§21. Formation of Negative Potential Structure Accompanied by Localized Negative Ion Generation

Ishiguro, S., Oohara, W., Hatakeyama, R., Sato, N.
(Dept. Electronic Eng., Tohoku Univ.)

When neutral particles which have large affinity for electrons are in a plasma, electrons attach to them, and, as a result, negative ions are generated. We have been investigating characteristics of negative ion plasmas which are produced by introducing SF_6 or C_{60} molecules into a Q-machine potassium plasma at Tohoku University. C_{60} and SF_6 have large collision parameter for attachment of 0.2 eV electrons which are in Q machine, so negative ion plasma which consists of positive ions, electrons and negative ions are produced.

Recent experiments in which C_{60} molecules are introduced in a Q machine have shown that a localized structure accompanied by a wide band low frequency oscillation has been created.

In order to investigate plasma characteristics in this situation, we have developed one-dimensional particle simulation code in which attachment of electrons to C_{60} molecules is introduced. We assume C_{60}^- ions are produced with constant rate in time in a specified region. Since the mass of C_{60} is much larger than that of the electrons, C_{60}^- stay there for a long time. This gives rise to an accumulation of negative charge in this region. Figure 1 shows the typical potential profile which is averaged over the time much longer than the ion plasma period. Here, electrons are replaced by C_{60}^- ions in the region $30 < z/\lambda_{De} < 50$. We can see a negative potential dip in the negative ion production region. Its depth is about $e\phi/T_e \sim 0.5$ where e and T_e are the electronic charge and electron temperature, respectively. This potential profile is similar to that obtained in Q-machine experiment, as shown in Fig. 2. Time evolution of potential structure in the simulation have shown that a negative potential structure which is created in the negative ion production region moves to the downstream region (positive z direction) over and over again. The propagation of the negative potential structure exhibits a wide band low frequency spectrum. There is a possibility that this corresponds to the wide band low frequency spectrum observed in the Q-machine experiment.

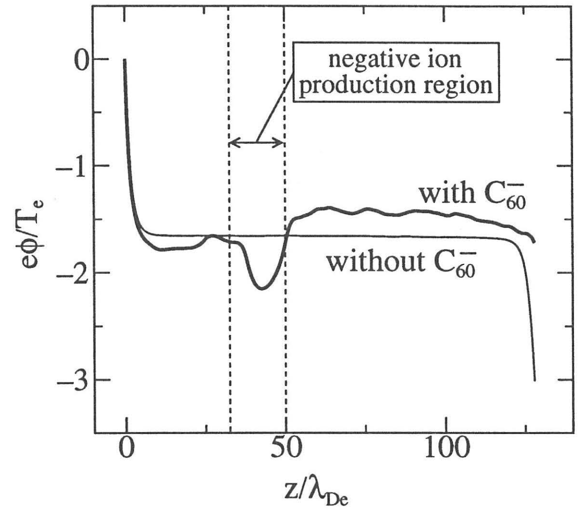

Fig. 1. Potential profile of particle simulation.

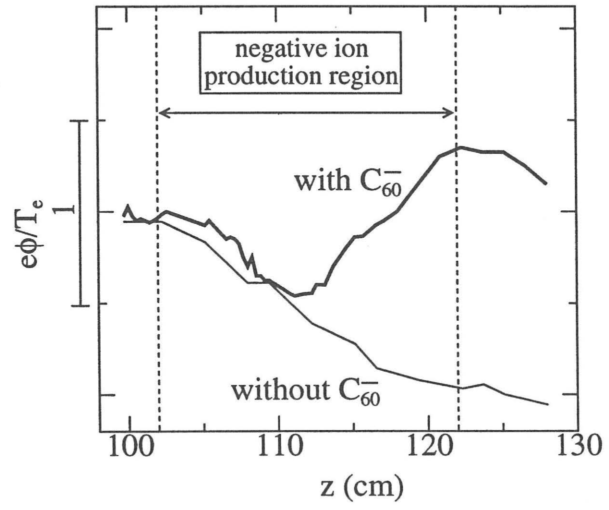

Fig. 2. Potential profile of Q-machine experiment.

References

1) Sato,N. *et al.*: Phys. Plasmas 1 (1994) 3480.