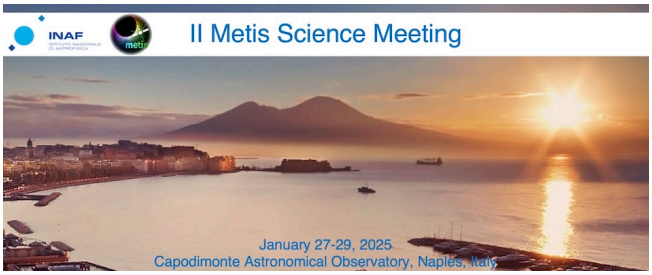

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Reconstructing the interplanetary propagation of the September 5, 2022 ICME event with a data-driven MHD simulation

On September 5, 2022, a Coronal Mass Ejection (CME) was multiply observed by coronagraphs on board the STEREO and SOHO spacecraft, and by the WISPR coronagraph on board the Parker Solar Probe (PSP). A few hours later, the plasma and magnetic field of the perturbation were measured in-situ by PSP at 0.07 AU and by Solar Orbiter at 0.7 AU. This event offers therefore a unique set of constraints for physical modeling. Here, we present a numerical MHD simulation of the interplanetary CME propagation in the heliosphere. The Parker Spiral is accurately reconstructed from 5 solar radii to 1 AU using RIMAP, a data-driven hybrid analytical-numerical technique. The magnetic field and solar wind background conditions are reconstructed from PSP in-situ measurements before and after the CME encounter. From the conditions ballistically remapped at 5 solar radii, the whole Parker spiral is then reproduced by solving numerically the MHD equations with the PLUTO code. The CME enters the RIMAP-reconstructed spiral at 5 solar radii as a magnetic flux-rope adapted from the Titov-Démoulin model, with parameters constrained from coronagraphic observations. The MHD simulation describes the propagation of the CME out to 1 AU. An artificial tracer allows us to track the CME plasma. The highly structured and realistic reconstruction of RIMAP allows us to draw conclusions on the interaction between the CME and the Parker Spiral with a good degree of accuracy. We compare the properties of the CME-driven shock to the in-situ measurements of PSP and Solar Orbiter, and, in the light of the few free parameters, discuss the validity and limitations of the model and also how this event would have been measured by a spacecraft at 1 AU.

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