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Influence of the neutron pf shell on the structure of 28Mg

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Excited states in ^{28}Mg were studied in an experiment at the ISAC-II facility at TRIUMF to investigate the evolution of nuclear shells and search for evidence of the lowering in energy of pf negative parity orbitals predicted near the $N = 20$ 'island of inversion'. For the first time ^{28}Mg was investigated using a fusion-evaporation reaction [12C(^{18}O,2p)^{28}Mg], leading to preferential population of states at high spin and excitation energy where the influence of the pf negative parity orbitals is expected.

Data corresponding to ^{28}Mg was extracted via time coincident identification of protons and gamma rays. Gamma-ray spectroscopy utilized the TIGRESS array at ISAC-II. Charged particles were detected and identified using a 38-detector CsI(Tl) scintillator array, which is a subset of the recently completed 128-detector 'CsI ball' array developed at SFU as part of the TIGRESS Integrated Plunger (TIP) infrastructure and commissioned at TRIUMF. Lifetime measurements of states populated in ^{28}Mg were performed using Doppler shift methods.

Three new excited states of ^{28}Mg were identified, including candidates for the $I^\pi = 5_1^+, 6_1^+$ levels near the neutron separation energy. Lifetime limits of several low-lying states were improved, with the extracted transition strengths suggesting reduced collectivity in the yrast band compared to previous results. Multiple candidates for negative parity states were also observed, including an unusually long-lived state thought to decay by an M2 transition ($I^\pi = (0,4)^-$). The observed level energies are consistent with shell model calculations in the sd and $sdpf$ shells, where negative parity levels arise from single neutron excitation to the pf shell. The data and its interpretation with respect to the lowering of intruder orbitals near the 'island of inversion' will be discussed.

Primary author: WILLIAMS, Jonathan (Simon Fraser University)

Presenter: WILLIAMS, Jonathan (Simon Fraser University)

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