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Experimental investigation of nuclei in $A \sim 50 - 60$ region

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The proton and neutron Fermi levels in nuclei with mass number $A \sim 50 - 60$ lie around the $N = Z = 28$ magic number. This shell gap is comparatively smaller which might have made the doubly magic ^{56}Ni ($N = Z = 28$) a soft core [1]. The $1g_{9/2}$ orbital, lies above fp orbital, has shape driving effect which leads to deformation and collectivity. Therefore, in these nuclei there is a competition between the single particle and collective excitations. Different nuclear shapes and shape transitions are expected for these nuclei, some of which have been observed [1-3].

We have performed an experiment at VECC, Kolkata using $^{55}\text{Mn}(^4\text{He}, 2p3n)$ reaction with 34-MeV α beam from the K-130 cyclotron to populate the nuclei near the vicinity of ^{56}Ni . The primary aim was to study the odd-odd nucleus ^{54}Mn ($Z = 25$, $N = 29$), which has $3h-1p$ ground state configuration with respect to ^{56}Ni . Being an odd-odd nucleus, different coupling possibilities exist between different valence proton and neutron orbitals which would lead to the production of several low-lying yrast and non yrast states. The experimental evidence of these states would provide information on the proton-neutron interaction.

The de-excited prompt gamma rays, emitted from the populated nuclei, were detected using a multi detector gamma-ray spectrometer consisting of 11 Compton-suppressed clover HPGe detectors and 1 LEPS detector. The clover detectors were at three angles, 40° (2 clovers + LEPS), 90° (6 clovers) and 125° (3 clovers). The PIXIE-16 digitizer based data acquisition system and IUCPIX package, developed by UGC-DAE CSR Kolkata [4], was used to record and process the data. While the detailed analysis of the data is in progress, the preliminary analysis of the coincidence matrix constructed from the addback energies from the clover detectors clearly indicates the production of excited states in other odd-even (^{57}Co , ^{55}Mn) and even-odd (^{57}Fe) nuclei in addition to ^{54}Mn . Another experiment ($\alpha + ^{58}\text{Ni}$) was also performed at VECC using similar detector setup to study the higher Z nuclei in this region [5].

According to the present data analysis, some states of ^{54}Mn reported in [6] are found to be highly questionable. The parity of a low lying state at ~ 1.9 MeV has been assigned as negative by [6]. The negative parity at such a low excitation is highly interesting for this nucleus. This is also under inspection. A few new gammas have also been identified in the present work. In addition, evidence of rotational band has been found in the odd- A isotope ^{55}Mn . Further data analysis is in progress.

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