§7. Effects of Electron Temperature Gradient on Low Frequency Plasma Instabilities

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In recent years, an anomalous electron heat transport in magnetically confined plasmas is a big issue,[1)] which is considered to be caused by an electron temperature gradient (ETG) driven instability (ETG mode). In addition, it is theoretically reported that the ETG mode is difficult to be suppressed by ExB velocity shear, which is different from an ion temperature gradient mode.[2)] On the other hand, since the ETG mode is affected by not only the ETG but also a density gradient, the radially uniform density profile is desired to understand the precise mechanism of exciting the ETG mode. Although there are some earlier experimental studies on the ETG mode in large fusion devices,[3)] the observations of the ETG mode are not enough to explain the exciting mechanism clearly, because the fusion devices do not fit in independently controlling the electron temperature and density gradients due to the additional discharge caused by the localized electron heating. Based on these backgrounds, a basic plasma experiment using a linear device which is able to independently control the plasma parameters has been performed to understand the excitation mechanism of the ETG mode.[4,5)]

Even in the basic experimental investigation, however, it is difficult to change the scale-length of the ETG with density and potential gradients kept constant, which is very effective in the growth rate of the ETG mode. In this sense, a particle simulation is very useful method to clarify the effects on the ETG, because the simulation can easily set these parameters. From the viewpoint of investigating the general properties of the ETG mode, the simulation should be performed in the three dimensional (3D) system because in most cases waves propagate obliquely or perpendicularly to the direction of the ETG.

In the first stage of this research, we consider the method of introducing the ETG in the conventional code which we have been used. In the basic experiment, as shown in Fig. 1, the ETG perpendicular to magnetic field lines is formed by superimposing high-temperature electrons of an electron cyclotron resonance (ECR) plasma, which pass through two different-shaped mesh grids, upon low-temperature thermionic electrons emitted from a tungsten hot plate. Furthermore, a radial profile of a space potential can be controlled independently of the ETG by changing the bias voltage of the hot plate.

In our work, we have discussed a plan to develop a three dimensional particle simulation with a configuration similar to that of the above-mentioned experiments to clarify more details of the ETG mode. Here, the electrons with different temperature and the ions with constant temperature are injected into the system from grounded emitters placed at the both ends of the system. In addition, the radial density profile of the high temperature electron will be varied in order to control the scale-length of the ETG.

On the other hand, in order to investigate the effect of the ExB velocity shear on the ETG mode, we attempt to control the radial potential profile by changing the potential of the low-temperature electron emitter.

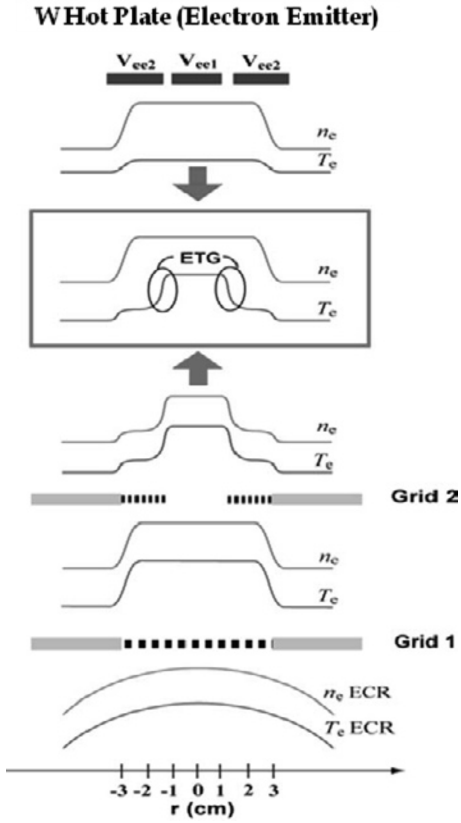

Fig. 1. Experimental configuration of the formation of the electron temperature gradient, where the high-temperature electrons of the ECR plasma are superimposed on the low-temperature thermionic electrons.

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2) Gao, Z. *et al.*, Phys. Plasma. **11** (2004) 3053.
3) Mazzucato, E. *et al.*, Nucl. Fusion **49** (2009) 055001.
4) Moon, C. *et al.*, Rev. Sci. Instrum. **81** (2010) 053506.
5) Moon, C. *et al.*, J. Plasma Fusion Res. SERIES, in press.