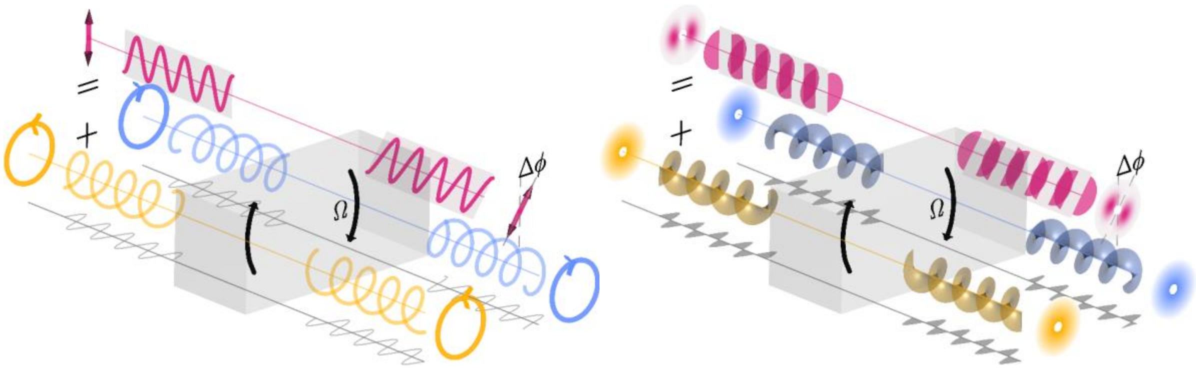
Wave propagation in rotating plasmas

M2 Internship

Laboratoire Plasma et Conversion d'Energie (Laplace)
CNRS - Université Paul Sabatier – Toulouse

Context – The properties of wave propagation in a moving medium differ from those in a medium at rest. In the case of a rotating medium, rotation leads to circular birefringence, and thus to a rotation of the polarization of a linearly polarized wave propagating along the rotation axis of this medium (left hand-side figure below). In plasmas, it has recently been uncovered that this mechanical effect might be at play in the rotating magnetosphere that surrounds pulsars, possibly affecting galactic magnetic field measurements in astrophysics [1]. This same mechanical effect in plasmas may also enable new means to manipulate light in laboratory on Earth [2]. Furthermore, beyond affecting wave polarization, that is the spin component of the wave's angular momentum, it has just been found that plasma rotation can also affect the wave's orbital angular momentum in a phenomenon known as image rotation [3] (right hand-side figure below). Besides bringing forth a suite of fundamental questions, this new effect in plasmas may hold promise for rotation diagnostics, notably in magnetic confinement fusion experiments.



Polarization rotation (left) and image rotation (right) resulting from the propagation of a wave along the rotation axis of a rotating medium

Objectives – Many questions remain on the properties of wave propagation in rotating plasmas and their possible applications [4]. Indeed, the first analytical results discussed above have been obtained for idealized configurations (geometry, composition, …) and it is anticipated that an in-depth examination will reveal more unique facets of rotation. The more systematic study of these effects is the objective of the ANR-funded Warp project which started in 2022, in collaboration with specialists both in astrophysics and high-energy density plasma experiments. As part of this project the intern will work alongside a PhD student and the PI to get acquainted with the basic theory capturing these effects. A particular focus of this internship will be on the study of numerical modelling tools that could be used to validate and extend theoretical results developed in this project. It is expected that the results of this internship will later be put to use as part of a PhD project (ideally as a continuation of this internship)

Candidate education - M2 Physics / plasma / astrophysics.

Candidate profile: Strong analytical skills, good physical intuition, curiosity and resourcefulness are essential assets for this project**.** Some coding experience and an interest for numerical modelling will prove useful.

Keywords - Electrodynamics / electromagnetism & optics / plasma physics.

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Preferred start date – March 1st, 2023.

Possibility to continue as a PhD project - Yes, as part of an ANR-funded project.

[1] R. Gueroult *et al.* (2019), Nat. Commun., **10**, 3232

[2] R. Gueroult, J.-M. Rax and N. J. Fisch (2020), Phys. Rev. E, **102**, 051202(R)

[3] J.-M. Rax and R. Gueroult (2021), J. Plasma Phys., **87**, 905870507

[4] R. Gueroult, J.-M. Rax and J. J. Fisch (2022), arXiv.2209.15346

To apply please send CV, cover letter and transcripts to renaud.gueroult@laplace.univ-tlse.fr