

## Proposal for a M2 internship (spring 2027)

Laboratory name: Laboratoire Interdisciplinaire des Sciences du Numérique  
CNRS identification code: LISN-CNRS, UMR 9015

Contacts : Caroline Nore, Victor Botez

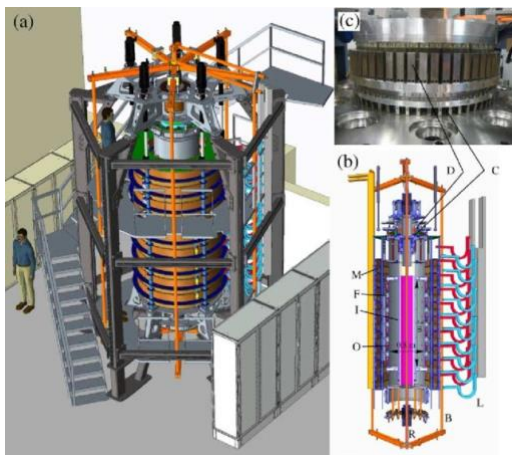
e-mail: [caroline.nore@universite-paris-saclay.fr](mailto:caroline.nore@universite-paris-saclay.fr) (phone : 01 69 15 80 90) ; [victor.botez@lisn.fr](mailto:victor.botez@lisn.fr)

Web page: <https://perso.limsi.fr/nore>

Location: Rue du Belvédère Campus Universitaire d'Orsay, bâtiment 508

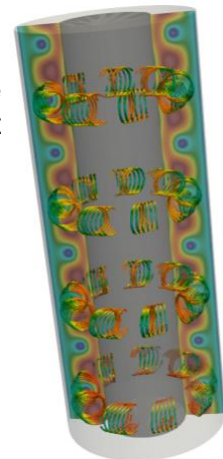
### Magnetorotational instability in an accretion disk

The aim of the project is to investigate the physical mechanisms and processes governing instabilities in an accretion disk orbiting a massive central object, which may give rise to turbulence. Because pure hydrodynamic models fail to explain astrophysical data, additional phenomena should be considered in order to explain how turbulence drives the transport of angular momentum. A primary candidate is the magnetorotational instability (MRI), which is triggered by the interaction of the accretion disk's motion with a background magnetic field. The proposed work will combine numerical simulations within an idealized framework known as the 'Taylor-Couette configuration' with magnetohydrodynamic theory. The results will enable a comparison with the forthcoming DRESDYN-MRI experiment [1] using liquid sodium, currently under construction at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR, Germany), which aims to detect and study different types of MRI in the laboratory.



Left figure: Sketches of the upcoming MATISSE experiment (credit: HZDR [1])

Right figure: Visualization of the unstable magnetic mode in the Standard magnetorotational instability (SMRI) configuration



**Methodology, tools:** Numerical computations will be carried out using a fully non-linear 3D code called SFEMaNS [2], coupled with a linear toolkit enabling the calculation of the most unstable modes responsible for the instability [3]. Validation will be assessed by comparison with published reference results.

**Benefits, expected results, supervision:** The results will be discussed in collaboration with colleagues working on the development of the future DRESDYN-MRI experiment [1], which uses liquid sodium at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR). The intern will work with Caroline Nore (head of the fluid mechanics department at LISN) and Victor Botez, a PhD student. Both are members of the COMET team.

- [1] F. Stefani, A. Gailitis, G. Gerbeth, A. Giesecke, T. Gundrum, G. Rüdiger, M. Seilmayer, and T. Vogt, The DRESDYN project: Liquid metal experiments on dynamo action and magnetorotational instability, *Geophys. Astrophys. Fluid Dyn.* 113, 51 (2019).
- [2] J. L. Guermond, R. Laguerre, J. Léorat et C. Nore : [Nonlinear magnetohydrodynamics in axisymmetric heterogeneous domains using a Fourier/finite element technique and an interior penalty method](#), *J. Comp. Physics* 228 (2009) 2739–2757.
- [3] <https://github.com/nekStab/LightKrylov>