§6. Spontaneous Magnetic Fluctuation in HYPER-I Plasma

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MHD phenomena commonly play an important role in astrophysical plasmas and confined plasmas in toroidal devices. There are increasing demands in laboratories to realize an MHD plasma in a linear device since the basic understanding on MHD phenomena can be easily obtained in a plasma with simple geometory. However, MHD plasmas are only produced in a few specially-desgined linear devices except toridal confinemet devices because of difficulty of producing a high density plasma.

The characreristic features of HYPER-I plasma are high density and low magnetic field intensity, which may provide an MHD plasma condition in an open linear device, and thus an experimantal envirtonment for studying MHD phenomena.

Spontaneously excited magnetic fluctuation has been observed in a high density operation of the HYPER-I device, where an argon plasma is produced by high power (10 kW) microwave with a frequency of 2.45 GHz. The tipical plasma parameters are as follows: $n \sim 1 \times 10^{13}$ cm^{-3} and $T_e \sim$ 10 eV. Since the ambient magneric field is 900 G, the beta value of the plasma is as high as 0.4%, which is exceptionally high among existing open-ended linear devices.

Figure 1 shows the magnetic fluctuation measured with a magnetic probe located at 3 cm from the center axis of plasma. In the magneric probe, a 100-turn coil with a diameter of 2 mm was instralled in a ceramic tube of 8 mm in diameter for thermal insulation. The detected fluctuation is the perpendicular component with respect to the magnetic field, and the parallel component is much smaller than the perpendicular one. The frequency of the largest component of the measured magneric fluctuation is about 100 kHZ, which is about three times higher than the ion cyclotron frequency (36 kHz) and much lower than the lower highbrid frequency. Since the magneric fluctuation was synchronously observed along the magnetic field, we measured the radial profile of the time averaged square of the fluctuation field. The result is depicted in Fig.2, which indicates that the intensity of the magnetic fluctuation peaks at r~3 cm. When the spontaneous magnetic fluctuation occures, high energy electron bursts (~ 100 eV) are observed in the core region of the plasma. Furthermore it is quite interesting to note that these high energy electrons are axially emitted both sides from a fixed position corresponding ω/ω_{ce}=0.9. It is also interesting that there exists a burst in magnetic fluctuations synchronous with the high energy electron emission. Altough the detailed understanding on this phenomenon has not been obtained, the experimental results shows that there may be a close relation between the MHD activities and particle acceleration. We may conclude that the HYPRER-I device provides a new environment for studing MHD phenomena in a simple geometory and in a steady state plasma condition.

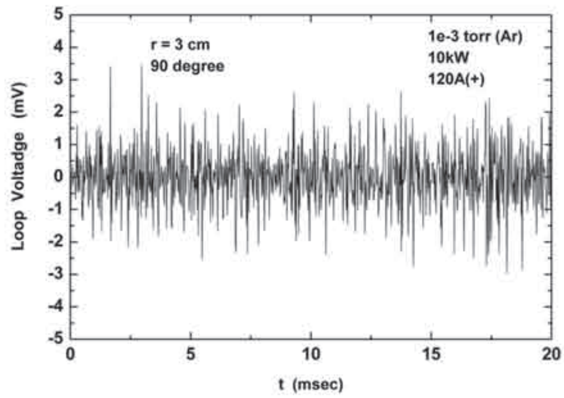

Fig.1 Perpendicular magnetic fluctuation measured with a magnetic probe. Radial position r = 3cm.

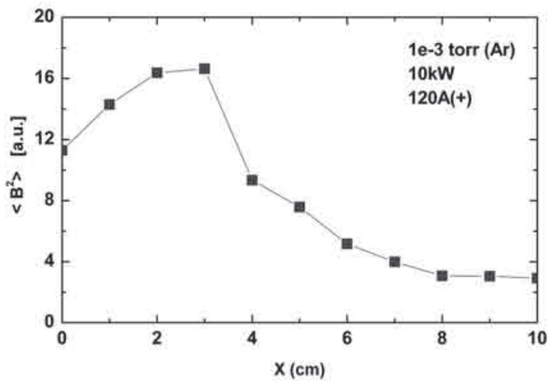

Fig. 2 Radial profile of intensity of magnetic fluctuation. High-energy electron bursts are observed r ~3cm.