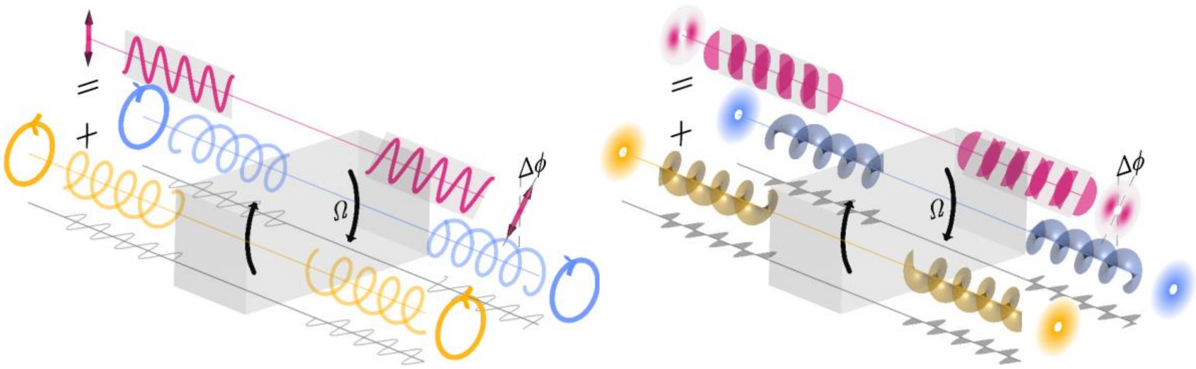
Importance of the plasma motion on wave propagation properties

Postdoctoral position (18 months)

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). This is the manifestation of the beam drag induced by the medium's motion. Besides bringing forth a suite of fundamental questions [4], 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 – Despite these new results, the effect of motion on plasma waves remains largely unexplored, and also importantly unaccounted for in models. 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. This includes two PhD theses, currently working on developing models to capture the effect of rotation on plasma waves [5,6,7], beyond the simple models available to date. An objective of the Warp project is however to eventually used these models to assess the importance of these effects in experiments or natural environments. The proposed scope for this postdoctoral project is therefore to apply these new models to practical rotating plasma configurations, to quantify the importance of rotation effects in these environments. This could, for instance and depending on the candidate's skills and interests, be in astrophysics or magnetic confinement fusion. Ultimately the goal will be to propose ways to account for or leverage these effects.

Candidate education – PhD in plasma physics or wave physics.

Candidate profile: Strong analytical skills, good physical intuition, curiosity and resourcefulness are essential assets for this project**.** Knowledge of and experience with wave physics in the context of magnetic confinement fusion and/or space physics will be helpful.

Keywords - Electrodynamics / electromagnetism & optics / plasma physics.

Supervisor & contact - Renaud Gueroult – renaud.gueroult@laplace.univ-tlse.fr, +33 (5) 61 55 62 43

Preferred start date – May 2025, until filled.

[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 (2023), Plasma Phys. Control. Fusion, **65**, 34006
[5] J. Langlois and R. Gueroult (2023), Phys. Rev. E, **108**, 045201
[6] J. Langlois and R. Gueroult (2024), Proc. R. Soc. A, **480**, 300
[7] A. Braud, J. Langlois and R. Gueroult (2025), Comptes Rendus Physique, **26**, 7

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