

Magicity versus superfluidity around ^{28}O viewed from the study of $^{30}\text{F}^\dagger$

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Studying isotopic chains of nuclei up to the drip lines provides important insights into nuclear structure and weak-binding effects. The heavy fluorine isotopes ($Z = 9$) are particularly interesting because of shell evolution, potential halo formation, and superfluid characteristics. The presented work aims at studying the spectroscopy and single-neutron separation energy S_n of the unbound $^{30}\text{F}_{21}$, which lies one neutron beyond $N = 20$. Produced in the $^{31}\text{Ne}(p, 2p)^{30}\text{F}$ quasi-free proton knockout reaction, ^{30}F is reconstructed from the $^{29}\text{F} + n$ invariant-mass spectrum, as shown in Fig. 1. The experiment at the SAMURAI setup, conducted using the ^{31}Ne beam produced by BigRIPS, utilized

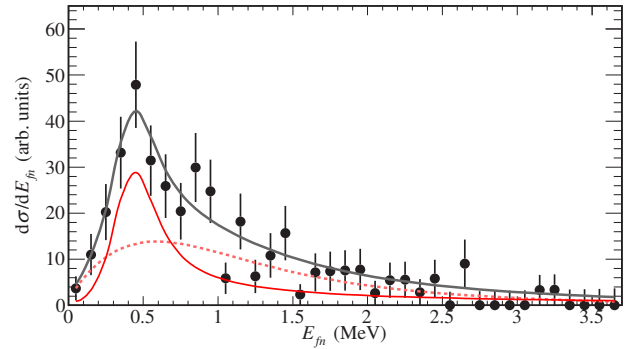


Fig. 1. Relative-energy spectrum of ^{30}F in the $^{31}\text{Ne}(p, 2p)^{29}\text{F} + n$ reaction, ground-state resonance at 472 keV (red line), and potentially unresolved resonances (dashed red line).

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the MINOS liquid hydrogen target, its TPC, DALI2 for γ -ray detection, and NeuLAND and NEBULA for forward neutron detection, and fragment tracking as in Ref. 1). The experimental relative-energy spectrum shows a clear peak identified as the ^{30}F ground-state resonance at 472 ± 58 (stat) ± 3 (sys) keV with no significant coincident γ -ray detected. This small energy indicates no sharp decrease in S_n beyond $N = 20$, which is a decisive proof that magicity is not restored close to ^{28}O .¹⁾ This is supported by large-scale shell-model calculations in the sd - pf space using the SDPF-U-MIX20 interaction. Additionally, the close proximity of neutron orbits indicates that the ^{29}F and ^{28}O nuclei are in a superfluid phase, with significant neutron-pair numbers (with $J = 0$) and their scattering across shells. Furthermore, ^{29}F and ^{31}F are candidates for two-neutron halo nuclei. Those aspects are topics for future experimental and theory work.

Reference

- 1) Y. Kondo *et al.*, Nature **620**, 965 (2023).