The Production of Ultra High Energy Cosmic Rays via Fermi Acceleration in Relativistic Jets

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Cosmic rays (CRs) composed of mostly protons have energies typically in the range of 10e8-10e13 eV and can plausibly be produced by active galactic nuclei (AGN) such as super massive black holes. However, ultra high energy cosmic rays (UHECRs) were recently identified at the Pierre Auger Observatory with surprising energies of 10e18-10e22 eV. While UHECRs seem to originate from AGN as well, AGN cannot account for the large energies of UHECRs. In a process conjectured by Fermi, it has been suggested that CRs could be accelerated into UHECRs by moving magnetic fields in bow shocks, such as those found in supernova remnants (SNRs). However, that mechanism has since been rejected due to the non-relativistic speeds of SNRs. Nevertheless, the idea of shock acceleration has led others to the hypothesis that jets emitted by AGN acting as a shock front could accelerate incoming CRs into UHECRs. Therefore, the purpose of this project is to evaluate the plausibility of such an acceleration mechanism through a simulation in IDL. With a jet structure based on cone shaped electromagnetic fields, a computable discretized formalism for drifting particles moving in perpendicular electric and magnetic fields was derived. The simulation results yielded a possible acceleration factor of about gamma squared, the gamma representing the relativistic speed of the jet, showing that CRs can plausibly be accelerated into UHECRs by relativistic jets.

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