# High wavenumber behaviors in 3D MHD instabilities of LHD

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MHD instability is one of a key physics of macroscopic motions in a fusion device. In a helical fusion device such as the Large Helical Device (LHD), the interchange and/or ballooning instabilities are considered as the most important instabilities. In these, so-called *short-wave instabilities*, unstable linear-eigen modes have larger growth rates for high Fourier wavenumbers. Since the unstable modes with high wavenumbers (high modes) should grow faster than the lower modes, they are expeceted to influence the growth of lower modes. (Here we refer to *high modes* as the modes with the toroidal Fourier wavenumber comparable to the pitch number of the device, that is $n = 10$ for the LHD.) The behaviors of the high modes are not clarified yet because it is difficult to identify them in experiments and it is difficult to simulate their growth in simulations since growths of them are often suppressed by some dissipative effects to avoid a numerical instability. Nevertheless, it is essential to study the growth of high modes, since their growth and possible saturations can be closely related to the lower modes.

Based on this understanding, we conduct numerical study on some basic behaviors of the high modes. Full 3D MHD simulations are carried out for the $R_{ax} = 3.6m$ inward-shifted magnetic configuration by the use of the MHD In Non-Orthogonal System (MINOS) code.[1] In the MINOS code, the 8th-order compact finite scheme[2] is adopted. Due to the very high accuracy/high resolution of the compact scheme, the MINOS simulation with sufficient number of grid points is suitable to study the numerical study of the high modes. Influences of some physical parameters such as the resistivity, heat conductivity, viscosity will be studied as well as some artificial effects such as the hyper viscosity, which is sometimes applied to enable nonlinear saturation with sufficiently high Reynolds number flows. It is also noted that the behaviors of very high modes should be influenced by the Hall effect in the induction equation, which is not included in an one-fluid MHD analysis. Some basic study of the Hall effect on the high modes will be also shown.

[1] H. Miura et al., AIP Conference Proceedings **871** (2007) pp.157-168
[2] S.K. Lele, J. Compu. Phys. **103** (1992) pp.16-42.