The structure of ^{12}N using ^{11}C + p resonance scattering

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The level structure of the drip-line nucleus ^{12}N has been studied in the past using conventional beams, see [1] and references therein. More recent references [2, 3] are basically extensions of those earlier works. Interest in the nuclear structure of ^{12}N is mainly related to the idea that many low-lying levels in ^{12}N should manifest one-particle-one-hole configurations, and therefore their features provide a test (and parameters) for shell model calculations.

In addition to the nuclear physics interest, studies involving ^{12}N around its ^{11}C + p threshold at 0.601 MeV are often also driven by nuclear astrophysics interests [4-8]. Namely, to be able to accurately determine the astrophysical rate of the $^{11}C(p,\gamma)^{12}N$ reaction, detailed knowledge of the low-lying level structure of ^{12}N is also required. The $^{11}C(p,\gamma)^{12}N$ reaction is associated with hot *pp* chains that might be able to bypass the triple alpha process in producing CNO material in low metallicity stars [9]. The ^{12}N excitation region in the vicinity of the ^{8}B + ^{4}He threshold at 8.008 MeV is also important for astrophysics due to the formation of ^{11}C in the $^{8}B(^{4}He,p)$ reaction [9]. Favorable states in ^{12}N close to this threshold could strongly enhance the corresponding reaction rate. The $^{8}B(^{4}He,p)^{11}C$ reaction has been experimentally studied in [10]. That measurement was done using the inverse kinematics reaction, i.e., it utilized a radioactive ^{11}C beam. Resonant states between 8.7 and 9.9 MeV in ^{12}N were probed, and no resonant structures were reported.

As a result of these past studies, we can conclude that the level structure in ^{12}N is relatively well established up to the first 3^- state at about 3.1 MeV. However, above that energy, the level scheme of ^{12}N is not yet complete. The present work extends our knowledge of the level structure of ^{12}N by covering the excitation energy interval from 2.2 to 11.0 MeV using the ^{11}C + p resonance interaction with thick targets and inverse kinematics.

Ninety and 125 MeV ^{11}C beams were obtained using the Berkeley Experiments with Accelerated Radioactive Species (BEARS) coupled cyclotron system [11], which can produce ^{11}C beams at 2×10^7 ions/s on target, an about 100 times stronger ^{11}C beam than, for example, was available for [10]. As an example of the quality of the experimental data obtained in the present work, Fig. 1 presents the zero degree ^{11}C + p excitation function. To convert the E_{cm} energy scale in Fig. 1 to excitation energy, 0.601 MeV should be added to it. The R-matrix analysis [12] of the data is currently in progress.

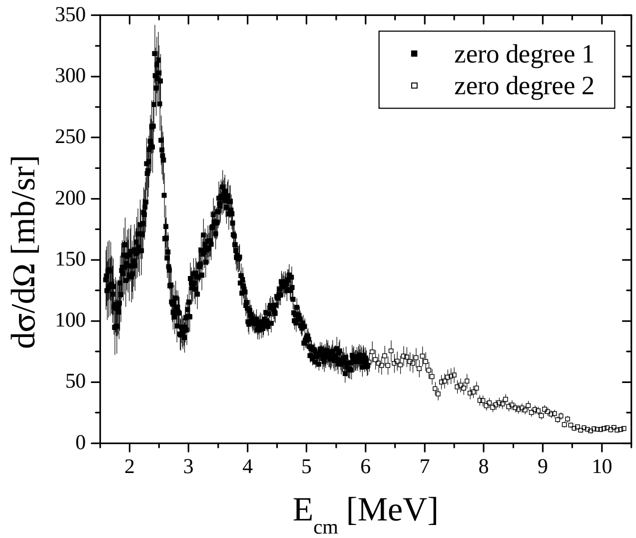

Fig. 1. The excitation function for ^{11}C + p elastic resonance scattering from 2.2 to 11.0 MeV in excitation energy, measured at zero degrees. Two different setups were used. Setup 1 covered 1.6 to 6.0 MeV and setup 2 covered 5.9 to 10.4 MeV in the c.m. system. See text.

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