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Magnetic dynamo in SWIFT simulations

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Dynamos and astrophysical magnetic field (MF) evolution can be studied with numerical simulations.
There is an ongoing effort to implement cosmological MFs evolution in SWIFT code using smoothed particle hydrodynamics (SPH) for the first time. The code contains several implementations: solve direct induction equations or evolve vector potential. Having different implementations might help to estimate numerical uncertainty in MF evolution.
To check the capabilities of the schemes we simulate a well-studied Roberts Flow dynamo.
We demonstrate the ability of all schemes to converge with the resolution, as well as reproduce critical magnetic Reynolds number that is within the 10% range from Pencil code results, and recover correct growth rate behaviour vs physical resistivity when the latter is large.
However, we find direct induction schemes produce incorrect growth rates, chaotic field configuration and unphysical growth in planar flow where we don't expect dynamos to happen.
We explore how adding artificial resistivity helps to fix the ideal MHD limit.
Next, we consider a system with MFs with two separate physical scales to see how the inverse cascade of magnetic fields happens in SWIFT and compare the results with analytical estimates from mean-field theory.
Dynamo action happens in galaxies, and created MFs are expelled by outflows. To test the code in the astrophysical setting we study a conducting gas disc with MFs and move on to low-resolution cosmological MHD runs.

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