Spectroscopy of Sc isotopes between the $N = 34$ and $N = 40$ subshell closures

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Evidence for the existence of a new "magic number," $N = 34$, has been obtained from the level structure of ^{54}Ca[1)] while there may not be a corresponding shell gap in Ti[2,3)] isotopes. This has created recent interest to study the evolution of neutron-rich scandium isotopes. These nuclei lie between Ca and Ti and the evolution of proton orbitals can reveal the nature of the magic numbers at $N = 34$, recently shown to vanish in ^{55}Sc,[4)] and the $N = 40$ pf-shell closure. In this case the valence proton occupies the $\pi f_{7/2}$ orbital, interacting with $\nu f_{5/2}$ orbital in ^{57,59,61}Sc.

The DALI2+ array has been coupled with the wide acceptance SAMURAI spectrometer[5)] in the third SEASTAR campaign. This made the measurement of the energies of low-lying states of a large number of isotopes in the previously discussed mass region possible. The radioactive beams were produced by a primary ^{70}Zn beam at 345 MeV/nucleon impinging on a 10-mm-thick ^{9}Be target. The BigRIPS fragment separator[6)] was used for the identification and separation of the secondary beams. The Sc isotopes of interest were produced by knock-out reactions in MINOS,[7)] consisting of a 150-mm-thick LH_2 target surrounded by an active TPC. Gamma rays were measured with the DALI2+ array, consisting of 226 NaI(Tl) detectors surrounding MINOS. The reaction products were identfied event-by-event using two drift chambers and a hodoscope plastic-scintillator array after Brho analysis in the SAMURAI magnet. NEBULA and NeuLAND were used in addition for neutron detection. Figure 1 shows all reaction channels producing $^{55-61}$Sc.

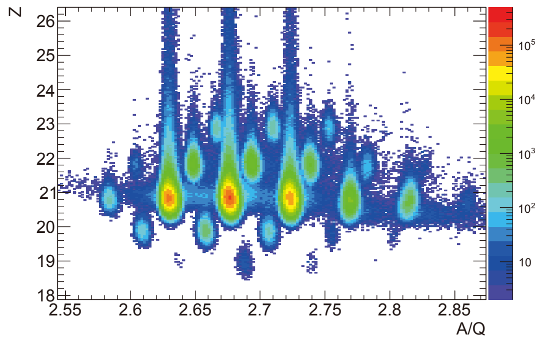

Fig. 1. Particle identification in BigRIPS after gating on $^{55-61}$Sc in SAMURAI.

In a preliminary analysis, the γ rays reported in Ref. 4) for ^{55}Sc were identified in the data from the neutron knock-out reaction, ^{56}Sc(p,pn)^{55}Sc. The full analysis of $^{55-61}$Sc is on-going.

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