EXPLORING THE STRUCTURE OF ^{17,19}C

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A new experimental technique has been recently used at the NSCL to investigate the structure of a number of exotic nuclei, such as ^{26,27,28}P [1]. It consists of measuring partial cross sections and longitudinal momentum distributions corresponding to specific final states of the fragments produced in single-particle removal reactions. This method has now been applied to ^{17,19}C. Characterized by a low neutron separation energy, these neutron-rich carbon isotopes are particularly interesting as they could be thought of as possible halo nuclei [2]. Halo nuclei can be naively pictured as a tightly bound core to which one or more delocalized valence nucleons (forming the halo) are loosely bound. This delocalization in space translates into a narrow distribution in momentum coordinates. A Fourier transform of the measured momentum distribution together with the selection of the breakup events in coincidence with possible core excitated states give an insight on the wave function of the valence nucleon(s).

The experiment was performed at the National Superconducting Cyclotron Laboratory at Michigan State University. The carbon isotopes were produced by fragmentation of a 80 MeV/u ^{22}Ne primary beam on a thick Be target, and purified in the A1200 separator. After one-neutron removal reactions on a 228 mg/cm^2 Be target, the momentum distributions of the outcoming fragments were measured with the large acceptance S800 spectrograph and its focal plane detectors: a segmented ion chamber and a 5 cm thick plastic scintillator for energy measurements and two x/y position-sensitive cathode-readout drift chambers for position information. With the additional information of the time of flight over a 70 m path, the fragments were thus identified and their momentum distributions obtained (Fig. 1).

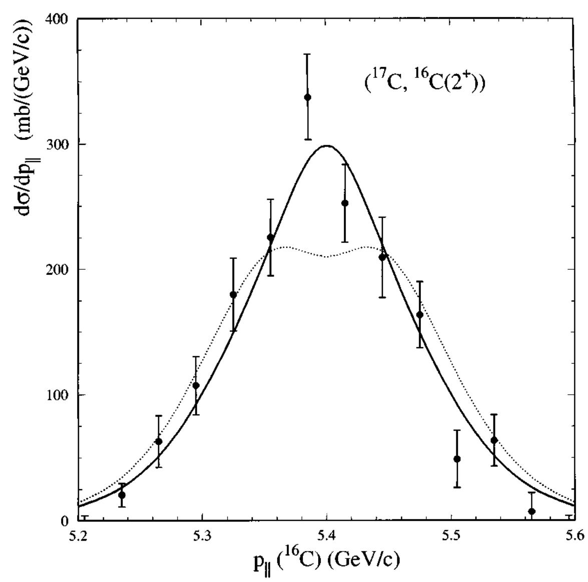

Figure 1:

The excited states of the fragments were tagged with the use of the NSCL position-sensitive NaI(Tl) array of 38 detectors placed around the target. The γ ray spectrum in coincidence with ^{16}C fragments, after one-neutron removal from ^{17}C, is shown in Fig. 2.

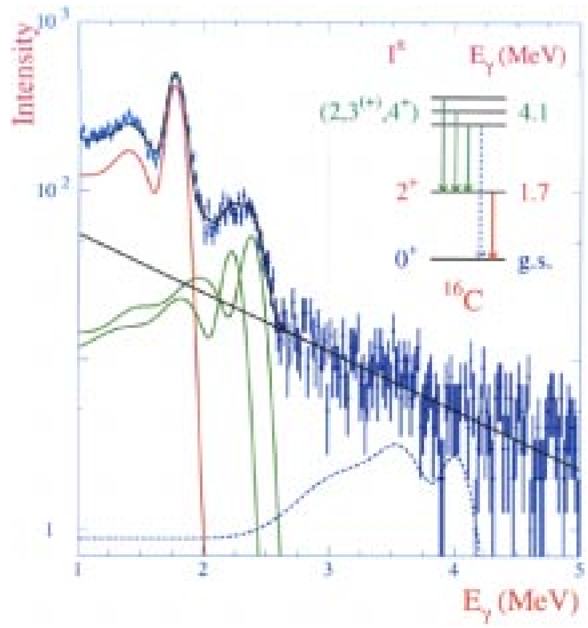

Figure 2:

The model used to interpret the data combines spectroscopic factors derived from the shell model [3] with single-particle cross sections calculated in an eikonal model [4], to account for the intrinsic structure and the reaction mechanism, respectively. In order to investigate the configuration of the ^{17}C ground state, the momentum distributions in coincidence with γ rays corresponding to different excited states in the residual fragments ^{16}C have been studied. The distributions for the excited states are consistent with a mixture of s and d components in proportions that are consistent with the theoretical prediction of a ground state spin and parity of $\frac{3}{2}^+$ for ^{17}C. The momentum distribution corresponding to events where the fragments were left in their ground state has also been extracted and is well described by a pure $d-$wave. The momentum distribution for (^{19}C,^{18}C(g.s.)), shown in Fig. 3, was obtained by selecting events in anticoincidence with γ rays from the excited states of the ^{18}C fragments. Its pure $s-$wave character points towards a ground state spin assignment of $\frac{1}{2}^+$ for ^{19}C. Also, limits on the separation energy have been extracted from the analysis of the momentum distribution. The result of S_n = 800(300) keV is consistent with the value obtained by Nakamura *et al.* [5], from a Coulomb dissociation experiment. A spectroscopic factor of about 0.6 for the 0^+(^{18}C(g.s.))$\times\frac{1}{2}^+$ configuration has been extracted and is also consistent with the theoretical shell model predictions of a $J^\pi = \frac{1}{2}^+$ for ^{19}C.

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References

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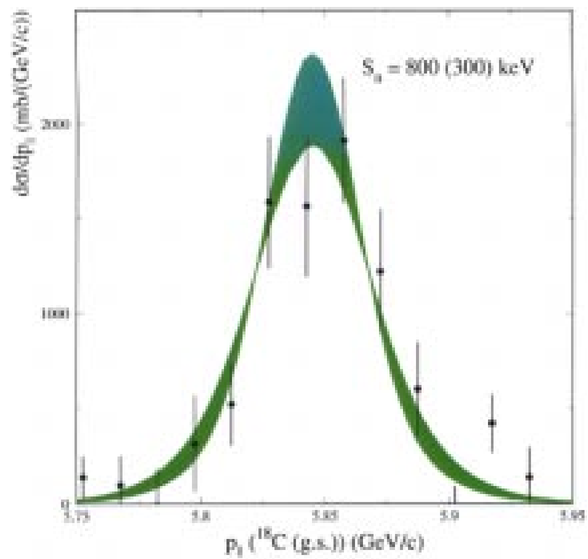

Figure 3:

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