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ECRプラズマ中の間欠的電子流束の統計的性質に対するイオン種の効果
Effect of Ion Species on Statistical Properties of Intermittent Electron Flux in an ECR Plasma

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Recently, spontaneous emission of intermittent electron flux has been observed in a linear electron cyclotron resonance (ECR) plasma produced in the HYPER-I device at NIFS. In order to investigate statistical properties of this phenomenon, the temporal variation of floating potential measured by a Langmuir probe connected to a high-impedance resistor (1 MΩ) was used in this experiment. One of the advantages of this measurement is its sensitivity to the rapid change in electron flux, i.e. intermittent influx of electrons is observed as a sharp negative spike in the floating potential signal. So far, we have analyzed the floating potential time series measured in helium discharges [1, 2]. The probability density function (PDF) exhibits a skewed non-Gaussian distribution with a long tail in the negative amplitude side, indicating that the signal is dominated by large amplitude negative spikes. The frequency distribution of waiting time, which is defined by the time interval between two consecutive spikes, is well fitted by an exponential distribution, suggesting that the phenomenon be considered as the stationary Poisson process characterized by a constant occurrence probability. In addition, a power-law dependence is found in the duration distribution.

Here we report the effect of gas species on the statistical properties of the intermittent electron flux. Figure 1 shows typical time series of floating potential measured in helium, neon, argon, and xenon discharges. With increasing the relative atomic mass of gas species for plasma discharge, the mean duration and the mean waiting time become longer. The frequency distributions, or PDF, of waiting time remain well fitted by exponential distributions for all gas species. Moreover the mean duration is proportional to the square root of the relative atomic mass. This result implies that the dynamics of heavier particles (neutrals and/or ions) plays a crucial role in this phenomenon.

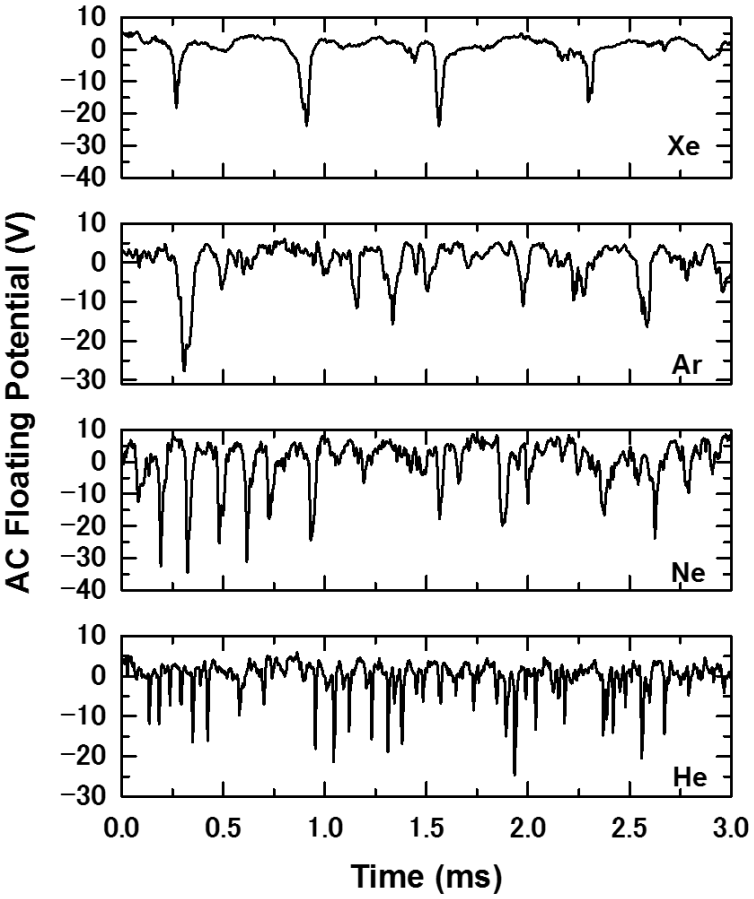

Fig.1 Typical time series of floating potential measured in various gas discharges (He, Ne, Ar, and Xe).

[1] S. Yoshimura et al., Proceedings of PLASMA2011, 24P158-B (2011).
[2] S. Yoshimura et al., Proceedings of the 39th EPS conference & 16th ICPP, P2.181 (2012).