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# Signatures of ultra-high energy cosmic ray sources in large-scale anisotropy measurements

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The most energetic particles that have ever been detected in the present Universe are the ultra-high energy cosmic rays. These fascinating particles originating from outer space are composed of protons and heavier nuclei with energies exceeding  $1\text{EeV}$  ( $10^{18}\text{eV}$ ). The identification of astrophysical sources that accelerate these nuclei up to the highest energies is hindered by cosmic magnetic fields responsible for the deflection of charged particles. Although the trajectories of ultra-high energy cosmic rays do not point straight towards the acceleration sites, their distribution of arrival directions can provide essential information to understand their origin. In particular, the Pierre Auger Observatory has recently measured a dipolar modulation in the large-scale anisotropies pointing almost to the opposite direction of the Galactic Center, which is an important piece of evidence of an extragalactic origin. (1) In this work, we further develop the understanding about the impact of astrophysical hypotheses in modeling the amplitude of the dipole measured by the Pierre Auger Observatory. We simulated the propagation of five representative stable primaries from nearby galaxies (three active galactic nuclei and 19 starburst galaxies) and from an uniform distribution of background sources taking into account extragalactic magnetic fields and relevant energy loss processes. The simulations were performed using the state-of-the-art propagation code CRPropa 3. (2) We obtained how the amplitude of the dipole behaves as a function of the energy for three sets of nearby galaxies and three luminosities of the sources so that we could encompass reasonable hypotheses of ultra-high energy cosmic ray sources. We also changed the density of the uniform distribution of background sources. For each density, a chi-squared statistical test was used to compare the amplitude of the dipole obtained from the simulations with the measurements of the Pierre Auger Observatory. (3) The density of background sources was considerably constrained regardless of the source model used.

**Palavras-chave:** Ultra-high energy cosmic rays. Astrophysical sources. Pierre Auger Observatory.

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