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O4.401 The Spectral Web of the super-Alfvénic rotational instability in accretion disks: an alternative to the MRI paradigm!

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The recently developed theory of the Spectral Web [1, 2] is a method to compute the full complex spectrum of stationary plasmas together with a connecting structure. This permits to consider the enormous diversity of MHD waves and instabilities of rotating tokamaks and astrophysical plasmas from a single unifying view point.
Presently, the Spectral Web approach is applied to explore the non-axisymmetric rotational instabilities of accretion disks about black holes and neutron stars. These modes are driven by the extremely super-Alfvénic equilibrium flows which are symmetry breaking through the dominant Doppler shift mOmega. Here, m is the toroidal mode number and Omega is the angular rotation frequency of the disk. The spectrum of complex modes becomes a very intricate interplay between the real frequencies of the four Dopplershifted forward and backward Alfv¥en and slow continua (Omega±A,S = mOmega ± w A,S) and the closely associated complex frequencies of the non-axisymmetric (m different from 0) instabilities. The latter appear as infinite sequences 'emitted' from the continua along paths in the complex w-plane provided by the Spectral Web method. Due to the closeness of the continua, the resulting modes exhibit extreme localization in the radial direction.
This is in complete contrast to the standard axisymmetric (m = 0) magnetorotational instabilities (MRIs) [3], where the continua w A,S are not Doppler shifted and they do not interact with the MRIs since they are located far away from them in the complex w-plane. Consequently, the MRIs form a finite sequence of unstable eigenvalues, which turn into stable waves when approaching the real axis. Hence, the modes do not have the extreme radial localization that is exhibited by the non-axisymmetric modes. Since the very reason of accretion is generally considered to be the turbulence caused by the magneto-rotational instabilities, it is clear that the non-axisymmetric super-Alfvénic rotational instabilities provide a relevant alternative.

[1] J. P. Goedbloed, Phys. Plasmas 25, 032109 & 25, 032109 (2018).
[2] Hans Goedbloed, Rony Keppens and Stefaan Poedts, Magnetohydrodynamics of Laboratory and Astrophysical Plasmas (Cambridge University Press, 2019).
[3] S. A. Balbus and J. F. Hawley, Astrophys. J. 376, 214 (1991).

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