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Study on the shell structure of 11C with alpha 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 from the stability line, many exotic phenomena have been found, such as the emergence of new magic numbers. The study of new magic numbers can provide us with a good perspective on understanding 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, which raised the question of whether the Z = 6 magic number persists in the neutron-deficient carbon isotopes. At present, there exist only the experimental results of 10C on the neutron-deficient side, which shows greater neutron contribution to E2 transition than that of protons. To further investigate the neutron-deficient carbon isotopes, we carried out an alpha inelastic scattering experiment to study the structure of 11C.

The a(11C, a') experiment was carried out at the RIBLL1, HIRFL. A primary beam of 12C bombarded a beryllium target to produce a 55-MeV/u secondary beam of 11C. The 11C beam was incident on an active target Time Projection Chamber (TPC) named MATE (Multi-purpose Active target Time projection chamber for nuclear astrophysical and exotic beam Experiments). MATE is a new detector developed at IMP in recent years and is mainly composed of TPC and silicon detectors. By measuring the yield of the recoil alpha particles, a differential cross-section can be obtained. The ratio of the neutron and proton contribution to the excitation Mn/Mp 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 11C.

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