Contribution ID: **353** Type: **Poster**

On the transition from 3D to 2D transport equations for a study of long-term cosmic-ray intensity variations in the heliosphere

Wednesday 14 July 2021 12:36 (12 minutes)

We consider in our study the exact two-dimensional (2D) transport equation (TPE) for galactic cosmic ray (GCR) intensity in the heliosphere, averaged over longitude, and derived by averaging the full three-dimensional (3D) steady-state TPE over longitude. As we showed before, this exact 2D TPE is equal to that with the averaged 3D TPE coefficients but with the "source-term"Q2D due to 3D modulation effects. In particular, Q2D is equal to the longitude convolution of the longitudinal variances of the coefficients as used in the 3D TPE and as applicable to the modulation of GCR intensity. In our previous work we also suggested an expression (Q˘_2D) for Q2D when estimated without solving the 3D TPE for the simplest case of the only characteristic, heliospheric feature depending on helio-longitude is the polarity of the solar magnetic field.
This study is focused on calculating the term Q˘_2D equal to the same longitude convolution as Q2D when solving numerically the steady-state 3D TPE for the above mentioned simplest case. For cases of close similarity between Q˘_2D and Q˘_2D, we come to the conclusion that the 2D approach with Q˘_2D can be used with confidence in the study of the long-term modulation of GCRs instead of using the complex way of solving the full 3D TPE for this simplest case. However, if the calculated (Q˘_2D) and estimated (Q˘_2D) terms are found to be different, the application of the complex way seems inevitable.
This work is supported in part by RU-SA NRF-RFBR grant No. 19-52-60003 SA-t.

Keywords

Collaboration

other Collaboration

Subcategory

Theoretical Methods

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Session Classification: Discussion

Track Classification: Scientific Field: SH | Solar & Heliospheric