

Hardening Effects of the TeV-scale Cosmic Ray Proton and Helium Spectra

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We suggest a new way to understand cosmic ray proton and helium spectrum around TeV-scale energy by introducing discrete local sources. The source of diffusion equation in cosmic ray propagation is set to be a point source given by delta function, contrary to conventional models which have continuous sources. We calculate the spectrum of proton and helium originated in close and young supernovas. By combining the solutions from discrete source and faraway continuous sources, we found cosmic ray propagation parameters of both helium and proton which explain the discrepancy between conventional model of cosmic ray and recent measurements of CREAM, PAMELA, and AMS-02 experiments, without any additional assumptions.

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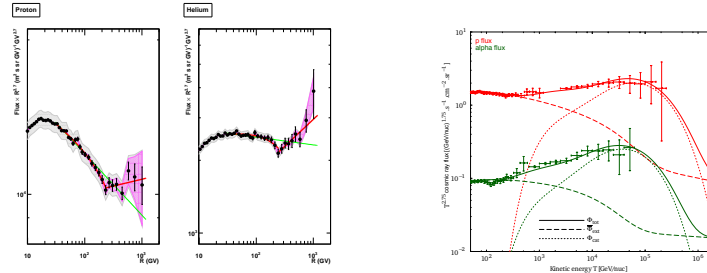


Figure 1: (A) Proton and Helium spectrum reported by PAMELA Collaboration [2], (B) Our result: Proton (upper curve) and helium (lower curve) spectra in the range extending from 50 GeV/nuc to 100 TeV/nuc, for the propagation parameters of model A in ref.[4], giving the best fit to the CREAM [1] and PAMELA [2] data : supernovae explosion rate $\nu = 0.8 \text{ century}^{-1}$. Solid lines show the total flux, short-dashed lines show the flux due to the sources of the catalog, and the long-dashed curve the flux due to the rest of the sources.

Discrepant hardenings in the TeV scale cosmic ray proton-helium nuclei spectra was reported by CREAM [1] and PAMELA [2] experiments. Recently this anomalous phenomena was also confirmed by AMS02 collaboration [3]. Observations have pointed towards an excess in the CR proton and helium fluxes above 250 GeV/nuc. The single power-law hypothesis is rejected at 95% C.L. In this poster, we explain that the proton and helium spectral hardening above 250 GeV/nuc can be attributed to local sources of cosmic rays, whose presence is associated to known supernova remnants (SNR) and pulsars. In the conventional model of CR propagation, these are treated as a jelly spreading over the Galactic disk and continuously accelerating cosmic rays. However in our model, we used the Green Function Method for the point like sources. As shown in Figure 1-(B), this excellent agreement makes us confident that the proton and helium anomaly can actually be explained by existing point-like local sources which have been extracted from SNR and pulsar surveys. To understand more details of our model, we suggest you to touch with our results [4].

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References

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