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 viewpoint.

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 \(m\Omega\). 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 Doppler-
shifted forward and backward Alfvén and slow continua \((\Omega_{A,S}^\pm \equiv m\Omega \pm \omega_{A,S})\) and the
closely associated complex frequencies of the non-axisymmetric \((m \neq 0)\) instabilities.
The latter appear as infinite sequences ‘emitted’ from the continua along paths in the
complex \(\omega\)-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 \((m = 0)\) magneto-
rotational instabilities (MRIs) \([3]\), where the continua \(\omega_{A,S}\) are not Doppler shifted
and they do not interact with the MRIs since they are located far away from them in
the complex \(\omega\)-plane. Consequently, the MRIs form a finite sequence of unstable eigen-
values, 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.