

The contribution of distant sources to the observed flux of ultra high-energy cosmic rays

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The Greisen-Zatsepin-Kuz'min (GZK) horizon traditionally sets the distance limit for sources generating the UHE CR flux detected on Earth. This horizon is caused by the strong attenuation of Ultra-high-energy (UHE) cosmic rays (CRs) due to their hadronic interactions with cosmic microwave background radiation. It has been argued that the propagation distance of UHE CRs of energies $\sim (10^{18} - 10^{20})$ eV would be about several tens Mpc. We demonstrate that a non-negligible fraction of the UHE CRs arriving on Earth could originate from beyond the GZK horizon when heavy nuclear CRs, and the population and evolution of UHE CR sources are taken into account. Here we present how the multi-particle CR horizon is modified by different source populations and discuss how this leads to the natural emergence of an isotropic background component in the observed flux of UHE CRs. This background component would coexist with an anisotropic contribution associated with nearby foreground sources within the GZK horizon

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Theoretical Results

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