## リチウムイオンプラズマと純電子プラズマを用いた2流体プラズマ生成実験 Experiments of two-fluid plasmas by using lithium and electron fluids in laboratory experiments

比村治彦,河合祥吾,山田祥平,古川耕佑,赤池聖公,岡田成文,政宗貞男 H. Himura, S. Kawai, S. Yamada, K. Furukawa *et al.*,

## 京工繊大·電気電子工学系 Department of Electronics, Kyoto Institute of Technology

The BX-U linear trap that is a modified version of the Penning-Malmberg trap was recently developed [1] wherein both positive and negative harmonic potential wells were created by using a set of multi ring electrodes. In the BX-U machine, pure lithium (Li<sup>+</sup>) and electron (e<sup>-</sup>) plasmas are not only produced independently but also trapped simultaneously [2]. Confinement properties of those non-neutral plasmas were investigated experimentally. In particular, weakly magnetized Li<sup>+</sup> plasmas were extensively studied also numerically [3]. Regarding diagnostic tools, we investigated, for the first time, the applicability of a micro-channel plate (MCP) followed by a phosphor screen to charged particles along with a calibration method for estimating the acceptable limit of input particle flux and appropriate operation parameters of a particular MCP [4]. To capture of images of Li+ and e- plasmas in one attempt, we developed a new innovative method of changing the axial potential applied to the MCP using a high-voltage vacuum relay [5]. This method allows consecutive images of Li<sup>+</sup> and e<sup>-</sup> plasmas to be successfully captured.

Then, using the high-voltage vacuum relay, we are now capturing the two images of  $Li^+$  ion and electron fluids before and after the superimposition. The scale length of the  $Li^+$  plasma is set to be the ion skin depth. Figure 1 shows a preliminary result. When an e<sup>-</sup> plasma is superimposed on a  $Li^+$  plasma and then, only the  $Li^+$  plasma is ejected from the trap, there appears a sharp peak of ion density at the plasma center. Perhaps this result may be due to some two-fluid effect, although more data are required to conclude it confidently.

In this meeting, we present our recent efforts along with detailed description of the BX-U for experimentally exploring two-fluid plasmas, for the first time, by using non-neutral plasmas.

 H. Himura, 'BX-U linear trap for one-way production and confinement of Li<sup>+</sup> and e<sup>-</sup> plasmas', Nucl. Instrum. Methods Phys. Res. A **811** (3), 100 (2016).

- [2] H. Himura, H. Shimomura, T. Nakase, A. Sanpei, S. Masamune, 'Initial results on simultaneous confinement of pure lithium ion and electron plasmas', Plasma and Fusion Research 8, 2401017 (2013).
- [3] S. Kawai, H. Himura, S. Masamune, 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 (2), 022113 (2016).
- [4] H. Himura, S. Nakata, A. Sanpei, 'Applicability of micro-channel plate followed by phosphor screen to charged particles', Rev. Sci. Instrum. 87 (6), 063306 (2016).
- [5] S. Yamada, H. Himura, 'Note: Consecutive capture of images of ions and electrons using high-voltage vacuum relay', Rev. Sci. Instrum. 87 (3), 036109 (2016).



Fig. 1 Typical images of Li<sup>+</sup> ion fluids.