§1. Effects of Dissipations on MHD Stability in Heliotron Configuration

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In heliotron configurations, the most crucial MHD instability is the interchange mode. The Mercier criterion gives a rough estimation against the mode and previous experiments in several machines showed the consistency between the criterion and the experimental data. In the recent CHS high beta criterion; however, an equilibrium beyond the beta limit estimated by the Mercier criterion were observed[1]. In order to consider the stabilizing mechanism, the effects of viscosity and heat conductivity on MHD stability are studied in heliotron configuration here. The RESORM code[2] is utilized to examine these effects, which is based on the reduced MHD equations. In this case, the viscosity and the heat conductivity terms are added in the vorticity and the state equations, respectively. The straightforward incorporating the viscosity term brings a block penta-diagonal matrix, which leads to a big loss of the calculation time and region, because the RESORM code utilizes the full implicit method. In order to avoid such loss, Okamoto-Amano's method[3] are employed here. By using the method, the viscosity term can be separated and the Laplacian operator is integrated analytically once. As a result, the block tri-diagonal matrix is retained as in the original RESORM code.

The linear stability of a currentless LHD equilibrium with a broad pressure profile. In this case, the equilibria at $\beta_0 = 1\%$ and $\beta_0 = 3\%$ are unstable against the resistive and the ideal interchange modes. First, only the effect of the viscosity is examined. As shown in Fig.1, the growth rates γ of both modes are reduced as the viscosity coefficient ν increases. However, only the viscosity cannot stabilize them completely. On the other hand, the modes are stabilized completely with large heat conductivity κ as shown in Fig.2. Of course, the modes are more effectively stabilized when both effects are included.

The coefficients of both effects for the substantial reduction of the growth rates are in the observed anomalous transport. Furthermore, in the case of sufficient large viscosity and heat conductivity, the higher mode number is, the more effectively the modes can be stabilized. It can explain that high mode number fluctuations are not dominant in experiments. Therefore, it can be considered that these dissipations are one of the candidates of the mechanism for the plasma observed in CHS experiments at higher beta value than the Mercier limit.

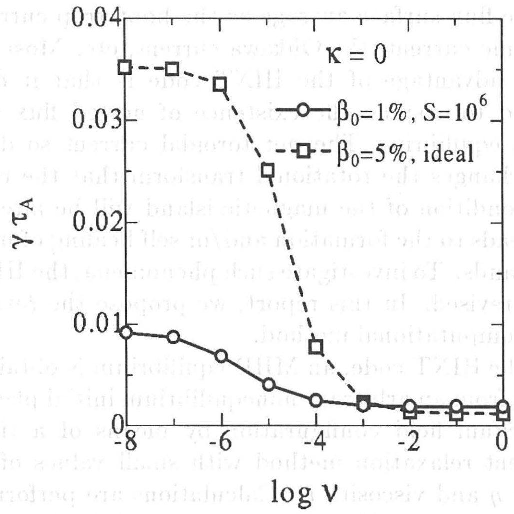

Fig.1 Growth rates versus viscosity.

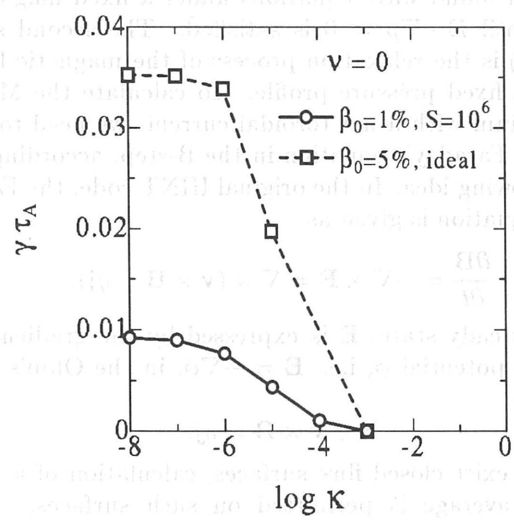

Fig.2 Growth rates versus heat conductivity.

References

1) Ichiguchi, K., et al., Nucl.Fusion 29 (1989) 2093.

2) Okamoto, M., Amano, T., J.Comp.Phys. 26 (1978) 80.

3) Okamura, S., et al., in Plasma Physics and Controlled Nuclear Fusion Research 1994(1995) 381.