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A new instability along toroidal magnetic field in differentially rotating plasmas

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We discuss a new type of instability expected to take place in an accretion disk, which has a differentially rotating plasma threaded by a weak magnetic field, by performing linear eigenvalue analysis. We study the linear stability of a disk with a localized, toroidal magnetic field in the radial direction, which can be expected in an accretion disk during the nonlinear evolution of the magneto-rotational-instabilities (MRI).

The MRI is believed to be a strong source of magneto-hydro-dynamic (MHD) turbulence and the resultant angular momentum transport in the accretion disk, which is required for the gas to accrete onto the central object. Once the MRI grows, the system is chiefly governed by the toroidal and radial magnetic field newly generated by the dynamo action of MRI. Such a configuration allows the Alfven waves to propagate along toroidal direction.

In this talk, we study the linear stability of the Alfven wave in the local Cartesian coordinate, the so-called shearing periodic box, and show that the toroidally propagating Alfven wave can become unstable if its wavelength is larger than the length scale of the localized magnetic field gradient. We investigate our results of the linear eigenvalue analysis by changing the structure of the localized magnetic field, and discuss some properties of the instability with examining the eigenvectors and eigenvalues. It is revealed that this type of instability may also appear in non-rotating plasma, but it is highly suppressed in a rigid body rotating plasma. In addition to the linear analysis, the corresponding nonlinear behavior will also be discussed by using MHD numerical simulations. This instability plays an important role in the plasma transport because it probably couples with the magnetic reconnection occurring in the equatorial plane and then to contributes to the saturation mechanism of the MRI.