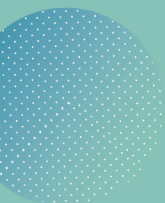




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Constraining the gamma-ray efficiency of LINER outflows with Fermi-LAT and MEGARA

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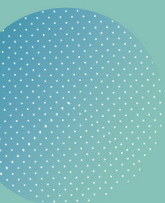
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Abstract

Low-ionization Nuclear Emission-line Regions (LINERs) commonly host ionized gas outflows, but their role as high-energy particle accelerators remains debated, particularly following the very-high-energy gamma-ray detection of NGC 4278, which implied extreme radiative efficiencies. We empirically determine the gamma-ray radiative efficiency of a local sample of LINERs to test whether their high-energy emission can be powered by extended ionized outflows or requires compact nuclear jets. We combine spatially resolved optical integral-field kinematics from the Multi-Espectrógrafo en GTC de Alta Resolución para Astronomía at the Gran Telescopio de Canarias, yielding ionized-outflow kinetic powers, with 17 years of Fermi-Large Area Telescope observations to derive 0.05–500 GeV luminosities or 95% confidence upper limits. We place the sample in an optical/gamma-ray diagram alongside archetypal starbursts and radio galaxies. We present the first empirical upper limits on the gamma-ray radiative efficiency of LINER outflows as a population. No LINER is formally detected ($TS \geq 16$). The strongest constraint is obtained for the radio-loud LINER NGC 1052, with an efficiency below 41%. For the remaining sources, the Fermi-LAT limits generally lie well above the outflow kinetic powers, while three sources show marginal hints of emission ($9 < TS < 16$). We conclude that extended ionized outflows in LINERs are highly inefficient high-energy particle accelerators, analogous to starburst superwinds. These constraints disfavor the outflows as the sole origin of extreme gamma-ray efficiencies and favor compact nuclear jets for the most efficient gamma-ray-emitting LINERs.

