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Early-time constraints on CR acceleration in the core-collapse SN 2023ixf with Fermi-LAT

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Most known Galactic supernova remnants do not appear to contribute significantly to the cosmic-ray (CR) flux at PeV energies at their current evolutionary stage. However, supernovae (SNe) could still be major contributors to the "knee"of the CR spectrum if their shocks are efficient hadronic accelerators at earlier times –within days or weeks after the collapse of their progenitor's core. Yet testing this hypothesis remains a challenging issue due to the low number of close SNe.

By studying the recent, nearby Type II SN 2023ixf, we present the first effective limits on CR acceleration within a few days after a core-collapse SN through GeV observations. Using Fermi-LAT data and under reasonable assumptions, we obtain a maximum efficiency on the CR acceleration as low as 1% within a week after the SN explosion. We further discuss the possible physical conditions that could loosen the limits back to the expected 10% efficiency for the standard Galactic CR origin scenario and their applicability to SN 2023ixf.

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