§6. Relation of High-n TAE Modes to High-n Ballooning Modes in Heliotron/Torsatrons

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Considered are the relation of high-n TAE modes to high-n ballooning modes in currentless heliotron/torsatrons allowing a large Shafranov shift. As mentioned in the report entitled "High-n ballooning modes in helical systems allowing a large Shafranov shift", the localized distribution of the Pfirsh-Schlüter current to keep the toroidal force balance causes the high-n ballooning modes in the Mercier stable strong positive global shear region through the vanishment of the local shear $\hat{s}$. The local shear $\hat{s}$ consists of the global shear s and an oscillatory part $\tilde{s}$:

$$\hat{s} = s + \tilde{s}$$

In the high-n ballooning stable low-β plasma, the deformation of the flux surface is weak, and the oscillatory part $\tilde{s}$ has the phase of the helicity of helical coils, which could not cancel the global shear. In this situation, the shear Alfvén spectral gaps are well separated from each other by the shear Alfvén continuum as is shown in Fig.1.

In the high-β plasma, however, as the Shafranov shift becomes large, i.e., the corresponding Pfirsh-Schlüter current becomes strongly localized away from the plasma boundary, $\tilde{s}$ has the phase of toroidicity which cancels the global shear in the strong positive global shear region. Moreover, the large Shafranov shift makes not only the toroidicity, but also the ellipticity and the triangularity of the flux surfaces. Thus, in the high-β plasmas with the large Shafranov shift, the 1st, 2nd, and 3rd spectral gaps in the shear Alfvén continuum are significantly widened by the toroidicity, the ellipticity, and the triangularity, respectively. This means that the shear Alfvén continuum between the shear Alfvén spectral gaps becomes narrow, leading to the coupling of the descrite eigenmodes in each spectral gap as is shown in Fig.2. Especially, the fact that the lowest shear Alfvén spectral gap from $\omega^2 = 0$ to the lower boundary of the 1st spectral gap becomes narrow seems to lead to the situation that the high-n ballooning modes are easy to occur.

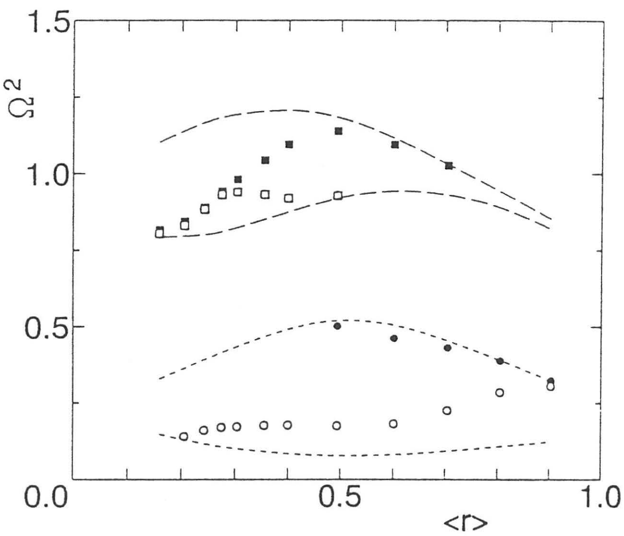

Fig.1 Eigenvalues of high-n TAE modes in a low-β heliotron/torsatron plasma. Open circles and squares indicate even modes. Solid circles and squares denote odd modes.

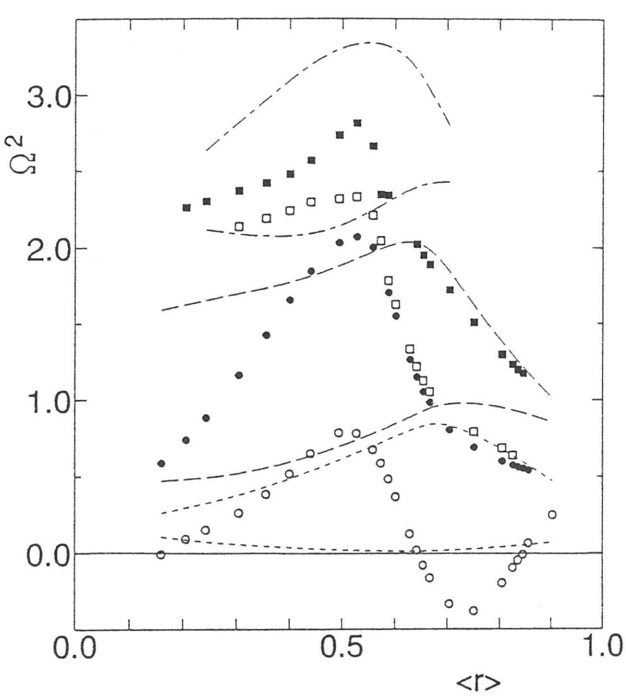

Fig.2 Eigenvalues of high-n TAE modes and high-n ballooning modes in a high-β heliotron/torsatron plasma. Symbols have the same meaning as ones in Fig.1.