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Cosmic ray propagation and the generalized central limit theorem

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It is amazing to realize that in the current description of Galactic propagation of cosmic rays (CR), sources are not point-like, at least for primary species like protons and helium nuclei. Considering that sources as localized in space and time is more realistic, but leads to puzzling results.

Actually, in the Myriad model, the Galactic variance of, say, the proton flux at the Earth is infinite. Several suggestions have been made to cure this problem. One approach is to consider known local supernova remnants (SNR) and to treat the external sources as a continuous jelly. The proton and helium anomalies observed by PAMELA and CREAM can then be explained in that framework.

It is also possible to go one step further and to solve the infinite variance problem of the Myriad model by making use of the generalized central limit theorem.

I will show that the probability distribution function of the flux does exist in spite of an infinite variance. It follows a stable law with heavy tail well-known by financial analysts. The probability that the PAMELA and CREAM anomalies are sourced by local SNR can then be calculated.

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