# Extraction of multi-nucleon transfer reaction products in the $^{136}$Xe and $^{198}$Pt system

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We have developed the KEK Isotope Separation System (KISS)[1] to study the $\beta$-decay properties of the neutron-rich isotopes with neutron numbers around $N = 126$ for astrophysics research.[2–4] We extracted elastic events of $^{198}$Pt and unstable nuclei of $^{199}$Pt and $^{196,197,198}$Ir produced in the $^{136}$Xe beam and $^{198}$Pt target system. We successfully dissociated the molecular ions by using a new multi-pole ion-guide (MPIG) system and measured the lifetime of the unstable nuclei of $^{199}$Pt[3] and $^{196}$Ir.

We performed on-line tests using the $^{136}$Xe beam with an energy of 10.75 MeV/nucleon and a maximum intensity of 20 pnA. The $^{136}$Xe beam was directed onto the $^{198}$Pt target placed in the gas cell, and was stopped at a tungsten beam dump after passing through the gas cell. The thermalized and neutralized reaction products were re-ionized in the gas cell, and the ions were extracted and detected after mass separation using a Channeltron detector for ion counting. The lifetimes were measured by using newly developed $\beta$-ray telescopes[5] whose background rate was reduced to 0.09 cps.

In our previous experiment, the extracted $^{198}Pt^+$ ions formed molecular ions such as $^{198}PtH_2^+$, $^{198}PtH_2O^+$, and $^{198}PtAr_2^+$ with the intensity ratio of 1, 1, and 6, respectively, relative to the intensity of $^{198}Pt^+$ ions. The extraction efficiency of the most intense $^{198}PtAr_2^+$ ion was 0.2 %. In order to reduce the amount of the molecular ions and increase the extraction yields, we developed three MPIGs which were installed at the exit of the gas cell to dissociate the molecular ions by applying a DC voltage of 15 V between the first and the second MPIGs as well as to transport the ions from the high pressure region to the low pressure region and, then, accelerate them by applying a high voltage of 20 kV. Figure 1 shows the measured mass distribution of $^{198}Pt^+$ ions extracted from KISS through the MPIGs. In the present measurement, we can successfully dissociate the molecular ions. Considering the molecular ion formation probability in the previous experiment, the extraction efficiency of $^{198}Pt^+$ ion with the most intensity was recovered to be 0.3%, which was a factor of about 1.5 higher than of 0.2% for $^{198}PtAr_2^+$ ion. This indicates that almost all molecular ions dissociated to $^{198}Pt^+$ ion.

We extracted the laser-ionized iridium isotopes $^{196,197,198}$Ir atoms. Figure 2 shows the measured lifetime of the $^{196}$Ir ($t_{1/2} = 52(1)$ s) isotope. The measured lifetime $t_{1/2} = 67(13)$ s was in good agreement with the reported value.

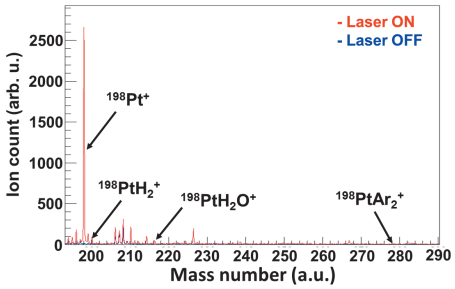


Fig. 1. Measured mass distribution of the platinum ions. Red and blue lines indicate the spectra measured with and without the irradiation of ionization lasers, respectively.

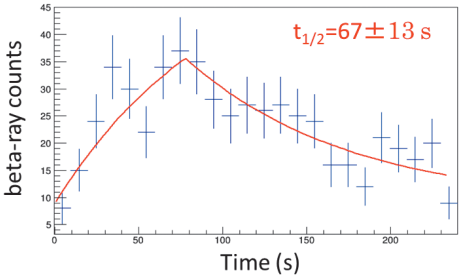


Fig. 2. Lifetime measurement of $^{196}$Ir.

To extend this study to more neutron-rich nuclei, we have been developing a doughnut-shaped gas cell to increase the available primary beam intensity and a low-background beta-ray telescope.

References

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