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Unveiling the cosmic-ray density with gamma-ray observations of molecular clouds

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High-energy γ rays, originating from interactions of cosmic rays (CRs) with the interstellar medium (ISM), carry direct information about the spatial and spectral distribution of these relativistic particles. Observations of Fermi-LAT of the diffuse gas unveiled a higher emissivity and a harder spectral index in the inner part of the Galaxy. Analyses of the diffuse emission however are performed on a large spatial scale, usually of several kpc^2 and therefore are subject to contamination both of mis-modeled sources and of unresolved sources. Giant Molecular clouds instead are a unique tool, which can be used as 'barometer'to infer the cosmic-ray density point by point, in distant and small regions of the Galaxy. Their enhanced density ($n_H > 100$ cm^{-3}), compared to the diffuse gas, allows us to derive the CR energy density on scales comparable to the size of the clouds (10–100 pc). We report here the results of the analyses of Fermi-LAT Pass8 data, obtained in the direction of molecular clouds located in the entire galactic disk from 0.1 kpc to 12 kpc from the Galactic Center (GC). The CR densities measured at the locations of these clouds have a high degree of fluctuation and are not always compatible with the values derived from the diffuse gas. I will discuss the observational results and their implications as well as the prospects for future observations.

Summary

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