellar origin are produced by the interaction of cosmic-ray (CR) particles with the gas and
radiation fields in the Galaxy. The main features of this emission are well-understood and are reproduced by existing CR propagation models employing 2D Galactocentric cylindrically symmetrical geometry. However, the high-quality data from instruments like the Fermi Large Area Telescope reveal significant deviations from the model predictions on few to tens of degree scales indicating the need to include the details of the Galactic spiral structure and thus require 3D spatial modelling.
In this contribution the propagation of CRs and generation of high-energy interstellar emissions are calculated using the latest release of the GALPROP code employing 3D spatial models for the CR source, interstellar gas, and interstellar radiation field (ISRF) densities. The interstellar emission models that include arms and bulges for the CR source and ISRF densities
provide plausible physical interpretations for features found in the residual maps from high-energy gamma-ray data analysis. The 3D CR and interstellar medium density models provide a more realistic basis for interpretation of the direct CR measurements and for their non-thermal interstellar emissions including the directions toward the inner Galaxy and about the Galactic centre.

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