β-γ spectroscopy of ^{195}Os at KISS

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Almost a half of nuclei in nature heavier than iron are considered to have been synthesized in the rapid neutron capture process (r-process) under an explosive stellar environment with a temperature higher than 10^9 K and a neutron density higher than 10^{20} cm^{-3}. The r-process goes through the region of extremely neutron-rich nuclei under such an explosive condition. The peak at the mass number of 195, called as the 3rd peak, on the observed solar r-abundance distribution is considered to be originated from the waiting point nuclei with the neutron number (N) of 126 on the r-process path. The astrophysical environment such as the temperature and the neutron density is not known for the formation of the 3rd peak. To investigate those conditions, the properties such as lifetimes and masses of the waiting point nuclei are important. However, they are too far from the β-stability line to experimentally access. Therefore, some theoretical prediction is employed for the physical values of the nuclear properties concerning the r-process in order to perform the nucleosynthesis simulation to survey the explosive stellar conditions. Thus a reliable theoretical nuclear model is required to precisely predict those nuclear properties to elucidate the astrophysical environments of the r-process. The region of the neutron-rich nuclei around $N = 126$ is predicted as a competitive region of the first-forbidden (FF) and the allowed Gamow-Teller (GT) β-decays.[1)] Such competition makes it difficult to theoretically predict their half-lives, and those predicted values in various theoretical models are deviated from each other. The systematic experimental investigation of nuclear properties of the neutron-rich nuclei around $N = 126$ is important for the selection of reliable theoretical model and improvement of their predictions.

Neutron-rich osmium isotopes are candidates to study their nuclear structures because they have the filled single particle orbits $h_{11/2}$ for protons, which contribute to the GT β-transitions for the nuclei around $N = 126$. We have performed β-γ spectroscopy of ^{195}Os at KEK Isotope Separation System (KISS)[2)] to study its β-decay scheme, which is unknown so far. The ^{195}Os isotopes were produced by multi-nucleon transfer reactions between the ^{136}Xe beam (50 pnA on target) with energy of around 10 MeV/nucleon and a ^{198}Pt target. They were collected, separated and extracted by the KISS, and finally the ^{195}Os ions of its ground state and isomeric state were transported with the rate of 14(2) cps to the measurement area. They were implanted into an aluminized Mylar tape, which was surrounded by the Multi-Segmented Proportional Gas Counter (MSPGC)[3)] and four High-Purity Germanium (HPGe) clover detectors. The MSPGC was used to detect β-rays, X-rays and conversion electrons, and the HPGe clover detectors were used to detect γ-rays. Figure 1 shows measured γ-ray energy spectra in coincidence with the MSPGC detector hit patterns $M = 1$ (red line) and $M = 2$ (blue line). The hit patterns $M = 1$ and $M = 2$ are sensitive to X-rays and β-rays, respectively. We have found 28 γ-ray peaks in total with some characteristic X-rays. 22 γ-ray peaks denoted by black labels agree with energies in the literature for γ-rays from ^{194}Ir$(n,\gamma)^{195}$Ir reactions and β-delayed γ-rays of ^{195}Ir. We found 6 γ-ray peaks for the first time. The lifetime measurements and γ-γ coincidence analyses reveal that two of them with blue labels are β-delayed γ-rays of ^{195}Os, and four of them with red labels are γ-rays associated with a newly found isomeric decay of ^{195}Os. Further analysis for the β-decay scheme and the isomeric decay of ^{195}Os is in progress.

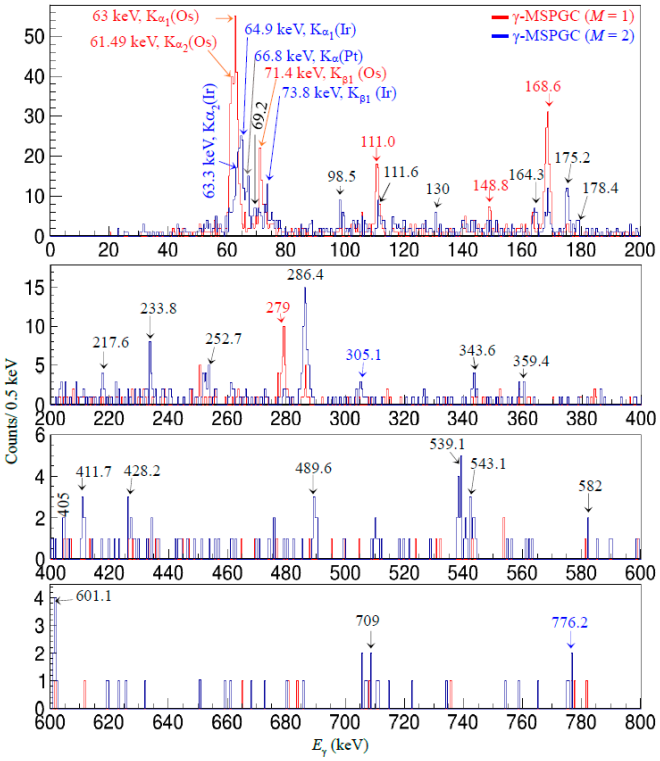

Fig. 1. Meausred γ-ray energy spectra in coincidence with the MSPGC detector hit patterns $M = 1$ (red line) and $M = 2$ (blue line).

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