Contribution ID: **873** Type: **Talk**

COSMICA: A GPU-Optimized Code for Solar Modulation Studies

Wednesday 16 July 2025 16:05 (15 minutes)

We present COSMICA, an opensource high-performance GPU-accelerated numerical code for modeling cosmic ray solar modulation, and its application to study CR diffusion parameters. Developed within the framework of the ICSC-Italian Research Center on High-Performance Computing, Big Data and Quantum Computing (Spoke-3), COSMICA is undergoing continuous software optimization to maximize efficiency on NVIDIA architectures. COSMICA is coupled with SDEGnO, another ICSC project, designed for the efficient parameter tuning, exploring the large parameter space in solar modulation studies. As a first physical use-case study, we exploit COSMICA to investigate Forbush decreases (FDs), which are transient cosmic ray intensity reductions caused by interplanetary disturbances. The analysis leverages the high-precision daily measurements from AMS-02, which provide cosmic ray fluxes across a wide range of rigidities. The ability to simultaneously study not only protons but also helium isotopes offers complementary insights into charge- and mass-dependent transport effects. By analyzing FD events, we assess localized variations in diffusion parameters and their impact on cosmic ray transport. The results confirm the stability of the rigidity dependence of the diffusion tensor, supporting the use of FDs as probes of localized well constrained heliospheric conditions. The computational efficiency of COSMICA paves the way for large-scale simulations, systematic FD catalogue analysis and a more in-depth understanding of the parameter that regulates the solar modulation, together with their dependencies.

Collaboration(s)

Author: DELLA TORRE, Stefano (Universita & INFN, Milano-Bicocca (IT))

Co-authors: Dr CAVALLOTTO, Giovanni (INFN Sez. Milano-Bicocca); LA VACCA, Giuseppe (Universita & INFN, Milano-Bicocca (IT)); Mr BACCIU, Leone (Università ca foscari); Prof. NOBILE, Marco Salvatore (Università ca foscari); GERVASI, Massimo (Universita & INFN, Milano-Bicocca (IT)); Mr GRAZIOSO, Matteo (Università ca foscari); Prof. ROSSI, Sabina (Università ca foscari)

Presenter: DELLA TORRE, Stefano (Universita & INFN, Milano-Bicocca (IT))

Session Classification: SH

Track Classification: Solar & Heliospheric Physics