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A Bayesian Framework for UHECR Source Association and Parameter Inference

The identification of potential sources of ultra-high-energy cosmic rays (UHECRs) remains challenging due to magnetic deflections and propagation losses, which are particularly strong for nuclei. In previous iterations of this work, we proposed an approach for UHECR astronomy based on Bayesian inference through explicit modelling of propagation and magnetic deflection effects. In this contribution, we present our completed framework, which uses spatial, energy, and mass composition data to infer UHECR source parameters. The event-by-event mass information is expected to provide tighter constraints on these parameters and to help identify unknown sources. However, the measurements of the average mass through observations from the surface detectors at the Pierre Auger Observatory already indicate that the UHECR masses are well represented through its statistical average. The explicit constraints on the $\ln A$ moments allow us to analyse publicly available data from the Telescope Array Project and the Pierre Auger Observatory. We apply our method to not only determine individual source-UHECR associations but also infer source properties such as luminosity and spectral index for both preselected source candidates and source catalogues.

Collaboration(s)

Author: WATANABE, Keito (Institute for Astroparticle Physics, Karlsruhe Institute of Technology)

Co-authors: Dr FEDYNITCH, Anatoli (Institute of Physics, Academia Sinica); Dr CAPEL, Francesca (Max Planck Institute for Physics); SAGAWA, Hiroyuki (University of Tokyo)

Presenter: WATANABE, Keito (Institute for Astroparticle Physics, Karlsruhe Institute of Technology)

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