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Probing the 10Li structure by the 9Li(d,p)10Li transfer reaction

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The study of the unbound system 10Li is of great interest since the knowledge of its structure is a crucial ingredient in the description of the two-neutron halo nucleus 11Li.
Despite the significant amount of experimental information gathered during the last years, the properties of the 10Li continuum remains unclear, to the extent that even the energy and the spin-parity of the ground state are still controversial. It is widely accepted that it is formed by either a 1p1/2 or 2s1/2 neutron which, coupled to the 3/2- spin of the 9Li core, would produce 1+, 2+ or 1-, 2- states, respectively. However, some calculations suggest that the ground state would correspond to an s-wave [1,2], whereas others conclude that it should be due to a p-wave coupling [3]. Indications of the presence of a low-lying virtual intruder s-state have been also reported [4] and are consistent with the trend of the N = 7 isotones, that should result in a parity inversion in the 10Li case. Nevertheless, due to the limitations of the existing data [5], many of the details predicted by the theory have not been tested.
We have investigated the 10Li structure via the 9Li(d,p)10Li transfer reaction in inverse kinematics at TRIUMF. A 100 MeV 9Li beam, produced by the ISAC-II facility, impinged on a CD2 target. The recoiling protons were detected at backward angles by the LEDA array of silicon strip detectors [6], thus allowing the study of the 10Li emitted in the crucial region at forward angles. Protons are detected in coincidence with the 9Li fragments produced from the breakup of the corresponding 10Li. 9Li fragments have been detected and identified by using a ΔE-E telescope of S2 annular DSSD detectors located downstream the target.
The 10Li excitation energy spectrum was reconstructed with significant statistics up to 6 MeV, allowing, for the first time, to explore the completely unknown high excitation energy region. The highly segmented detection system allowed to also measure the angular distributions of the observed resonances at forward angles. The comparison with an extended mean-field approach, where the pairing correlations are introduced [7], allows to disentangle the s, p and d orbital contributions in the different portions of the energy spectrum.

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