High excitation energy resonances in α-conjugate nuclei

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We reported on an investigation where we performed an "*Examination of evidence for resonances at high excitation energy in the 7α disassembly of ^{28}Si*" [1]. In this work, we studied excitation energy distributions of the breakup of ^{28}Si and observed several high energy peaks in the 7α decay as shown by the red points in Fig. 1. Some of the observed peaks were in the region of excitation energies predicted by constrained self-consistent Skyrme–Hartree–Fock model calculations [2]. In that work, the excitation energy was calculated as a function of the quadrupole moment and a toroidal isomer was consider located if a minimum in the distribution was observed [2]. Since some of the peaks in the experiment were in the range of those predicted for toroidal configurations, namely about 143MeV for ^{28}Si, we decided to pursue this interesting subject in more depth.

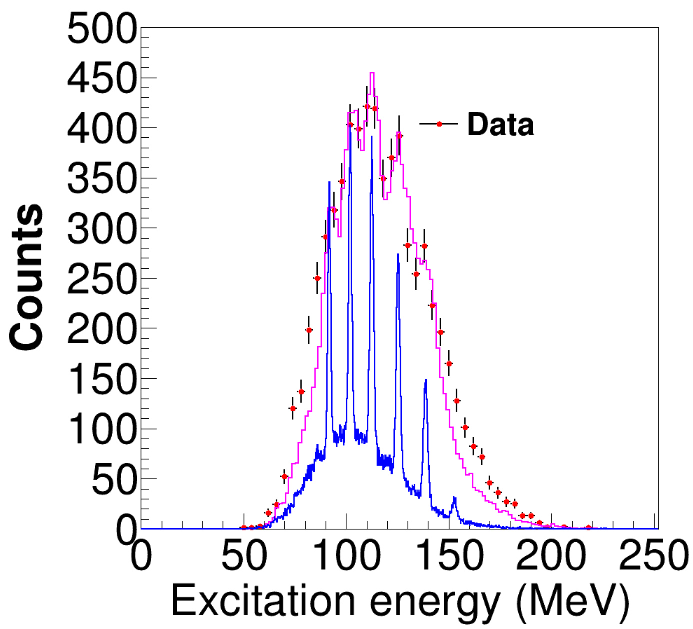

FIG. 1. Excitation energy distribution of the 7α breakup of ^{28}Si.

The experiment was performed using the NIMROD [3] multi-detector array. The angular resolution of the detectors in NIMROD is completely determined by the area of the respective detector leading to angular uncertainty in the reconstruction of any excitation energy. Any possible resonances, therefore, will be smeared.

The pink curve in Fig. 1 represents a background distribution which is constructed by using mixed 7α events from the experimental data. Narrow peaks representing possible resonances are added to this background distribution. The entire curve is then filtered by the experimental acceptance of NIMROD in particular taking into account the finite angular resolution given by the size of the respective detector elements. We can observe in the distribution that the smearing of these narrow peaks leads to peaks of similar widths to what is observed in the experiment.

In order to confirm that these high energy peaks are truly resonances, we propose to repeat the experiment using a position sensitive detector array. The FAUST [4] array at the Cyclotron Institute has been outfitted with position sensitive DADL detectors. Any narrow peaks which show up as wide peaks in the pink curve in Fig. 1 would be significantly narrower with the 1mm position resolution that the DADL detectors provide. This is shown by the blue curve in Fig. 1 where the same mixed event background distribution with narrow resonances added are filtered by the FAUST acceptance using a DADL position resolution of 1mm. We observe that the peaks are significantly sharper.

While the initial experiment focused on ^{28}Si, we anticipate using a number of alpha conjugate projectiles that include, but are not limited to, ^{28}Si, ^{32}S, ^{36}Ar and ^{40}Ca in the experiments to extend this study. We also anticipate doing a beam energy scan in order to further characterize the observed peaks.

The experiment is in the planning stages and we anticipate executing the experiment in the coming year.

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