Contribution ID: **1340** Type: **Talk**

Compact binary millisecond pulsars and the positron excess

Thursday 15 July 2021 19:18 (12 minutes)

We present an analytical model for the fluxes and spectra of positrons accelerated within the intrabinary shocks of compact binary millisecond pulsars (CBMSPs). We find that the minimum energy $E_{\rm min}$ of the pairs that enter the shock is critical to quantify the energy spectrum with which positrons are injected into the interstellar medium. We measure for the first time the Galactic scale height of this new and growing population of nearby neutron stars ($z_{\rm e} = 0.4 \pm 0.1$ kpc) and use this to estimate their local density (5−9 kpc^{-3}). In the isotropic diffusion approximation, our model predicts only a minor contribution from CBMSPs to the diffuse positron flux at 100 GeV observed at Earth. We also quantify the effects of anisotropic transport due to the ordered Galactic magnetic field, which can change the diffuse flux from nearby sources drastically. We find that a single "hidden" CBMSP close to the Galactic plane can yield a positron flux comparable to the AMS-02 measurements at 600 GeV, if its line-of-sight to Earth is along the ordered Galactic field lines. Its combined electron and positron flux at higher energies would be close to the measurements of CALET, DAMPE and Fermi-LAT.

Keywords

cosmic ray theory; millisecond pulsars; neutron stars; particle acceleration

Collaboration

other Collaboration

Subcategory

Theoretical Results

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Session Classification: Discussion

Track Classification: Scientific Field: CRD | Cosmic Ray Direct