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An ab initio high performance computing approach to time-dependent cosmic-ray modulation

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A physics-first approach is followed to model cosmic-ray (CR) modulation from first principles, using a novel time-dependent three-dimensional stochastic solver of the Parker transport equation. This approach places a strong, primary emphasis on understanding the basic causes of cosmic-ray modulation. This requires knowledge and an understanding of both the large scale quantities such
as the heliospheric magnetic field, heliospheric tilt angle and the solar wind speed, and the small scale quantities such as the magnetic variance and correlation scales. By its very nature, this approach is extremely computationally expensive, and requires high-performance computation on a large scale, such as that made available by the CHPC. The end result is the most realistic solar-cycle dependent three-dimensional cosmic-ray modulation model to date, that is able to self-consistently reproduce the major salient features of the observed cosmic ray intensity temporal profiles. A better understanding of the primary drivers of cosmic-ray modulation, is essential to being able to glean valuable insights into new, fundamental physics in the transport of highly energetic charged particles originating from astrophysical sources.

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