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Studying the structure of Li-11 via transfer reactions

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The term "halo nucleus" was coined to describe nuclei exhibiting an unusually large spatial extension, deviating from the standard formula $r=r_o \cdot A^{1/3}$. The initial empirical observation of this phenomenon arose from scattering experiments involving, among others, lithium isotopes [1]. These experiments, designed to measure the interaction cross-section of neutron-rich nuclei, revealed a significant increase in cross-section as we approach the neutron dripline when going from ^{9}Li to ^{1}1Li.This discovery led to the interpretation of a new type of nuclear structure [2], characterized by a compact core and an external set of nucleons (1n for ^{11}Be and 2n for ^{11}Li). Subsequent momentum distribution studies of ^{9}Li from ^{11}Li break-up experiments confirmed this hypothesis [3].

Our focus is on the ^{11}Li isotope, considered the quintessential two-neutron halo. While the ground state of ^{11}Li is well established [4], the same cannot be said about its excitation spectrum, despite multiple experimental attempts [4]; there is no consensus over the energy and number of excited states. Most of these experimental attempts are based on promoting an ^{11}Li nucleus from the ground state to its excited states through reactions, with the only exceptions being [5] and [6], which suffer from a complex experimental setup.

We are undertaking a new experiment to populate the excited states of ^{11}Li using the ^{9}Li(t,p)^{11}Li reaction, as the structure of ^{9}Li is simpler [7]. The experiment, scheduled for 2024, will take place at the Scattering Experiment Chamber (SEC) at CERN-ISOLDE in Switzerland. Our state-of-the-art setup consists of a central tritium target surrounded by a system of five telescopes (PAD+DSSD) forming a pentagon around the target, covering both forward and backward angles. The pentagons are complemented by a system of silicon discs and an S3 at the back, along with an S3-S5 telescope at the front, maximizing angular coverage.

The tritium target will receive a ^{9}Li beam with an energy of 72 MeV/nucleon, populating the excited structure of ^{11}Li through the ^{9}Li(t,p)^{11}Li reaction. Information on the excited states will be gathered from the emitted proton, which will be detected by our setup. To process the data, our DAQ employs compact digitizer cards (64 channels per card) developed by Mesytec. These cards handle all electronic readouts while requiring only two cables (optical link and power), making the setup extremely compact (only six cards are needed).

In this contribution, we present Geant4-MC simulations of the setup and discuss the status of our setup, which is nearing completion.

Refrence

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