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On the impact of the Local Bubble on cosmic ray electron and positron spectra and anisotropy

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The positron fluxes measured by PAMELA and most recently AMS-02, show an excess far above the expectations of secondary positron production in the ISM. These locally observed energetic positrons require a near-by source of even more energetic positrons.
Among the possible explanations for a primary source of such positrons, unaccounted astrophysical point sources or dark matter (DM) decay or annihilation are the most promising ones.
In this context the level of anisotropy in the locally measured $e^{\pm}$ arrival directions is a key observable to differentiate between point sources, such as pulsars, and the DM hypothesis. Compared to protons and nuclei, energetic $e^{\pm}$ lose energy on short timescales. Therefore, any source of energetic $e^{\pm}$ needs to be located in the solar neighborhood, and thus in the proximity of the local bubble, an underdense region surrounding the Sun which is assumed to have its origin in about 20 supernova explosions in the past 10-20 Myrs. This rather peculiar environment may have a non-negligible impact on local cosmic ray transport and in particular on the expected level of anisotropy.
Using general assumptions on the local variations of the diffusion coefficient, as expected for the local bubble, we discuss the impact of this structure on the observed $e^{\pm}$ spectra and the local anisotropy.
We find that under reasonable assumptions about the diffusion coefficient, both the spectra and the local level on anisotropy are affected in a sizeable way. We further find that a good description of the AMS-02 data is possible, while the level of anisotropy may be decreased by up to 80%.

Collaboration

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717

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