Search for deep hole states in medium weight nuclei by (p,2p) reactions

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We performed ^{40}Ca(p,2p) experiment with 392 MeV proton beam from the ring cychrotron of Research Center for Nuclear Physics (RCNP). The aim of this experiment is to study the spectroscopic factor and the width of the deep orbital states of medium and heavy nulei for understanding the nuclear structure and correlations in deep hole states. The experiment was performed under the program number of E168.

According to the report of (e,$e'p$) experiments at NIKHEF performed with high accuracy, the sum of spectroscopic factors for orbits close to Fermi surface decreases to about 50~80% of the $(2j + 1)$ value which is the shell model limit [1] [2]. This decrease may be an effect of the short range correlation. Furthermore a nuclear matter calculation which reproduce the spectroscopic factors for low-lying states obtained from (e,$e'p$) experiments suggests that spectroscopic factors for deep orbital states also quench with respect to $(2j + 1)$. However spectroscopic factors for deep orbital states have not been measured until now because of the difficulty to observe the deep hole states. Because nucleons in deep orbital states feel higher density rather than those near surface, the short range correlation might affect the spectroscopic factor more strongly in deep orbital states. Hence, it is interesting to investigate spectroscopic factors for deep orbital states.

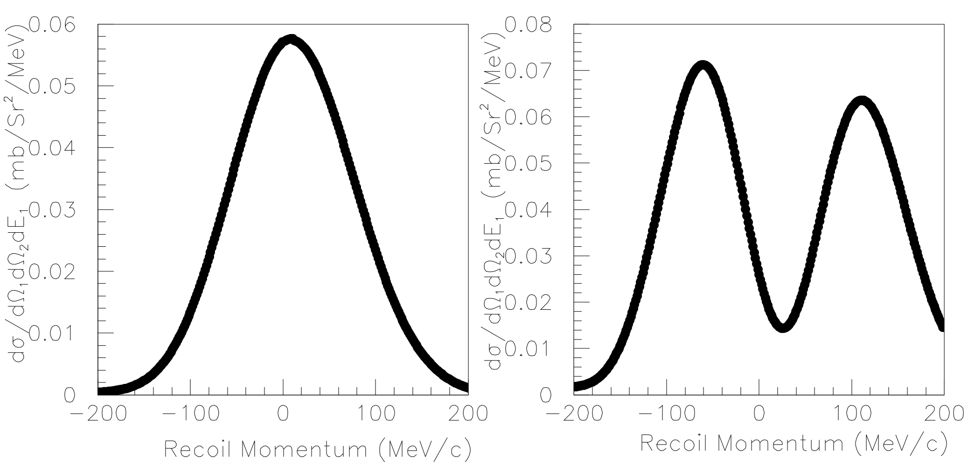

Figure 1: Recoil momentum distribution for the $1s_{1/2}$ knock-out(left) and $1p_{3/2}$ knock-out(right) of ^{40}Ca(p,2p) reaction at E_p=392 GeV. The cross section for the $1s_{1/2}$ has a maximum at zero recoil, whereas the cross section for the $1p_{3/2}$ shows minimum at zero recoil.

Since the cross section of the (p,2p) reaction strongly depends on the recoil momentum of the residual nucleus which approximately reflect the moment of the knocked-out proton in nucleus before the scattering. In Fig.1 the calculated cross section for the s-state and the p-state are shown versus recoil momentum. In our experiment E168, as shown in Fig 2, we have installed two new MWPC's in front of the spectrometers Grand Raiden and LAS to tag the vertical and horizontal scattering angles to identify the recoil momentum for each scattering event. The MWPC for the GR has 16 wires of 20 μ spanned in 2 mm spacing for x and x' planes and 32 wires for y and y' planes. The angular resolution of the GR angular tagging counter is 2.0 mr in vertical direction and 2.0 mr in horizontal direction. The other MWPC for the LAS has 48 wires for x and x' planes and 80 wires for y and y' planes. The angular resolution of the LAS angular tagging were 2.0 mr in vertical direction and 2.0 mr in horizontal direction. The total recoil momentum resolution in the present measuremet was 6 MeV/c. We have used alamid carbon film for cathod electrodes. For the readout electromins we have used 22 16-channel preamprefiers made by RINEI, 11 LeCroy 2731 Latch and encoder module, 2738 POCS3 controller, RDTM[3], and 2 VME memory buffers. The readout system is accomodated by the TAMI DAQ system[4].

The preliminary results of E168 are shown in Figure 3. Assignment of orbital states is according to S.S. Volkov *et al.*[5]. The Figure 3 shows the separation energy spectrum of ^{40}Ca(p,2p) with the condition that recoil momenta are less than 20 MeV. The bump of $1s_{1/2}$ is seen at the separation energy of about 50 MeV which is almost consistent with the result at PNPI[5]. Since the phase space which recoil momentum of residual nucleus is close0 MeV/c is small, we do not have enough statistics. The measured range of recoil momentum distribution was from 0 to 70 MeV/c, and is too narrow to compare with theoretical calculation.

Detailed analysis is in progress. We need to compare the recoil momentum distribution of cross section for each orbital states with theoretical calcuration to confirm these orbital states and determine spectoroscopic factors of deep orbital states.

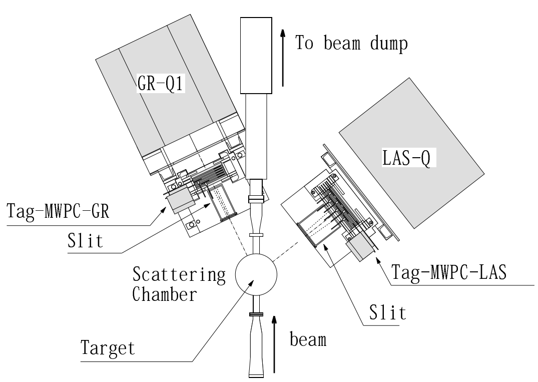

Figure 2: Schematic view of Scattering Chamber and Tagging PC.

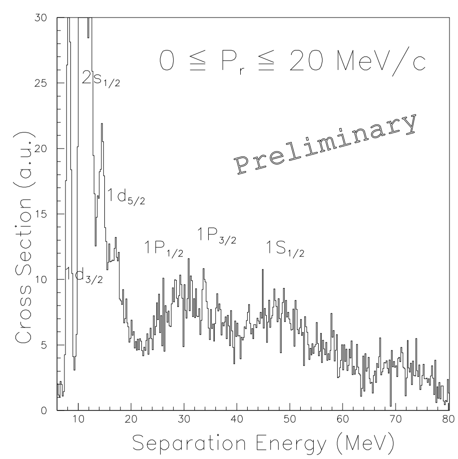

Figure 3: Separation Energy Spectrum with 0-20 MeV/c recoil momenta

References

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