Structure at and beyond the dripline in the vicinity of the N=14 and 16 sub-shell closures

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The structure of the neutron-rich nuclei in the vicinity of the N=14 and 16 sub-shell closures have attracted considerable interest in recent years. In particular, ^{19}B and ^{22}C represent the heaviest canididate two-neutron halo systems[1–3] whilst also spanning N=14 and 16 below doubly-magic ^{22,24}O. In terms of the most neutron-rich oxygen isotopes, the behaviour beyond ^{24}O, with the ultimate goal of investigating ^{28}O, has taken on renewed interest in the light of recent improvements in sophisticated structure modelling[4,5]. The present report describes the status of the analysis of data acquired during a series of three experiments, undertaken with these goals in mind, as part of the initial phase of operation of the SAMURAI spectrometer[6] coupled to the large area neutron array NEBULA[7] and DALI2[8] NaI array.

One of the systems of particular interest in terms of modelling ^{22}C and the evolution of the $\nu 2s_{1/2}$ and $\nu 1d_{5/2}$ levels is ^{21}C[9], the unbound sub-system of Borromean ^{22}C. In the present work we have attemped to populate ^{21}C via both neutron and proton removal from ^{22}C and ^{22}N respectively, whereby it is expected that the different valence neutron configurations of the projectile ground states should result in the population of correspondingly different final states. Figure 1 shows the reconstructed ^{20}C+n invariant mass (or decay energy) spectra for the two reactions. As may be seen, the selectivety of the two reactions is markedly different, with neutron removal from ^{22}C exhibiting in particular a rather narrow structure close to 1.5 MeV. We note that in comparison to the featureless, but very limited statistics spectrum of Ref.[10], the proton removal from ^{22}N shows here a very pronounced structure at around 1 MeV.

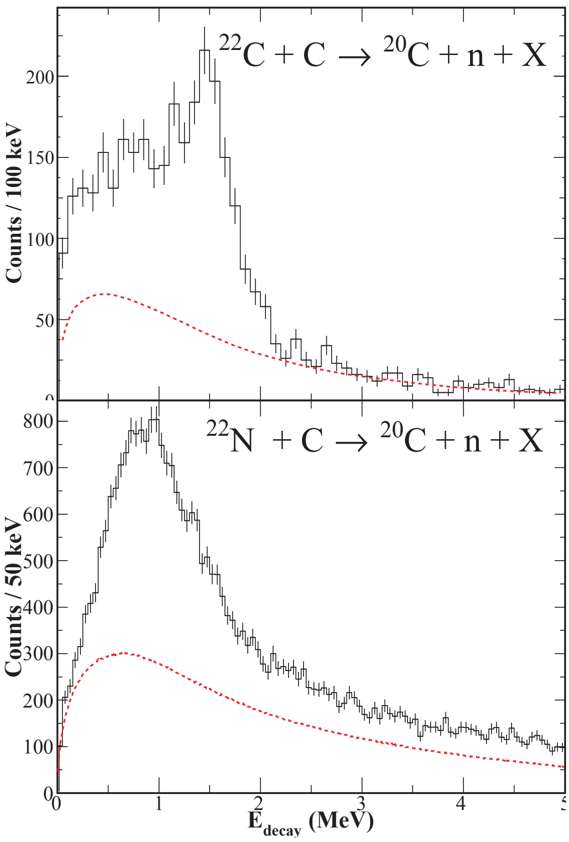

Fig. 1. Preliminary results for the ^{20}C+n decay energy spectra obtained for neutron (upper) and proton (lower panel) removal reactions at 240 MeV/nucleon. The dotted line, normalised at high decay energy, represents an event-mixed estimate of the corresponding uncorrelated distribution.

The further analysis of these preliminary results is currently underway, including the extraction of the ^{20}C+n momentum distribution for the neutron removal channel, which will shed light on the angular momentum of the removed neutron and hence the character of the corresponding ^{21}C states. Analysis of the data acquired for two-proton removal from ^{23}O is also in progress with the initial results exhibiting a decay

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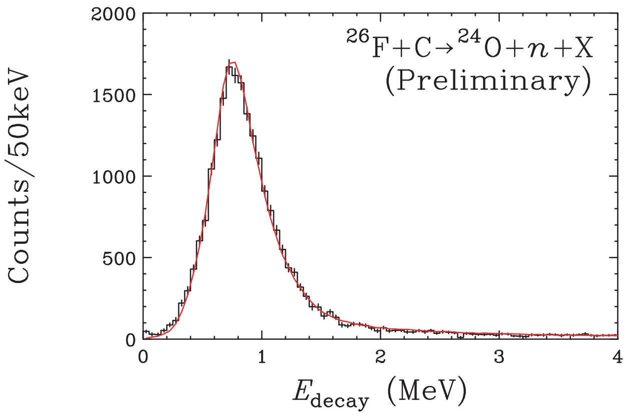

Fig. 2. Preliminary results for the ^{24}O+n relative energy spectrum obtained for proton removal from ^{26}F at 212 MeV/nucleon. The solid curve shows the results of a fit assuming a single resonance (see text)

Beam	Energy (MeV/nucleon)	$\Delta P/P$ (%)	Intensity (kpps/100pnA)
^{27}F	241	±3	1.0
^{28}Ne	212	±3	29
^{26}F	212	±0.6	2.5
^{27}Ne	240	±0.6	14

Table 1. Intensities, in terms of the ^{48}Ca primary beam (354 MeV/nucleon) intensity (pnA), for the secondary beams employed to investigate ^{25,26}O. The momentum aecceptance of the BigRIPS separator is noted in each case as is the mean secondary beam energy.

energy spectrum similar to that observed in single-proton removal from ^{22}N.

Data was also acquired for reactions of ^{19}B and ^{22}C beams on a Pb target with the goal of deducing the E1 strength functions for the two-neutron dissociation channel. This should enable further constraints to be placed on the halo structure of both nuclei as well as insight into the halo neutron spatial configurations[11]. The analysis of the data is on going, with very preliminary results indicating that both nuclei exhibit considerable near threshold strength.

In the case of the heavy oxygen isotopes, the analysis of the data obtained for proton removal from a ^{26}F beam to populate ^{25}O is in its final stages. Figure 2 shows the preliminary results obtained for the ^{24}O+n decay energy spectrum, including a comparison with the best fit results for an ℓ=2 resonance. A resonance energy of 0.75 MeV and width of 0.09 MeV have been estimated, which are in line with the results of earlier studies undertaken elsewhere employing the same reaction[12,13].

Work is currently proceeding to finalise the analysis of the data acquired for single-proton removal from ^{27}F to populate ^{26}O. To date the ^{24}O+2n decay energy spectrum has been successfully reconstructed after implementation of neutron cross talk rejection procedures based on kinematic conditions. The spectrum exhibits a feature at around 1.3 MeV, which represents the first observation of an excited (presumably 2^+) state in ^{26}O, together with a very sharp peak at threshold corresponding to the ground state[13,14]. A detailed analysis is being performed to determine the characteristics (energies and widths) of both states. The considerably higher statistics obtained in the present work should allow for a much more precise determination of the ground state energy. In the near future the data acquired for the two-proton removal from ^{27,28}Ne will also be exploited in the hope of providing further insight into the structure of ^{25,26}O.

We note that in an earlier report[15], intensities were quoted for the secondary beams employed for the investigation of ^{25,26}O. For reference, for future experiments, Table 1 lists updated determinations of the intensities.

The work described here relating to the investigation of ^{21}C forms part of the PhD thesis of S. Leblond (LPC-Caen).

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