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Search for efficient laser resonance ionization schemes for Ta and W using a new reference-cell in KISS

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In KISS (KEK Isotope Separation System) [1], laser resonance ionization [2] is employed for the element-selective ionization of multi-nucleon transfer reaction products around N = 126. We searched for efficient laser resonance ionization schemes for tantalum (Z = 73) and tungsten (Z = 74), which will be studied in KISS.
In laser resonance ionization technique, an atom is element-selectively excited by the first step laser with a wavelength of λ1. By irradiating the atom with a second-step laser of wavelength λ2, the atom then transits from the excited state to an auto-ionization state (AIS), which is located above ionization potential. The AIS's, through which the ionization efficiency is more than one order of magnitude higher than that via an atomic continuum states, are searched for in general. Our goal is to achive the laser ionization efficiency more than 15% in the KISS gas cell which is filled with an argon gas of 50 kPa.
The ionization schemes of tantalum and tungsten were studied using a reference-cell. The reference-cell consists of the two-step acceleration electrodes, the drift tube, a channeltron and a filament. The lasers were focused to a spot of a few mm2 between the ion-acceleration electrodes. Neutral atoms were evaporated by heating the filament and ionized by laser irradiation between the electrodes. Ions were accelerated by the electric field and detected by a channeltron at about 30 cm away from the ionization region. The ions were mass-analyzed by measuring the time-of-flight (TOF). However, we could not search for the high efficient laser ionization schemes. We are going to search for efficient laser ionization schemes in the same elements using a newly designed reference-cell. The new reference-cell was designed to separate the isotopes of A ~ 180 wtih the mass resolution of ~ 330. It is achived by adjustment of the distances between the electrodes and the drift distance (56 cm) to converge the position distribution of the atoms in the ionization region. It makes possible to study of the ionization scheme, the ionization efficiency and the iosotope shift in each isotope.
We will study the power broadening and the pressure broadening of the excited states and the AISs to obtain the more realistic ionization efficiency in the KISS gas cell.

[1] S.C. Jeong et al.: KEK Report 2010-2.
[2] Y. Hirayama et al.: J. Phys. B: At. Mol. Opt. Phys. 47 (2014) 075201.

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