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Application of physics-informed neural networks to neutron star magnetospheres

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Physics-informed neural networks (PINNs) have gained massive popularity in recent years as competent PDE solvers in a wide variety of physical applications. Combining powerful machine-learning techniques with information about the physical system at hand, they manage to surpass many obstacles that inhibit other classical numerical methods, such as the curse of dimensionality. In addition, they are able to produce new solutions with different physical parameters, boundary conditions or source terms extremely fast once trained, proving to be more efficient in cases where multiple solutions are required. In this work, we employ PINNs for the solution of neutron star magnetospheres. We show that our solver is suitable enough to reproduced any of the well-established results and give insight to new, unexplored families of solutions. Furthermore, we demonstrate that with the correct configuration of the optimization process that takes place during training, PINNs can be competitive with classical numerical methods in terms of accuracy and computational speed, while maintaining an advantage in terms of flexibility and generality.

Presenter: STEFANOU, Petros (Universidad de Alicante / Universidad de Valencia)

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