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多パルス蓄積法でプラズマ生成を行う時に生じるイオン加速現象の観測とそのPICシミュレーション

The observed results and PIC simulations of the ion acceleration when the ion plasmas are produced by the multi-pulse injection.

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A linear non-neutral plasma with a single sign of charge can be confined for long time because of its strong conservation of angular momentum. Recently, the non-neutral plasma has been widely applied to researches of a magneto-fluid dynamics and a particle physics such as antimatter. There are several linear traps to confine the non-neutral plasma. Among them, the trap, consisting of a harmonic potential well created by a set of ring electrodes and an axial magnetic field, is called Penning-Malmberg trap.

We have used a pure ion plasma composed of only lithium ion (Li^+) for exploring the state of two-fluid plasmas. This experiment has been performed on the BX-U linear trap, a modified version of the Penning-Malmberg trap [1]. Weakly magnetized Li^+ plasmas have been created in the BX-U and properties of the Li^+ plasmas are investigated both experimentally and numerically [2]. In order to create the Li^+ plasmas in the trap, we have used a Li^+ beam. During the Li^+ beam is continuously extracted, the upstream positive potential barrier of the trap has been quickly lowered and raised to accumulate the Li^+s into the trap. However, while the Li^+s are accumulated by this way, a part of Li^+ is accelerated and leaked from the trap. This phenomenon has been verified from an image appearing on a phosphor screen installed in the downstream region of the trap. Almost same observation was already reported (see Ref. 3), however the reason is still unknown.

In this work, we investigated this phenomenon by developing PIC simulation code, and found that the acceleration is caused by the change in external potential ϕ_{ext}; ϕ_{ext} is raised when Li^+s are injected into the trap. Simultaneously, the space potential ϕ_{self} of Li^+s varies, as they are confined in the trap. Figure 1 shows the dynamics calculated by the PIC code. As recognized, beamlike particles are injected into the trap, and then confined. At this time, the leakage happens certainly, which seems to correspond to the observation in experiments.

By precisely analyzing the leaked Li^+s, time evolutions of not only their orbits but also energies can be investigated. Preliminary data shows that changes in ϕ_{ext} and ϕ_{self} are caused by the axial motion of the trapped Li^+s. And, in fact, because of those, the acceleration of some Li^+s is induced. In this talk, we explain details of the leakage phenomenon and the PIC simulation.

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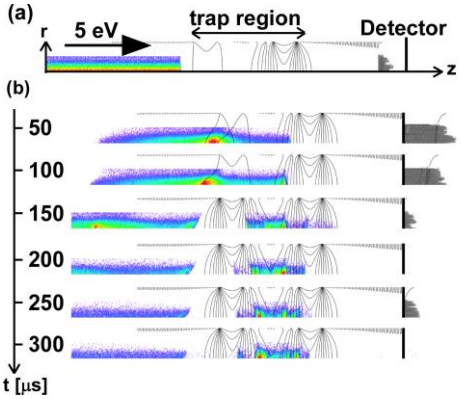

Fig.1 : The typical result of PIC simulation.

[1]. H. Himura, “BX-U linear trap for one-way production and confinement of Li^+ and e^- plasmas”, Nucl. Instrum. Methods Phys. Res., Sect. A **811**, 100 (2016).

[2]. S. Kawai, H. Himura, S. Masamune, and J. Aoki, ”Initial results of confinement of weakly magnetized lithium ion plasmas in a harmonic potential well of the beam experiment upgrade linear trap”, Phys. Plasmas **23**, 022113 (2016).

[3]. E. Sarid, F. Anderegg, and C. F. Driscoll, ”Cyclotron resonance phenomena in a non-neutral multispecies ion plasma” Phys. Plasmas **2**, 2895 (1995).