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Constraints on acceleration of ultra high-energy cosmic rays in Fermi gamma-ray sources

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The current experimental statistics of ultra high-energy cosmic rays (UHECRs) is not sufficient for identification of the sources, although a spatial correlation between the arrival directions of UHECRs and nearby active galactic nuclei (AGNs) has been discussed using the data of the Pierre Auger Observatory and the Telescope Array.
Here, we focused on the Fermi Large Area Telescope gamma-ray sources to search candidates of accelerators of UHECRs because gamma rays would provide the direct evidence of the existence of high energy particles. We first investigated a spatial correlation between gamma-ray sources and the arrival directions of UHECRs. We selected gamma-ray sources with more than one UHECR within 4 degrees from them, taking into account that trajectories of UHECRs are deviated typically about 4 degrees from the directions of acceleration sites mainly due to the Galactic magnetic field. After that, we excluded sources whose redshifts are larger than 0.1 when considering the energy loss of cosmic rays due to the interaction with the cosmic microwave background photons. Finally, we selected five AGNs as candidates of accelerators of UHECRs.
We analyzed their spectrum energy distributions by using multi-wavelength archival observational data (Radio, IR, Optical, X-ray and Gamma ray). Pe'er & Loeb (2012) derived constraints on the ability of AGN to produce UHECRs by using observational quantities which are synchrotron peak luminosity and the ratio of inverse Compton to synchrotron peaks. By introducing the constraints, we evaluate the physical conditions in the acceleration regions of these five AGNs and discuss whether they can accelerate to UHECRs.

Collaboration

– not specified –

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