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A method to search for correlations of UHECR masses with the large scale structures in the local galaxy density field

One of the main goals of investigations using present and future giant extensive air shower (EAS) arrays is the mass composition of ultra-high energy cosmic rays (UHECRs). A new approach to the problem is presented, combining analysis of arrival directions with the statistical test of paired EAS samples. An idea of the method is to search for possible correlations of UHECR masses with their (separate) sources.

The method is based on non-parametric statistical test, specifically Wilcoxon rank sum routine, which does not depend on the populations fitting any parameterized distributions. Two particular algorithms are proposed: first, using measurements of the depth of EAS maximum position in the atmosphere, and second, relying on the age variance of air showers initiated by different primary particles.

The formulated method is applied to the Yakutsk array data in order to constrain a possible difference in average mass composition of two paired UHECR sets arriving from the supergalactic pancake and a complementary region.

Author: IVANOV, Anatoly (Shafer Institute for Cosmophysical Research & Aeronomy)

Presenter: IVANOV, Anatoly (Shafer Institute for Cosmophysical Research & Aeronomy)