MHD Theory of Rotating Tokamak Plasmas

in collaboration with
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This activity withthin the ***Space and plasma physics*** programme is focused on fundamental plasma theory with application to fusion research, at present mainly MHD stability theory of rotating tokamak plasmas. The research is a part of the Swedish and European research programme on magnetic confinement fusion and is financed by EURATOM.

Geodesic acoustic mode (GAM) induced by plasma rotation [1, 2]

A geodesic acoustic mode induced by toroidal rotation in a tokamak plasma was discovered in [1]. Through a centrifugal-convective effect the zonal-flow eigenmode of zero frequency in a static plasma gets a finite frequency .

$$\omega_{GAM\,1}^2 = \omega_s^2\left(2+\frac{1}{q^2}+\frac{8\mathcal{M}^2}{\Gamma}\right)$$

$$\omega_{GAM\,2}^2 = \frac{\mathcal{M}^2\Omega^2}{3}\left(1-\frac{1}{\Gamma}\right)$$

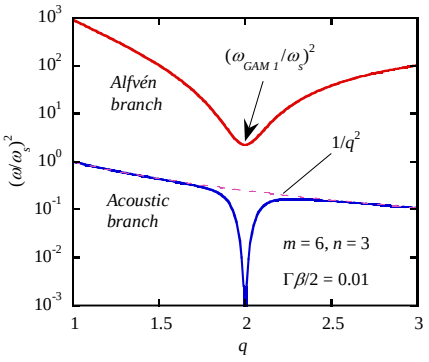

Fig. 1: MHD continua in a static plasma

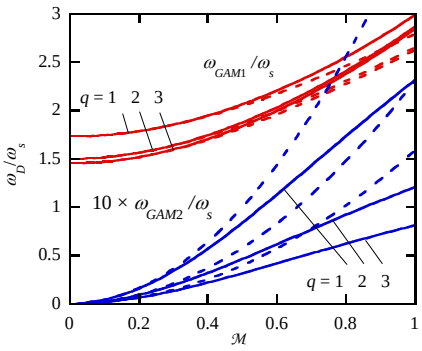

Fig. 2: Continuum frequencies vs Mach number at the resonant surfaces in a rotating plasma [1,2]

Stabilizing/destabilizing effects of toroidal rotation and rotation shear on various MHD modes in tokamak plasmas [3, 4, 5]

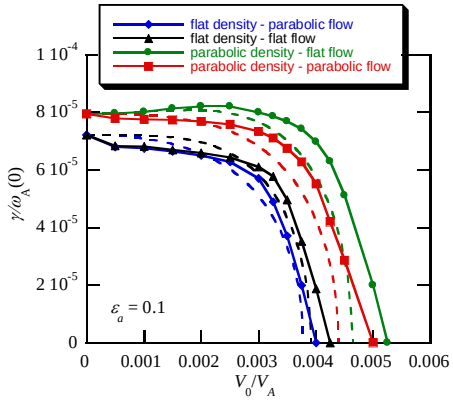

Fig. 3: Stabilization of the internal kink mode in tokamaks by toroidal rotation (dashed = analytical, solid = numerical code) [3,4]

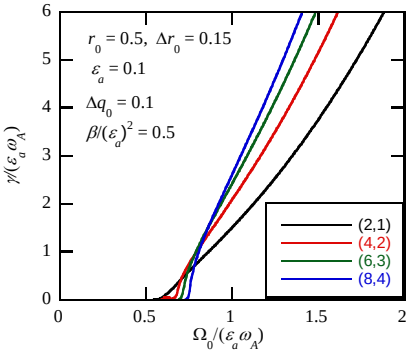

Fig. 4: Destabilization of Kelvin-Helmholtz instability of different mode numbers (m,n) in a rotating tokamak plasma with strong rotation shear [5]

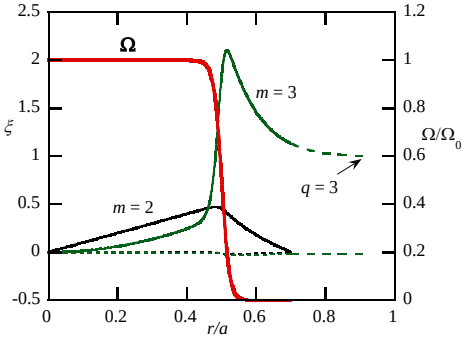

Fig. 5: Rotation profile and eigen-function associated with the Kelvin-Helmholtz instability in the Fig. 4 [5]

References

[1] Wahlberg, C., Physical Review Letters, 101, 115003, 2008.
[2] Wahlberg, C., Plasma Physics and Controlled Fusion, 51, 085006, 2009.
[3] Wahlberg, C., Chapman, I. T., Graves, J. P., Physics of Plasmas, 16, 112512, 2009.
[4] Chapman, I. T., Graves, J. P., Wahlberg, C. and the MAST Team , Nuclear Fusion, 50, 025018, 2010.
[5] Chapman, I. T., Walkden, N., Graves, J. P., Wahlberg, C., Physical Review Letters, 2011, (to be submitted)

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