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Modelling the antiproton modulation related to AMS-02 observations between 2011 and 2021

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In this study, the previously established set of modulation parameters used to reproduce PAMELA and AMS-02 proton observations between 2006 and 2022 is applied in the 3D steady-state drift numerical model to simulate antiproton spectra observed by AMS-02 detector between 2011 and 2021. In this way, the only differences between galactic protons and antiprotons simulations in the model remain their local interstellar spectra (LIS) and the sign of their charges. This is a better approach to antiproton modelling, especially when novel insights into potentially new physics are sought. Surprisingly, the simulated solar modulation effects on antiprotons were found to be much less pronounced than on protons at the same rigidity. For example, the computed intensity of antiprotons at ~ 1 GV was found to increased by ~13% between 2011 and 2019, whereas for protons at the same rigidity the intensity increased by ~ 86%. This result has now been confirmed by precise AMS-02 observations done at the same position around the Earth and over a long period. In this study it will be shown how the antiprotons LIS at lower rigidities intriguingly resembles the shape of the modulated spectra, and how this greatly influences the adiabatic energy losses these particles experience deep inside the heliosphere.

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