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(G*) Lifetime Measurement of the First 2+ State in 40Ca Using Direct Population via an Alpha-transfer Reaction

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At TRIUMF, Canada's particle accelerator centre, the TIGRESS Integrated Plunger (TIP) and its configurable detector systems have been used for charged-particle tagging and light-ion identification in Doppler-shift lifetime measurements using gamma-ray spectroscopy with the TIGRESS array of HPGe detectors. An experiment using these devices to measure the lifetime of the first 2^+ 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 first 2^+ state. 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 the ^{36}Ar beam nucleus, rather than fusion-evaporation from a compound ^{48}Cr nucleus. The low centre-of-mass energy resulted in the direct population of the 2^+ state of ^{40}Ca, which eliminated feeding cascades, and therefore restricted the decay kinetics predominantly to first order. Currently, Monte-Carlo simulations using the Geant4 framework are being developed to locate the precise beam spot and to verify the reaction mechanism. Simulations with the correct parameters 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 first 2^+ 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 analysis of the experimental data and simulations will be presented and discussed.

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