

§17. Fishbone like MHD Modes Observed in NBI Heated Plasmas

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Two types of fishbone like MHD modes destabilized by the presence of energetic ions are observed in plasmas heated by co-injected neutral beams, that is, one is $m=2/n=1$ fishbone like modes excited only in inward-shifted plasmas (i.e., magnetic axis-position of the vacuum field $R_{ax} \leq 92$ cm) and the other is $m=3/n=2$ modes excited in slightly outward-shifted plasmas ($97 \text{ cm} \geq R_{ax} \geq 95 \text{ cm}$). In these plasmas the beam beta is 0.2-0.3 % and comparable to the averaged bulk plasma beta. The frequency of $m=2/n=1$ modes is relatively low (≤ 50 kHz) and that of $m=3/n=2$ ones is relatively high (50-110 kHz). However, the frequency of both fishbone like modes is rapidly shifted during each burst, that is, "frequency chirping" takes place. Figure 1 shows expanded time evolution of the $m=3/n=2$ mode amplitude and temporal frequency. From heavy ion beam probing, it is confirmed that this frequency shift is not due to change of the electrostatic potential during each burst. The relative fluctuation amplitude to the toroidal magnetic field reaches $b_{\theta}/B_t \sim 1 \times 10^{-4}$. Figure 2 shows correlation between the $m=3/n=2$ fishbone like modes and energetic ion loss flux for three cases: for the configuration of $R_{ax} = 95$ cm (top and middle figures) and for $R_{ax} = 97$ cm (bottom figure). As seen from Fig. 2, energetic ion loss flux is transiently enhanced in the plasmas of $R_{ax} = 97$ cm, when the fluctuation amplitude grows up to a certain amplitude ($\sim 6 \times 10^{-5}$ T). In the plasmas produced at slightly inward position ($R_{ax} = 95$ cm) than the case of $R_{ax} = 97$ cm, the transient increase in ion loss flux is not always observed, associated with the modes. The transient increase in energetic ion loss flux is preferentially observed in outward

shifted plasmas where sizable particle loss cone exists in CHS.

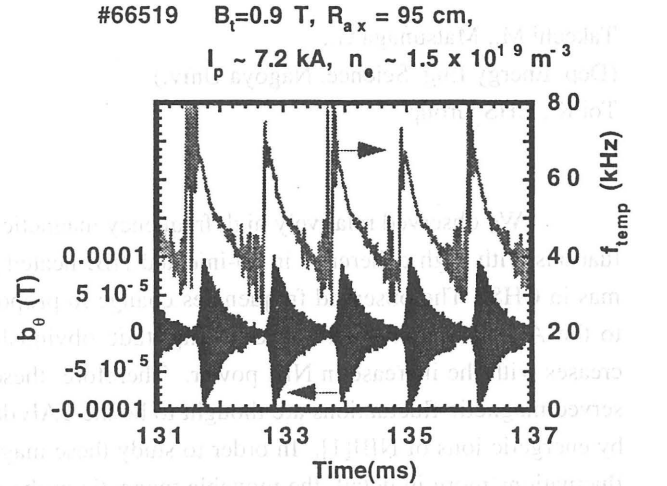


Fig.1 Enlarged time evolution of magnetic fluctuation amplitude and temporal frequency for the $m=3/n=2$ fishbone like modes in the $R_{ax} = 95$ cm configuration.

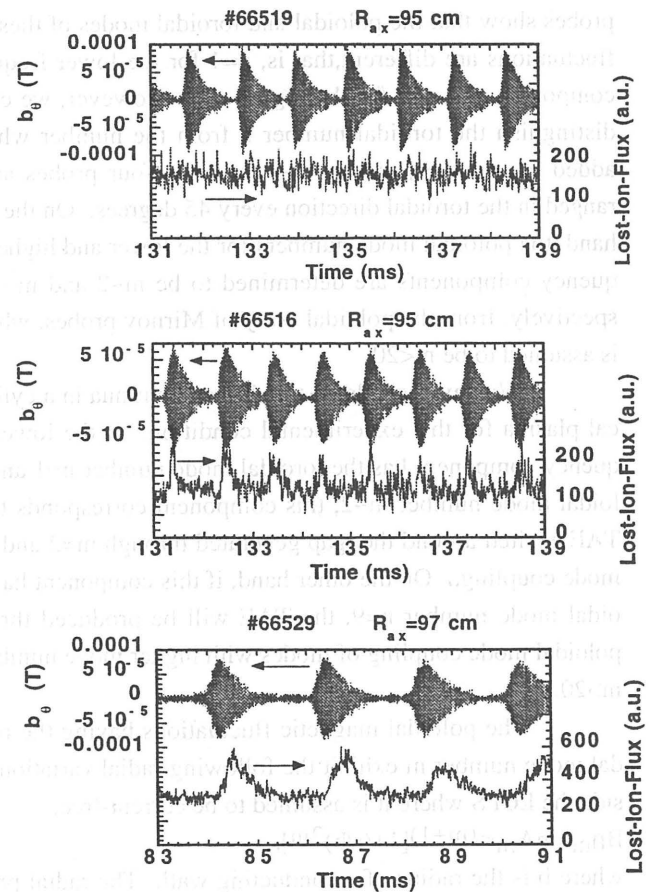


Fig.2 Time evolution of the $m=3/n=2$ fishbone like modes and energetic ion loss flux measured with a lost ion probe, for two configurations with $R_{ax} = 95$ cm (top and middle figures) and 97 cm (bottom figure).