^{25}O - Beyond the Neutron Dripline *

C. Caesar[1,2], T. Aumann[1,2], K. Boretzky[2], M. Heil[2], M. Heine[1,2], M. Holl[1,2], R. Plag[3], D. Rossi[2], H. Scheit[1], H. Simon[2], and the R^{3}B Collaboration

[1]IKP, TU Darmstadt, Germany; [2]GSI, Darmstadt, Germany; [3]Goethe Universität, Frankfurt a.M., Germany

The R3B-collaboration has studied proton knock-out reactions from the very neutron-rich isotope ^{26}F populating neutron-unbound states in ^{25}O [1, 2]. The incoming ^{26}F ions have been identified on a event-by-event basis. For the outgoing reaction products the four-momenta ($P_i = (E_i/c, \vec{p}_i)$) have been measured and those have been combined to reconstruct the invariant mass.

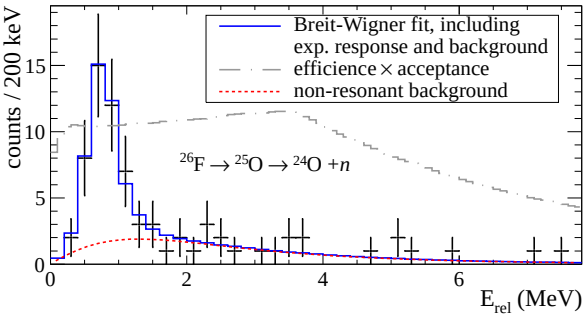

Figure 1: Relative-energy spectrum of the ^{24}O+n system. The blue solid line shows a Breit-Wigner fit to the data, which includes the experimental response and a non resonant background (red dotted curve). The grey dashed-dotted histogram indicates the experimental response to a white spectrum.

The resulting ^{24}O+n relative-energy spectrum as shown in Fig. 1 exhibits a peak at around 700 keV. This peak corresponds to the ground-state of ^{25}O. The resonance position E_r and width Γ were determined in the following way. A Breit-Wigner line shape in the one-level approximation as given in [3] has been used:

$$f(E; E_r, \Gamma) = \frac{\Gamma}{(E_r + \Delta - E)^2 + 1/4 \cdot \Gamma^2} \cdot \qquad (1)$$

The resonance shift Δ has been set to zero, the width Γ is given by the reduced width γ and the penetration factor P_l; $\Gamma = 2P_l(E;R) \cdot \gamma^2$. For the angular momentum $l = 2$ is used, since the additional neutron of ^{25}O compared to ^{24}O is most likely in the $0d_{3/2}$ - shell. A channel radius R of 4 fm has been choosen.

This distribution has been convoluted with the experimental response as shown in Fig. 2. A non-resonant background has been modeled with:

$$f(E) = a \times \mathrm{erf}(b \cdot E) \times e^{c \cdot E} \,, \qquad (2)$$

* This work was supported by HIC for FAIR, BMBF (06DA70471), and through the GSI-TU Darmstadt Cooperation.

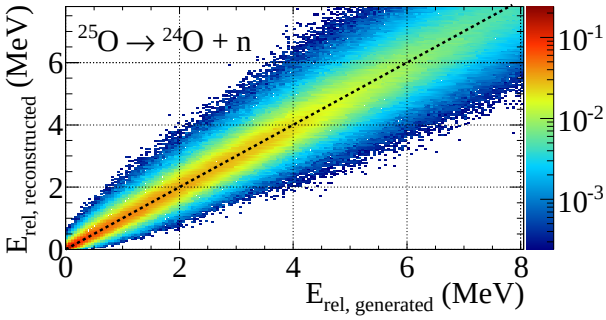

Figure 2: Simulated experimental response for detection of a ^{24}O+n decay from the (unbound) isotope ^{25}O. The x-axis depicts the relative energy used as input for the simulation while the y-axis shows the reconstructed relative energy E_{rel} reflecting the measured values.

where 'erf' is the error-function and the paramters a, b and c have been varied freely. The sum of convoluted Breit Wigner and background was used to fit the experimental data. The χ^2 minimization was done using a χ^2 based on the Poisson likelihood [4]. The results are as follows:

$E_r = 725^{+54}_{-29}$ keV,

$\Gamma = 20^{+60}_{-20}$ keV.

The result on the resonance position (width) is in agreement with the result from [5] within 1-σ (2-σ). Our result is within (1-σ) in agreement with a single-particle width calculated for a pure d-state character ($\Gamma_{s.p.} \approx 65$) keV.

References

[1] T. Aumann *et al.*, GSI Scientific Report (2010) PHN-NUSTAR-NR-04.

[2] C. Caesar *et al.*, GSI Scientific Report (2011) PHN-NUSTAR-NR-12.

[3] A. M. Lane and R. G. Thomas, Rev. Mod. Phys. **30** (1958) 257.

[4] S. Baker and R.D. Cousins, NIM A **221** (1984) 437.

[5] C.R. Hoffman *et al.*, Phys. Rev. Lett. **100** (2008) 152502.