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Lifetime Measurement of the First 2^+ State in ^{40}Ca Using Direct Population via an Alpha-transfer Reaction

Thursday, 11 June 2020 13:00 (15 minutes)

At TRIUMF, Canada's particle accelerator centre, the TIGRESS Integrated Plunger and its configurable detector systems have been used for charged-particle tagging and light-ion identification in Doppler-shift lifetime measurements employing gamma-ray spectroscopy using TIGRESS, an array of HPGe detectors. An experiment using these devices to measure the lifetime of the first 2^+ (2^+_1) state of ^{40}Ca has been performed by projecting an ^{36}Ar beam onto a $^{nat.}$C target. Analysis of the experimental gamma-ray spectra confirmed the direct population of the 2^+_1 state. Event-by-event relativistic kinematic reconstruction of the invariant mass of the two-alpha system indicated that fold-two alpha particle events, detected in the PIN array, came from the decay of a single ^{8}Be, rather than fusion-evaporation from a compound ^{48}Cr nucleus. Since the centre-of-mass energy in the entrance channel was below the Coulomb barrier, the reaction mechanism is believed to be the transfer of one alpha particle from the ^{12}C target to ^{36}Ar beam nucleus. The low centre-of-mass energy resulted in the direct population of the 2^+_1 state of ^{40}Ca, which eliminated feeding cascades, and therefore the decay kinetics were predominantly first order. Verification of this alpha-transfer reaction mechanism is being performed using GEANT4 Monte Carlo simulations. Simulations with the correct reaction mechanism are expected to reproduce the experimental energy spectra and angular distributions of alpha particles while providing a Doppler Shift Attenuation Method measurement of the lifetime of the 2^+_1 state in ^{40}Ca. In the future, the observed reaction mechanism can be applied to N=Z radioactive beams to provide direct access to low-lying excited states of nuclei with (N+2) and (Z+2), enabling transition rate studies at the N=Z line far from stability. Results of the analysis of the experimental data and simulations will be presented and discussed.

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