4 - 6 Measurement of the Ratio of C^{3+} and O^{4+} Ions Produced by ECR Source to Prepare a Laser Cooling Experiment at Storage Rings*

Zhu Xiaolong, Wen Weiqiang, Ma Xinwen, Li Jinyu, Feng Wentian, Zhang Ruitian, Yan Shuncheng, Guo Dalong, Hai Bang, Qian Dongbin, Zhang Pengju, Xu Shenyue, Zhao Dongmei, Yang Jie, Zhang Dacheng, Li Bin, Gao Yong, Huang Zhongkui and Wang Hanbing

The cooling of heavy ions can provide high-quality beams that are especially important for high-precision experimental nuclear and atomic physics. The laser cooling of relativistic C^{3+} ion beams at the experimental cooler storage ring (CSRe) is being currently prepared at Institute of Modern Physics (IMP) in Lanzhou. An electron cyclotron resonance ion source (ECRIS) will be used to produce C^{3+} ion beams. Meanwhile, O^{4+} ions could also be produced due to residual gas because of the same mass-to-charge ratio. Therefore, both C^{3+} and O^{4+} ion beams will be injected and circulate in a storage ring during the laser cooling experiment at the same time. A higher ratio of C^{3+} ions will lead to a better result for the laser cooling experiment.

A novel experiment was performed using a reaction microscope to determine the ratio of C^{3+} ions in mixed ion beams of C^{3+} and O^{4+} that are produced by an Electron Cyclotron Resonance Ion Source (ECRIS) [1]. The mixed ion beams at an energy of 4 keV/u were directed to the reaction microscopes and collide on a supersonic helium gas target. In the single-electron capture channel, the fractions of C^{3+} and O^{4+} ions in the primary beam were obtained. Different injection gases were used for ECRIS, including O_2, CO, CO_2, and CH_4, at a fixed radio-frequency power of 300 W. Fig. 1 show the measured ratio of the C^{3+} and O^{4+} ions for various injection gases. Our results show that the fraction of C^{3+} ions is larger than 70 % for the injection gases of CO and CO_2. The ratio of C^{3+} ions was improved from 62.3 % to 69.9 % when we also adjusted the radio-frequency power from 300 to 150 W with the injection gas CH_4. The results demonstrated that further experimental investigation is still necessary to increase the ratio of C^{3+} ions in the mixed beam by changing the sensitive conditions of the ECRIS, such as radio-frequency power and auxiliary gases. Our results are very important and helpful for the upcoming laser cooling experiments for the relativistic C^{3+} ion beams.

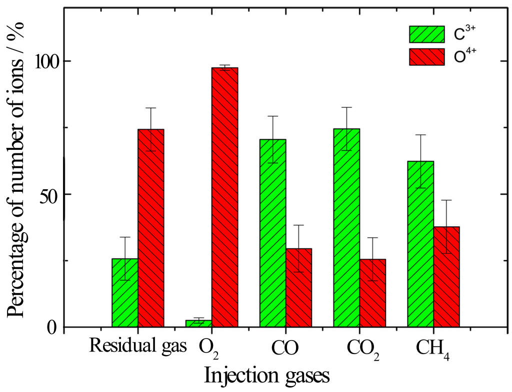

Fig. 1 (color online) Fraction of C^{3+} and O^{4+} ions measured by the reaction microscope as a function of the various injection gases of the ECRIS.

Reference

[1] X. L. Zhu, W. Q. Wen, X. Ma, et al., Nucl. Instrum. Methods. Phys. Res. Sect. A, 764(2014)232.

* Foundation item: National Natural Science Foundation of China (10979007, 91126004, 11274317)