Shell structure of the near-dripline nucleus ^{23}O

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Recent studies in neutron-rich oxygen isotopes near the neutron dripline have shown very exciting issues. ^{24}O [1] with no excited states below 4 MeV is today accepted to be the last bound oxygen isotope reinforcing the idea of the $N = 16$ magic number replacing the $N = 20$ gap for the heavy dripline nuclei [2]. In this context, ^{23}O is a key nucleus to understand the structure of light neutron-rich isotopes. Consequently, it has been subject of interest and several experiments have been dedicated to its study in the last years gaining a new interest because the interpretation of different inclusive experimental results [3, 4] yield for different spin and parity assignment for its ground state. For better understanding of this problem gamma coincidence data are crucial. Therefore, we have performed an experiment at GSI to distinguish between the ^{22}O *g.s* contribution to the ^{23}O wave function from any other contribution of ^{22}O excited states.

The experiment was performed at the FRagment Separator(FRS) and was dedicated to the study of the nuclear structure evolution when approaching the dripline using the one-neutron breakup of light neutron-rich secondary beams. The secondary beams were produced by nuclear fragmentation of relativistic ^{40}Ar at 1 GeV/nucleon, on a carbon target. A complete description of the experimental technique used can be found in [5, 6].

The inclusive longitudinal momentum distribution (p_{long}), of ^{22}O fragments after one-neutron removal from ^{23}O was measured in this experiment. The FWHM for this inclusive measurement is found to be 134 ± 10 MeV/c. A minor correction for the intrinsic momentum resolution (19 ± 1 MeV/c) gives a final width of 133 ± 10 MeV/c. The corresponding one-neutron removal cross-section amounts 85 ± 15 mb.

The γ-rays emitted during de-excitation of ^{22}O were recorded with NaI detectors and allow to gate the longitudinal momentum distributions in order to obtain the exclusive momentum distributions. The FWHM for these exclusive measurement are found to be 126 ± 20 MeV/c and 236 ± 20 MeV/c for ^{22}O in its ground and any excited state respectively. The experimental exclusive momentum distribution allows the extraction of the corresponding cross-section that amounts of 50±18 mb and 35±17 for the ^{22}O ground state and excited states contributions. The experimental momentum distribution for the one-neutron removal channel leaving the ^{22}O core in its ground state is compared in figure 1 to theoretical momentum distributions calculated in an Eikonal model for the knockout process [7]. Two calculations are shown for angular momenta $l = 0$ and $l = 2$. Clearly, the distribution assuming a $2s_{1/2}$ neutron coupled to the ^{22}O(0^+) core is in much better agreement with the data.

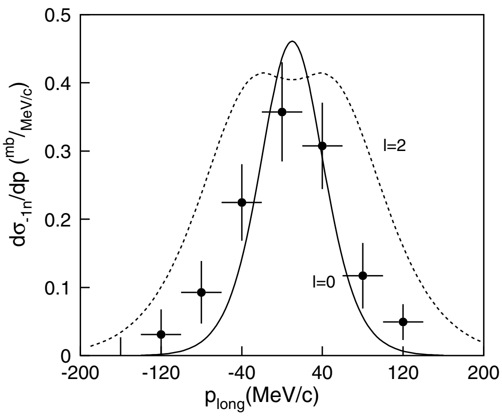

Figure 1: Ground state exclusive momentum distribution for ^{22}O fragments after one-neutron knock-out reaction from ^{23}O compared with calculations assuming $l = 0$ and $l = 2$ for the removed neutron

In conclusion we have measured for the first time the ^{22}O distribution after one-neutron knock-out of ^{23}O in coincidence with the ^{22}O γ de-excitation thereby demonstrating that the ground-state spin of ^{23}O is $I^\pi = 1/2^+$, providing a clear solution to the discrepancy of the ground-state spin and parity assignment of ^{23}O.

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