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Surface Flux Transport Modelling using Physics Informed Neural Networks.

The evolution of the solar magnetic field is the key factor governing space weather drivers. Accurate forecasting of space weather requires precise modelling of the magnetic field's evolution on the solar surface using methods like Surface flux transport (SFT). Conventionally used SFT modelling techniques involve grid-based numerical schemes, making them computationally expensive. In this presentation, we present a novel, mesh-independent machine learning-based approach using Physics-Informed Neural Networks (PINNs) to simulate the temporal evolution of Bipolar Magnetic Regions (BMRs) on the solar photosphere. We compare the PINNs-based model with the state of the art numerical model using the Runge-Kutta Implicit-Explicit (RK-IMEX) scheme for both 1D and 2D SFT equations. We find PINNS to be more accurate with better flux conservation than conventional schemes. We further validate the applicability of PINNs with real data by comparing the magnetic flux results from PINNs with observations from SOHO/MDI. The ability of PINNs to solve advection-diffusion equations make it an efficient and accurate technique to simulate magnetograms. These simulations may serve as input boundary conditions for space weather forecasting tools to predict solar wind plasma parameters at the L1 point.

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Track Classification: Diagnostic tools and numerical methods in solar physics