3 - 26 Study on the Shell Structure of ^{11}C with α Scattering by Using MATE*

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The nuclear shell structure provides an important guide for our understanding of the nuclear structure and the underlying nuclear forces. Following a series of studies on the weakly-bound nuclear region far away the stability valley exotic phenomena have been found, such as the emergence of new magic numbers. The study on new magic numbers can provide us a good perspective to understand the evolution of the nuclear shell structure. Recently, the existence of the new proton magic number $Z=6$ was found in the neutron-rich carbon isotopes[1], which raised the question of whether the $Z=6$ magic number persists in the neutron-deficient carbon isotopes. At present, it only exists the experimental results of ^{10}C on the neutron-deficient side, which shows greater neutron contribution to E2 transition than that of protons[2]. To further investigate the neutron-deficient carbon isotopes, we carried out an α inelastic scattering experiment to study the structure of ^{11}C.

The α(^{11}C, α′) experiment was carried out at the RIBLL1. A primary beam ^{12}C with an energy of 75 MeV/u bombarded a beryllium target to produce a 55 MeV/u secondary beam ^{11}C. The ^{11}C beam was incident on an active target Time Projection Chamber (TPC) named MATE (Multi-purpose Active target Time projection chamber for nuclear astrophysical and the exotic beam Experiments)[3]. MATE is a new detector developed at IMP in the recent years, and mainly composed of a TPC and silicon detectors (Si). A schematic diagram of the experimental setup is shown in Fig. 1. The intensity of the incident ^{11}C beam particles injected into the MATE chamber was about 5×10^4 pps, and a mixture gas of He+CO_2(5%) was used which served simultaneously as the working gas and target particles. The Combination of TPC+Si helps us broaden the energy range of the particle detection. Two typical events are shown in the inset in Fig. 1: a low energy recoil α particle stopped in TPC, and a high energy recoil α penetrated TPC and stopped in the Si detector. By measuring the yield of these recoil α, the differential cross section can be obtained. The ratio of the neutron and proton contribution to the excitation M_n/M_p will be obtained from reaction theory analysis, combining the results from this work and earlier (p, p') measurement. The results will shed light on the important question of whether or not there exists a proton subshell closure in ^{11}C. The experimental data is currently being further analyzed.

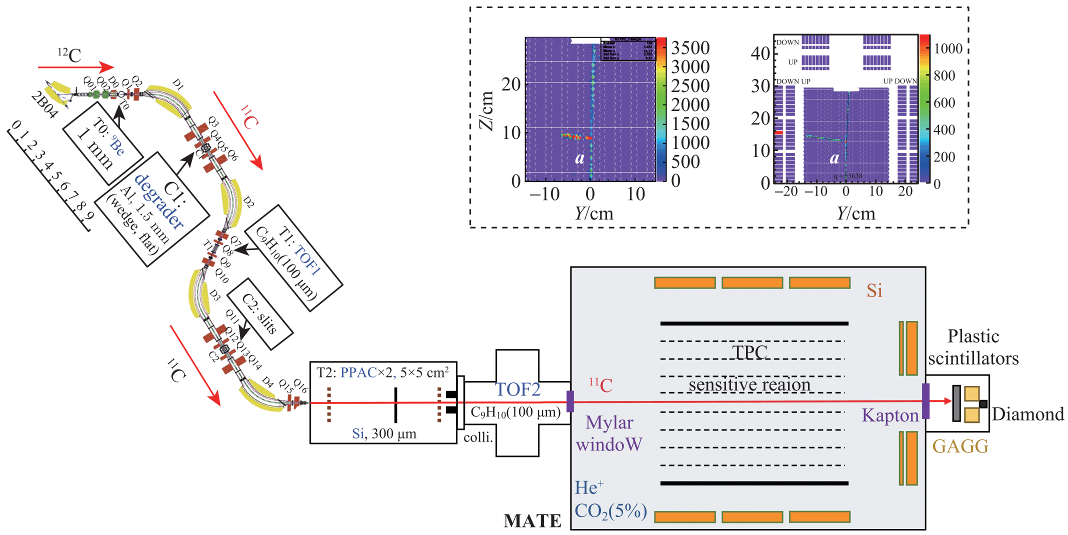

Fig. 1 (color online) Schematic diagram of the α(^{11}C, α′) experiment setup.

References

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