Spectroscopic Studies of the N=16/N=20/N=28 Shell Gaps via (d,p) Transfer

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The evolution of shell structure as nuclei become more neutron rich [1] arises primarily from residual neutron-proton interactions and gives rise to different "magic" shell gaps away from stability, compared to the traditionally recognised gaps. This has many implications and the structure and reaction cross sections for exotic nuclei [1,2]. To measure just the spins and parities of states is not sufficient to study this shell evolution; it is important also to extract the spectroscopic factor (or an equivalent number) that measures the purity of the single-particle structure for each state. We have instigated a programme of such measurements using beams of reaccelerated radioactive beams, wherein the transfer of a single neutron via the (d,p) reaction provides the ideal tool for probing single particle structure. Our first measurements addressed the structure of the N=15 and 17 nuclei ^{25}Ne [3] and ^{27}Ne [4] using the particle and gamma-ray arrays TIARA and EXOGAM at GANIL. Extensions of the programme now include studies of ^{26}Na [5,6,7], ^{25}Na and ^{29}Mg using SHARC and TIGRESS at TRIUMF. In the case of ^{26}Na, new techniques involving the gating on individual gamma-ray peaks to isolate different final states were successfully developed, and detailed results will be shown. The results reveal a structure for ^{26}Na in line with the systematic opening of a shell gap at N=16 and point to the need to know the single-particle structure of ^{29}Mg in order to constrain large-scale shell model calculations. Preliminary analysis of very recent data for ^{29}Mg will also be presented.

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