Across the neutron drip-line: Study of the heaviest nitrogen isotopes at RIKEN

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- Where are the limits?
- Why are there limits?
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Why are there limits?
Explore both sides of the dripline

- Anomaly: N=16 → 22
- Some results for Oxygen

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Nitrogen anomaly
- Few calculations
- No data beyond the dripline

$E_{g.s.}$ [MeV]

$\hbar \omega = 24$ MeV
$\lambda_{SRG} = 2.0$ fm$^{-1}$
• Study of the heaviest two-neutron halo nuclei ($^{19}$B and $^{22}$C)
• Survey of systems around the neutron dripline ($^{12}$Li → $^{26}$O)
This work: End point of the nitrogen isotope chain
This talk: First observation of $^{24}$N and $^{25}$N
Invariant mass spectroscopy

- Nucleon knockout ($\beta \sim 0.6$) + in flight decay
- Selective population of the states

\[ E_{rel} = \sqrt{\left( \sum_i E_i \right)^2 - \left( \sum_i \vec{p}_i \right)^2} - \sum_i m_i \]

\[ E_{rel} \approx \frac{1}{2} \mu (\vec{V}_n - \vec{V}_f)^2 \]
Experimental setup

- Primary beam on Be target
- Secondary beam selected by BigRIPS separator
- Secondary beam on C target
Fragments are deflected in SAMURAI

Bρ reconstructed through two drift chambers

Neutrons go straight to NEBULA

- Fragments are deflected in SAMURAI
- Bρ reconstructed through two drift chambers
- Neutrons go straight to NEBULA
Results: First observation of $^{24}\text{N}$

- Only one state populated ($3/2^+$)
- Selectivity: $-1p$ preserves neutron configuration
Results: First observation of $^{24}\text{N}$

- $\pi(1p_{1/2})^{-1} \otimes v1d_{3/2}$
- Expected doublet: $J^\pi = 2^-,1^-$
- Only one structure observed in the $E_{\text{rel}}$ spectrum
Results: First observation of $^{24}\text{N}$

- Compatible with two resonances
- $\Delta E_r \leq 400$ keV
Results: First observation of $^{25}$N

- Mostly populates $0^+$ G.S.
- Selectivity: -1p preserves neutron configuration
Results: First observation of $^{25}\text{N}$

\[ \varepsilon_{2n} \sim 7\% \]

\[ \psi(1p_{1/2})^{-1} \otimes (\nu 1d_{3/2})^{2} \]

- Expected state: $J^\pi = 1/2^{-}$
First observation of two new nuclei!

- $^{24}\text{N}$
  - Ground state @ $E = 1.32(20)$ MeV above $S_n$
  - About 1 MeV difference with AME2012
  - Compatible with doublet if $\Delta E_r \leq 400$ keV

- $^{25}\text{N}$
  - Ground state @ $E = 1.7(4)$ MeV above $S_{2n}$
  - Compatible with AME2012

Perspectives

- Beam time approved for re-measurement of $^{24,25}\text{N}$
  - Better resolution (HIME)
  - More statistics (NEBULA Plus)
Thank you for your attention!
Counts

\[^{28}\text{Ne},^{23}\text{N}+2n\]

\(E_{\text{rel}}\) (MeV)