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TIME-DEPENDENT PROPAGATION TIMES AND ENERGY LOSSES OF PROTONS IN THE HELIOSPHERE: A SOLAR MODULATION MODELLING IN LIGHT OF NEW COSMIC-RAY DATA FROM OBSERVATIONS

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After entering the Galactic cosmic rays (GCRs) into the heliosphere, their intensities decrease during their propagation toward the Earth. This effect is subjected to a variety of physical processes through their propagation which is referred to as CR solar modulation. The key ingredients in the study of this phenomenon are the knowledge of the local interstellar spectrum (LIS) of Galactic cosmic rays and the understanding of how solar modulation affects the LIS inside the heliosphere. For this purpose, here we present an improved data-driven description of the solar modulation phenomenon, that is, the temporal evolution of the CR flux inside the heliosphere caused by the 11-year variability cycle of the Sun's magnetic activity. The model was applied to the Galactic proton flux measured by Voyager 1, AMS-02, and PAMELA missions which provide valuable information, allowing us to shed light on the shape of the LIS and the details of the solar modulation for the time period from mid- 2006 to mid-2017. The new results for the temporal dependence of the key model parameters, their relationship with solar activity proxies, the implications for the CR transport in magnetic turbulence, and the new insights into our understanding of the solar modulation effect are presented. The study of the time variation of GCR spectra observed on Earth can shed light on the underlying physical processes, specifically diffusion and particle drifts.

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