§13. Density Threshold of Plasma Detachment in Gas Target Experiments

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The simulated gas target divertor experiment has been performed to investigate fundamental physics of plasma detachment in the linear plasma device, TPD-I, which has a high heat flux and high density plasma in steady state[1]. The existence of density threshold for plasma detachment was observed in our experiment. It is found the electron-ion temperature relaxation process is a key to deterimin the density dependence of the plasma detachment[2].

The inset in fig. 1 shows the schematic of experimental arrangement. When the plasma is attached, the plasma is terminated by the water-cooled target plate, located at a distance 87 cm from the orifice. Neutral pressure P_n measured with the capacitance manometer at 33cm away from the orifice, can be controlled up to 25 mTorr. The n_e, T_e and space potential Vs are measured by two fast-scanned Langmuir probes deginated "downstream" and "upstream," installed at a distance 20 cm and 53 cm from the target plate, respectively.

Figure 1 shows the dependence of plasma pressure P, which is estimated as $n_e T_e$ by meaning n_e and T_e at different positions along the magnetic field line, on the neutral pressure P_n. Furthermore, we note that the plasma pressure P is much larger than the neutral pressure P_n, in which the plasma detachment is observed. At a high plasma density $n_{e0} \sim 1.3\times10^{19}$ m^{-3}, the downstream plasma pressure is found to be decreasing more dramatically with an increase in P_n than that at upstream, as shown in fig. 1(a). On the other hand, at $n_{e0} \sim 2.0\times10^{18}$ m^{-3}, P is gradually decreasing at both positions. Figure 1(c) shows the ratio of P' s at downstream and upstream, which indicates that there is a steep plasma pressure drop only in the high plasma density $n_{e0} \sim 1.3\times10^{19}$ m^{-3}. Figure 2 shows n_{e0}'s dependence of the neutral pressure: P_{detach} at which plasma detachment occurs. As decreasing n_e, the threshold value of P_{detach} is found to be rapidly increased, and below $n_e \sim 1.6\times10^{18}$m^{-3}, plasma detachment is not observed in our experimental condition. This result indicates that there is the plasma density threshold for a generation of the plasma detachment.

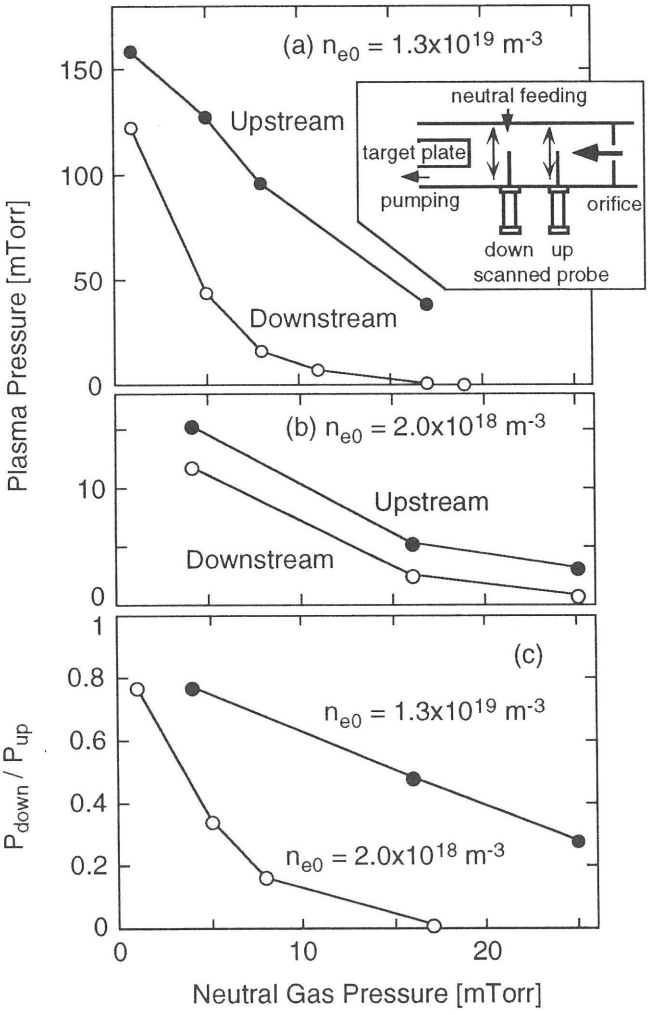

Fig. 1 Dependence of plasma pressure on neutral gas pressure P_n. (a) $n_{e0} \sim 1.3 \times 10^{19}$ m^{-3}, (b) $n_{e0} \sim 2.0 \times 10^{18}$ m^{-3} and (c) the ratio of the plasma pressures measured at upstream and downstream.

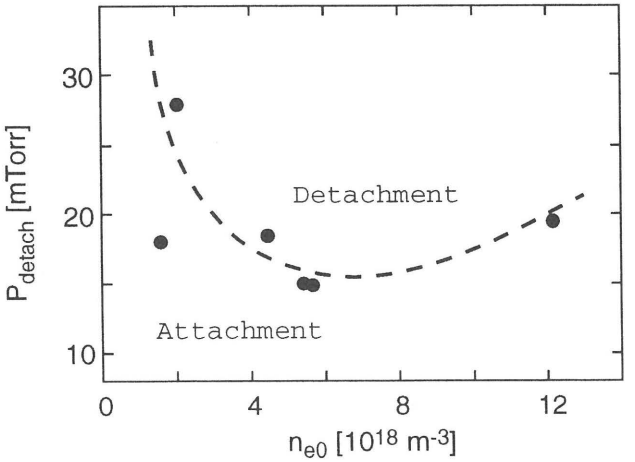

Fig. 2 Threshold values of the neutral pressure for the plasma detachment as a function of n_{e0}.

Reference

1) N. Ohno et al., J. Nucl. Mater. 220-222 (1995) 279.
2) N.Ohno et al., Contri. Plasma Phys. to be published.