Robustness of the $N = 34$ shell closure: First spectroscopy of $^{52}$Ar

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It is now well known that magic numbers are not universal across the nuclear landscape and that new shell closures may emerge in exotic nuclei. For example, a new subshell closure at $N = 34$ has been predicted for neutron-rich nuclei.\(^1\) On the experimental side, the systematics of the $E(2^+_1)$ of Ti isotopes show no evidence for the existence of the $N = 34$ shell gap.\(^2\) Recently, the $E(2^+_1)$ of $^{54}$Ca was measured to be $\sim 0.5$ MeV smaller than that of $^{52}$Ca.\(^3\) This drop was attributed to the larger ground state correlation energy of $^{52}$Ca, and the results were interpreted as confirming the $N = 34$ magic number in Ca isotopes. For $^{52}$Ar, no spectroscopic information has been measured; however, its $E(2^+_1)$ was predicted to be the highest among Ar isotopes with $N \geq 20$.\(^5\) The spectroscopy of $^{52}$Ar thus offers a unique chance to explore the robustness of the $N = 34$ subshell closure and pin down the mechanism of its emergence.

The measurement of $^{52}$Ar was performed at the RIBF as part of the third campaign of the SEASTAR program. The fast radioactive beam containing $^{53}$K, amongst other products, was produced by fragmentation of a $\sim 220$ pA $^{70}$Zn primary beam at 345 MeV/nucleon on a 10-mm thick Be target. The constituents were identified using the BigRIPS frag-

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\includegraphics[width=\textwidth]{Fig1.png}
\caption{Particle identification after the secondary target.}
\end{figure}

ment separator with the $\Delta E$-TOF-$Bp$ method. The incident beam, magnetically centered on $^{50}$K, was impinged on a 150-mm thick MINOS$^{31}$ liquid hydrogen target to induce proton-removal reactions. The recoil protons were detected by the MINOS TPC tracker\(^5\) to reconstruct the reaction vertex. The MINOS efficiency was measured to be 90(5)%. The kinematic energy and intensity of the $^{53}$K beam in front of the target were $\sim 240$ MeV/nucleon and 1.0 pps, respectively. The reaction residues passed through the SAMURAI$^{50}$ magnet with a central magnetic field of 2.7 T, and were identified by a 24-element plastic hodoscope and two forward drift chambers. Figure 1 shows the particle identification of the reaction residues. The de-excitation $\gamma$ rays from the reaction residues were measured by the upgraded DALI2$^{+}$ array,\(^7\) which consists of 226 NaI(Tl) crystals. The preliminary Doppler-corrected $\gamma$-ray spectrum of $^{52}$Ar was obtained, and a clear ($2^+_1 \rightarrow 0^+_0$) candidate peak was found. Evidence for other transitions in $^{52}$Ar requires further analysis.

References
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  \item 7) I. Murray et al., in this report.
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