Energy Dependence of Cosmic Ray Anisotropy

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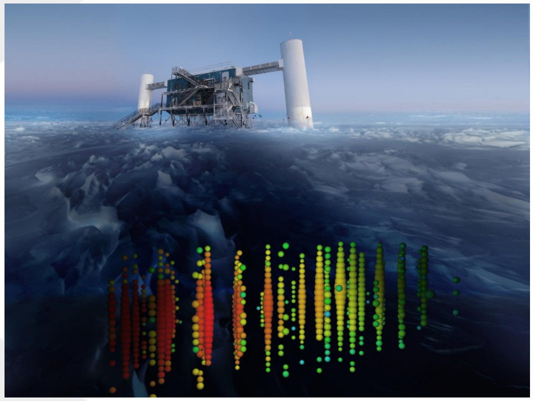
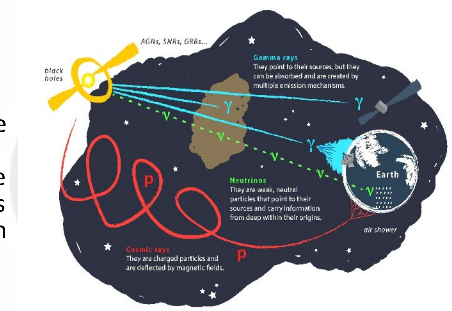
Background

IceCube is a Neutrino Observatory located in the geographical south pole. It is a cubic kilometer in size consisting of 5,160 digital optical modules (DOMs). The optical modules detect incoming cosmic rays from the Southern Hemisphere. We can then reconstruct the arrival direction and energy of these cosmic ray events in order to better understand their origin.



Cosmic Ray Anisotropy

Anisotropy in this case is the uneven distribution of cosmic rays within the range of the sky that the IceCube observatory covers. The focus here is on energy dependence of the observed cosmic ray anisotropy. The ten year data we have collected with IceCube-86 strings provides us with the highest statistical power analysis in studying this phenomenon up to date.



Data Quality Checks

Each run of data at the observatory has a certain amount of good and bad runs. Each run of data lasts for 24 hours. The bad runs must be singled out and subtracted from the good data, and then the new compiled data must be corrected to compensate for the missing time from the 24 hour runtime in the time scrambling method. Several quality checks were applied by me and my collaborators from Mercer University to ensure that this process is done correctly and without any biases.

Conclusion

This analysis of nine years of data taken with the IceCube detector shows an energy-dependent anisotropy in the arrival direction distribution of TeV to PeV cosmic rays in the Southern Hemisphere. Through the IceCube Neutrino Observatory we are able to continue working on the anisotropy of cosmic rays. The phase of the large-scale anisotropy changes rapidly between 130-240TeV. In the near future, we plan to use IceTop data to search for the composition energy dependence in the southern sky.

Acknowledgment

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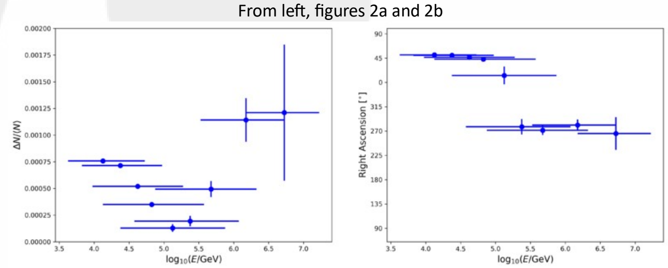
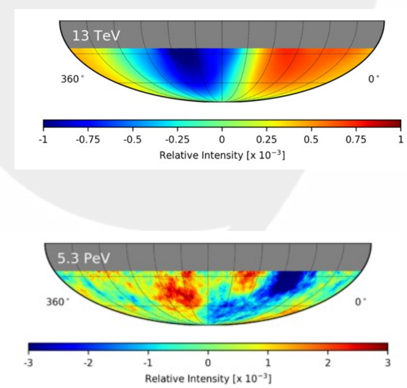
Anisotropy Energy Dependence

The energy dependence of the cosmic ray anisotropy skymaps as observed by IceCube is studied using the number of DOMs and the arrival direction of the detected cosmic rays. Figure 1a and 1b show an example of the two dimensional skymaps for the 13 TeV and 5.3 PeV using the studies event selection method. The two dimensional skymaps are then projected in one dimension and fitted to the first harmonic function. The energy vs. amplitude of the first harmonic fit is shown (Figure 2 a) and energy vs. phase of the first harmonic is shown in (Figure 2b). The excess in the low energy anisotropy flips to deficit in the high energy anisotropy.

From left, figures 2a and 2b





From top, figures 1a, 1b

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