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Initial Experimental Results of Producing Multicharged Ions Efficiently by Lower Hybrid Resonance Heating with Exciting Helicon Waves on Electron Cyclotron Resonance Ion Source

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For many years, we have been promoting basic and applied research on multiply-charged ion generation in an electron cyclotron resonance (ECR) ion source (ECRIS). Based on these experimental results, we considered the accessibility conditions for wave propagation in the magnetized plasma in ECRIS, and proposed various microwave feeding methods to improve the efficiency of multiply-charged ion generation by ECR, and tried them experimentally. As a typical original application case, the lowest-order Bernstein wave (BW) mode of conversion from electromagnetic (EM) to electrostatic wave (ES) mode in extra-ordinary mode (X-mode) introduction of higher frequency microwaves than ECR ones had been tried to induce upper hybrid resonance (UHR) heating. Next, we firstly excite helicon waves by introducing electromagnetic waves with frequencies lower than those of ECR and UHR into the ECRIS. Then, we generate the lower hybrid resonance (LHR) in the ECRIS by the electric field of the X-mode of the helicon wave which additionally heat the electrons, and then it was conducted to improve the efficiency of multiply-charged ion generation experimentally. As a result, due to the introduction of the X-mode electric field by the helicon wave introduction, under the critical condition where the LHR condition is satisfied, the LHR efficiently contributes to the electron heating, and the efficient generation of multiply charged ions is achieved, and then multicharged ion current were increased successfully. Under this condition, the electron energy distribution function obtained by the electrostatic probe measurement shows an increase in the high-energy region in the corresponding region, supporting occurrence of the resonance heating. In this paper, for the first time we will describe the initial experimental results on enhanced production of multiply-charged ions by the LHR resonance phenomenon of the low-frequency RF electromagnetic waves introduced to the ECRIS.

Funding Agency

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