One proton removal cross section of ^{25}F with a carbon target

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Experimental one-proton (neutron) removal cross sections σ_{-1p} (σ_{-1n}) with light target nuclei (Be and C) at intermediate energies have been shown to be hindered with respect to the corresponding theoretical values. Their ratio $R_s = \sigma_{\rm exp}/\sigma_{\rm th}$ (reduction factor) shows a strong linear dependence on the difference between the $1p$ and $1n$ separation energies, $\Delta S = S_p - S_n$ ($S_n - S_p$).[1,2] This dependence has been recognized as a key to understand correlations beyond the shell-model-based picture of atomic nuclei. The theoretical cross sections are evaluated using shell-model spectroscopic factors C^2S combined with an established reaction theory at intermediate energies, such as eikonal and impulse approximation. The reduction factor depends on the reaction used and the reduction mechanisms are yet to be clarified.[3]

We report a preliminary result of the one-proton removal cross section of ^{25}F with a carbon target at 218 MeV/nucleon. This data point is a useful addition to the systematics of the one-nucleon removal cross sections. It should be noted that ^{25}F has one proton more than doubly-magic ^{24}O. Accordingly, we expect that the spectroscopic factor for proton removal from ^{25}F is close to unity. However, the recent ^{25}F$(p,2p)$ measurement at SHARAQ at RIBF[4] obtained a much-reduced value of 0.36(13) from ^{25}F to the bound ^{24}O. We also note that the ΔS value of 10.17(24) MeV for ^{25}F lies between those of the stable nuclei ($|\Delta S| < 8$ MeV) and drip-line nuclei ($|\Delta S| = 15$–30 MeV). As such, the one-nucleon removal cross section from ^{25}F on the carbon target is a valuable addition.

The ^{25}F$(-p)$ removal cross section on the carbon target was measured using the SAMURAI device at RIBF, as a by-product of the measurement of the one-proton removal of ^{26}F and ^{27}F into ^{25}O and ^{26}O, respectively.[5] For details of the experimental setup and method, see Ref. 5). The ^{25}F secondary beam was produced by the projectile-fragmentation of ^{48}Ca at 345 MeV/nucleon with a thick beryllium target. The beam intensity of ^{25}F reached 1.1×10^3 particles/s with a purity of 3.4%. The ^{25}F projectile then impinged on the carbon target with a thickness of 1.8 g/cm^2. The mean energy at the middle of the target was 218 MeV/nucleon, with momentum acceptance of $|\Delta P/P| \leq 0.6\%$. The particle identification (PID) for ^{25}F was obtained by the standard method at the BigRIPS.[5] The PID of the ^{24}O residue was made by the measurements of the time of flight (TOF), and energy loss ΔE at the hodoscope (HODF), with the magnetic rigidity ($B\rho$) obtained by the tracking with the two multi-wire drift chambers, FDC1 and FDC2, at the entrance and exit of the SAMURAI superconducting magnet, respectively.[5,6] The central field of the magnet was 3.0 T.

The ^{25}F$(-p)$ removal cross section was extracted using the ratio of the counts of the outgoing ^{24}O to those of ^{25}F, where the background events measured with the empty target were subtracted. The effect of reaction loss in the thick target was incorporated using the procedure in Ref. 7). The obtained preliminary value of the one-proton removal cross section of ^{25}F is 7.1(8) mb. USDB-interaction shell- and eikonal-model calculations give the theoretical cross section 14.9 mb, resulting in the reduction factor $R_s = 0.48(5)$. Further evaluation of nucleon removal cross sections in neighboring neutron-rich isotopes is in progress.

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