

P4.1052 SPH simulation of cylindrical and toroidal MHD systems

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See full abstract here

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Smooth Particle Hydrodynamics (SPH) [1] is a Lagrangian numerical method to solve the equations of hydrodynamics. It has been used by the Astrophysical community to model MHD phenomena quite successfully and it has been recently extended to include laboratory plasmas in cylindrical geometries [2]. Its Lagrangian nature allows us to discretise the MHD equations without the need of an underlying mesh and its derivation endows the resulting equations with simultaneous conservation of mass, momentum and energy. In SPH all the MHD fields are defined over a discrete set of moving particles and smooth fields are constructed through an interpolation technique. Temporal integration of the SPH equations does not require large matrix inversions which gives SPH the potential to be efficiently parallelised into many processors. Also, the ability of the method to construct its evolution equations in Cartesian coordinates allows it to tackle complex geometries like ITER and the Wendelstein-7X, with relative simplicity.

In this contribution we aim at extending the applicability of the SPH method by creating initial conditions for toroidal geometries restricted to circular cross-sections and aspect ratios $a/R > 2$ and around its curved boundaries. Finally, we test our Smooth field constructed with SPH. results by initialising our system to Solo'vev equilibrium solution of the Grad-Safranov equation and addressing stability questions and conclude by sketching the way towards a general toroidal geometries and realistic fusion scenarios.

References

- [1] J.D.Price, "Smoothed particle hydrodynamics and magnetohydrodynamics", *Journal of Computational Physics*, 231, 759-794, (2012)
- [2] Vela Vela L et. al., "Magneto-hydrodynamical nonlinear simulations of magnetically confined plasmas using smooth particle hydrodynamics (SPH)", *PoP*, 26, 1, 012511 (2019)

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