Wave propagation in rotating plasmas ⋆

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As postulated by Fresnel and demonstrated by Fizeau, 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 for instance to circular birefringence, and thus to a rotation of the polarization of a linearly polarized wave propagating along the rotation axis of this medium.

While the examination of rotation effects on propagation in isotropic dielectrics can be traced back to the work of Fermi, the exploration of these effects in anisotropic plasmas is only at its inception. Yet, 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]. If confirmed, this mechanical effect in plasmas could also enable determining the otherwise inaccessible rotation direction of pulsars. Furthermore, looking this time on Earth, this same mechanical effect in plasmas may also enable new means to manipulate light in laboratory experiments [2]. Lastly, 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].

Besides bringing forth a suite of fundamental questions, the uncovering of these new manifestations of rotation in plasmas may hold promise for rotation diagnostics, notably in magnetic confinement fusion experiments. In this talk I will discuss both the fundamental modifications to wave physics introduced by rotation and the manifestations of these effects in real-world settings.

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References

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