The Structure of ^{12}N Using $^{11}C + p$ Resonance Scattering

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Interest in the nuclear structure of ^{12}N (and ^{12}B) is primarily related to the idea that many low-lying levels in ^{12}N (and ^{12}B) should manifest one-particle-one-hole configurations, and therefore their features provide a test (and parameters) for Shell Model (SM) calculations. ^{12}N is more unstable to single particle decay than ^{12}B. Therefore, the nucleon widths of the levels in ^{12}N could provide direct information on their single particle structure.

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 [1]. The ^{12}N excitation region in the vicinity of the $^{8}B + \alpha$ threshold at 8.008 MeV is also important for astrophysics due to the formation of ^{11}C in the $^{8}B(\alpha,p)$ reaction [1].

The level structure of ^{12}N has been investigated from 2.2 to 11.0 MeV in excitation energy using a $^{11}C + p$ resonance interaction with thick (gas and solid) targets and inverse kinematics [2]. The measurements were made at LBNL and TAMU facilities providing for radioactive beams of ^{11}C [3,4]. Excitation functions were fitted using an **R** -matrix approach. Fig.1 presents the R matrix fit to the low energy zero degree data. As a result sixteen levels in ^{12}N were identified, many of them are new. Spin-parity assignments, excitation energies and widths are proposed for these levels. A narrow state with a tentative low spin assignment was found about 200 keV below the $^{8}B + \alpha$ threshold in ^{12}N.

Conventional **R** -matrix calculations generated cross sections at the highest energies which were too large. We related this effect to the increasing role of direct reactions and took their influence into account by adding imaginary parts (parameterized by a simple expression) to the phase shifts generated by the hard sphere scattering. Generally, the SM predictions were a good guide for the analysis of the lowest excited states. However, at higher excitation energies, the spread of the $d_{3/2}$ strength appeared to be underestimated and the predicted dominant $d_{3/2}$ levels appeared to be shifted to lower energies.

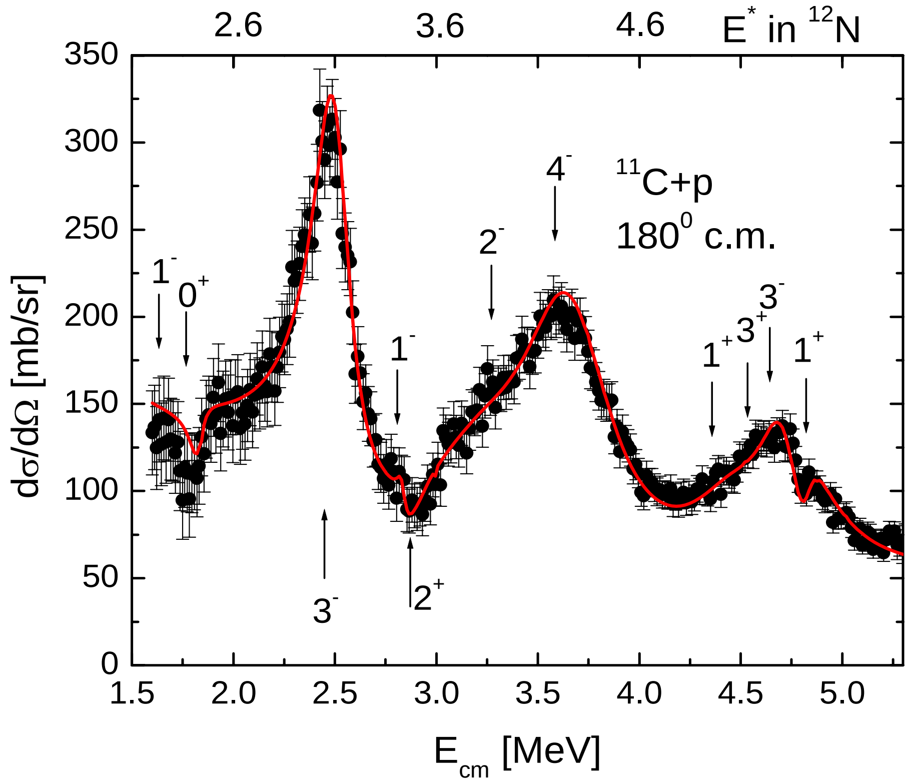

Figure 1. The zero degree (lab.sys.) excitation function and the corresponding *R* –matrix fit. Excitation energy E^* is $E_{c.m.}$ + 0.601 MeV.

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