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Relativistic Jets as Particle-Energy Calorimeters: Implications for Astrophysics and Cosmology

Abstract

Relativistic jets from supermassive black holes provide a unique connection between elementary-particle acceleration, high-energy astrophysics, and cosmic evolution. We propose a framework linking jet kinetic power Q_jet to radio luminosity P_radio through

Q_jet = A (P_radio)^β

where A and β encode particle acceleration, magnetic-field properties, and radiative efficiency. By investigating the redshift dependence of this relation, we aim to determine whether jet energy conversion evolves with cosmic time. This approach could establish radio galaxies as laboratories for studying relativistic particle transport, black-hole feedback, and the role of energetic processes in galaxy evolution.