Two-fluid plasmas are one of extended magnetohydrodynamics (MHD) models and are recently used for explaining phenomena that cannot be explained by the conventional MHD. In two-fluid plasmas, velocity fields of ion and electron (e-) fluids are independent each other. However, no such two-fluid state has not been clearly observed in laboratory experiments. Also, the related two-fluid effect on especially the better confinement of ions and the suppression of several fluid instabilities is not clearly confirmed experimentally.

To investigate the two-plasma state and the related two-fluid effects, we have used nonneutral plasmas. Usually, a nonneutral plasma consists of either pure ion or e-, and its confinement time is much better than that of neutral plasmas. In BX-U linear trap [1], we confine lithium ion (Li+) [2] and e- fluids not only independently but also simultaneously [3]. In the BX-U, a uniform magnetic field in the axial direction confines particles radially, and both positive and negative potential wells separately trap the Li+ and the e- fluids, respectively. Regarding diagnostics, a micro-channel plate (MCP) followed by a phosphor screen [4] is installed in the most downstream region of the BX-U and a high-speed camera is set outside. When charged particles are injected into the MCP, the phosphor screen emits light. From images of this luminescence, we analyze two-dimensional distributions of both fluids. To capture both images of Li+ and e- plasmas successively, we built an electric circuit by which the high voltage applied to the MCI is switched [5]. With this method, we continuously take photographs of the luminescence caused by the Li+ and e- fluids.

To produce the two-fluid state, we superimpose Li+ and e- fluids. In Fig. 1, we show preliminary images that are taken after the cases where (a) only a Li+ fluid is confined, (b) only an e- fluid is confined, and (c) both Li+ and e- fluids are superimposed. For these, Li+ and e- fluids are continuously injected in this order in the trap [6], as shown in Fig. 2. Details of the data on superimposing the two fluids will be presented in the conference.


Figure 1. Typical images of luminescence obtained after (a) only a Li+ fluid is confined, (b) only an e- fluid is confined and (c) both Li+ and e- fluids are superimposed in a nested trap of the BX-U.

Figure 2. Schematic of the nested trap in the BX-U.