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Electromagnetic Transition Rate Studies in 28Mg

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Neutron rich Mg isotopes far from stability belong to a region known as the island of inversion where the single particle description of the shell model breaks down, and the predicted configuration of the nuclear states becomes inverted. Nuclei in this region also exhibit collective behaviour in which multiple particle interactions play a significant role in nuclear matrix elements. These matrix elements can be studied through electromagnetic transition rate measurements, which allow for tests of theoretical models using the well-understood electromagnetic transition operators.

In-beam reaction experiments performed at TRIUMF, Canada's particle accelerator centre, allow for precise measurements of nuclei far from stability. Using TIGRESS in conjunction with the TIGRESS Integrated Plunger (TIP) allows for the implementation of Doppler shift techniques to measure transition rates in excited states of nuclei produced in low cross section reactions.

In June 2021, an experiment was performed using TIGRESS and TIP to measure excited state lifetimes in 28Mg using both the Doppler Shift Attenuation and Recoil Distance Methods to be sensitive to both short- and longer-lived states. ^{28}Mg nuclei were populated using the ^{12}C(^{18}O,2p) fusion-evaporation reaction, with charged particles detected using the TIP CsI(Tl) ball, and gamma rays detected using TIGRESS.

Event reconstruction using detector-specific time windows were applied to remove uncorrelated background, while particle identification of light-charged ions was performed using offline fitting of CsI(Tl) waveforms taken during data collection. The resulting spectra demonstrate the successful separation of reaction channels by particle content, essential for studying ^{28}Mg, as well as show clear evidence of the Doppler effects used to measure excited state lifetimes. The current status of data analysis and the impacts on nuclear physics will be discussed in this talk.

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