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Evolution of nuclear shell structure with neutron excess in the fp-shell

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The evolution of properties of atomic nuclei with respect to increase in neutron richness is one of the crucial issues in the modern nuclear structure studies. In particular, neutron-rich nuclei above the doubly magic 48Ca have recently attracted a lot of interest due to an N=32 subshell closure that was evidenced in 52Ca, 54Ti and 56Cr. This phenomenon was attributed to the strong proton f7/2 - neutron f5/2 monopole interaction, which causes an increase in energy of the ⊠f5/2 single particle orbital with respect to the ⊠p3/2 and ⊠p1/2 levels as protons are subtracted from the ⊠f7/2 shell. However, the magnitude of this increase, particularly in Ca isotopes, is difficult to detect as the states involving the neutron f5/2 orbital in such nuclei like 51-53Ca are very hard to reach. In our recent experiments we studied neutron-rich species close to Z=20 using deep inelastic processes occurring in heavy ion collisions of a 48Ca beam on a 238U target. In one measurement, a thick target technique was applied and the gamma coincidence data were collected with GAMMASPHERE at Argonne NL. In the second experiment, the same reaction was studied employing the PRISMA+CLARA detection system at LNL in Legnaro. With A and Z reaction fragment identifications obtained from PRISMA, we were able to assign the observed (with CLARA) gamma transitions to a given product. These transitions were subsequently used as "starting points"in the analysis of thick target gamma coincidence data. Among many findings, yrast structures in the N=31 isotones, 52Sc and 51Ca were located - these structures include excitations involving f5/2 neutrons. The presentation will discuss new results in light of shell model calculations and theoretical predictions for the ⊠f7/2 –⊠f5/2 monopole interaction strength arising from the tensor component of the nucleon-nucleon interaction.

Primary author: Prof. FORNAL, Bogdan

Presenter: Prof. FORNAL, Bogdan

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