$^{1}H(^{14}Be,^{13}Be):1$ 2013Ak02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. H. Kelley, C. G. Sheu and J. E. Purcell	NDS 198,1 (2024)	1-Aug-2024

2010Ko17: The authors studied resonances in the ^{13}Be nucleus by measuring products from the one-neutron removal reaction on ^{14}Be via the ^{1}H(^{14}Be,^{12}Be+n) reaction using a E(^{14}Be)=69 MeV/nucleon beam (at target center) at RIKEN (ΔP/P=±2%).

The ^{12}Be ions were detected in a spectrometer, while 54 plastic scintillator rods detected the neutrons; γ-rays identifying populated ^{12}Be states were also measured. The ^{13}Be resonance energies were deduced from reconstruction of the invariant mass. A low-energy s-wave strength is observed, which is characterized with a scattering length a_s=−3.4 fm *6*. Resonances are suggested at E_{res}=0.51 MeV *1* with Γ=0.45 MeV *3* and σ=48 mb *4*, along with E_{res}=2.39 MeV *5* with Γ=2.4 MeV *2* and σ=34 mb *3*. The peak corresponding to E_{res}=2.39 MeV can also be reproduced with groups at E_{res}=2.0 MeV and E_{res}=2.9 MeV as suggested by (1992Os04,1998Be28). This three-state interpretation is preferred in the ENSDF evaluation. Analysis of the transverse momentum distribution along with the 0.45 MeV width of the lower state was interpreted as evidence for a *p*-wave (J^{π}=1/2$^-$) nature for this state. The authors suggest this intruder configuration implies a disappearance of N=8 magicity.

In this measurement, the low energy strength is attributed to a background resulting from ^{1}H(^{14}Be,^{14}Be*→^{12}Be+2n) channel vs the single-neutron removal ^{1}H(^{14}Be,^{13}Be+n→(^{12}Be+n)+n) channel. However, the measurement provided n+^{12}Be+γ coincidence data that gave hints for a low-energy neutron component feeding ^{12}Be*(2.1 MeV).

The (2010Ko17) data is reanalyzed in (2013Ak02) guided by details on other resonances discovered in other measurements. In this reanlysis information on states isolated in the n+^{12}Be+γ coincidence data provided new information. Relevant fit parameters from that analysis are E_{res}=0.46 MeV *1* with Γ=0.11 MeV *2*, E_{res}=2.07 MeV *3*, E_{res}=2.98 MeV *3*, E_{res}=5.2 MeV *1* with Γ=1.4 MeV *2*; resonances at E_{res}=0.81 MeV *1* with Γ=2.1 MeV *3* and E_{res}=2.0 MeV *1* decaying to ^{12}Be*(2.1 MeV), and the Γ=0.5 MeV widths of E_{res}=2.0, 2.07, 2.98 were fixed in the analysis. Results from the reanalysis are preferred in this evaluation.

2013Ak02: XUNDL dataset compiled by TUNL, 2013.

The authors reconstructed the ^{12}Be+n relative energy of ^{13}Be states populated in the one-neutron knockout reaction ^{1}H(^{14}Be,^{13}Be→^{12}Be+n) at E(^{14}Be)=304 MeV/u. Analysis was carried out by simultaneously fitting new data as well as data collected earlier at RIKEN at E(^{14}Be)=69 MeV/nucleon (2010Ko17).

An E(^{14}Be)=304 MeV/nucleon beam, produced by fragmenting a ^{18}O beam on a Be target at the GSI/FRS, impinged on a 5.0 cm long liquid hydrogen target. The ^{12}Be ions were identified by ΔE-E techniques while their momentum was determined using a set of Multi-Wire Proportional Chamber (MWPC) combined with the magnetic rigidity analysis of the ALADIN spectrometer. Neutron momenta were measured using the large area neutron detector (LAND). Resolution for the relative energies varies from 250 keV at E_{rel}=500 keV to 700 keV at E_{rel}=2 MeV.

The new E(^{14}Be)=304 MeV/nucleon GSI data are simultaneously analyzed with the relative energy spectrum data from RIKEN, which was collected at E(^{14}Be)=69 MeV/nucleon (2010Ko17). While subtle differences are visible among the two spectra, the analysis resulted in a coherent description of both data sets by fitting the resonances with Breit-Wigner shapes whose locations and angular momenta were partly guided by information from previously observed ^{13}Be and ^{12}Be states.

Strength from six neutron resonances were considered in fitting the measured neutron spectra: the unbound resonances at S_n=−0.44, −0.81, −1.95, −2.0, −3.02 and −5.2 MeV. In the analysis, two components were fixed by prior neutron + γ coincidence data of (2010Ko17): first, neutron decay from the high energy tail of a J^{π}=5/2$^+$ level at S_n=−2.0 MeV with Γ=0.5 MeV decays to ^{12}Be*(2.1: J^{π}=2$^+$) producing a structure peaked near E_{rel}(n+^{12}Be*)≈0 MeV; second, neutron decay from a J^{π}=(5/2$^+$,3/2$^-$) level at S_n=−5.2 MeV with Γ=1.4 MeV decays to ^{12}Be*(2.7) producing a peak near E_{rel}(n+^{12}Be*)≈2.5 MeV. Results from that fit are in table 3 of (2013Ak02) and are given below.

In contrast to the above analysis of the neutron group energies, the low-energy part of the spectrum was analyzed with an assumption that two expected *l*=0 (J^{π}=1/2$^+$) resonances are present at E_{res}=0.46 and 2.9 MeV. Such an assumption results in a good fit to the data for destructive interferences, and is able to account for the enhancement at $E_{rel.}$=0.81 MeV without requiring a level at S_n=−0.81 MeV. This interpretation is not preferred in the present ENSDF evaluation.

See detailed discussion on spin values, taken from other experimental results.

Theory.

2010Fo11: A simple model is developed suggesting that an appreciable part of the strength associated with decay of the ≈ 0.5 MeV resonance to ^{12}Be$_{g.s.}$ is actually connected with the decay from the $5/2^+_2$ to the long lived ^{12}Be($J^{\pi}=0^+_2$) isomer.

$^{1}H(^{14}Be,^{13}Be):1$ 2013Ak02 (continued)

^{13}Be Levels

E(level)[‡@]	J^{π}[‡]	Γ[‡]	E′ (MeV)[†]	Comments
0	$1/2^-$	0.39 *5*	0.44 *1*	See also S_n=−0.46 MeV *1* and Γ=0.11 MeV *2* in (2013Ak02) analysis of (2010Ko17) data. J^{π}: From *l*=1 resonance in (2010Ko17).
0.36×10^3 *6*	$1/2^+$	2.1 MeV *3*	0.81 *6*	E(level),J^{π},Γ: Parameters are taken from a fit to data given in (2004Le29). Precise values appear to be from a private communication. The authors debate the origin of this group; since a two interfering state interpretation suggests the strength may arise from destructive interference between $1/2^+$ states. This evaluation does not accept the two interfering state interpretation.
1.50×10^3 *5*	$5/2^+$	0.5[#] MeV	1.95 *5*	See also S_n=−2.07 MeV *3* in (2013Ak02) analysis of (2010Ko17) data. E(level): Decays to $^{12}Be_{g.s.}$ and its high energy tail decays to $^{12}Be^*$(2.1 MeV) with $E_{res}(n+^{12}Be^*)\approx 0$ MeV.
2.57×10^3 *9*	$1/2^-$	0.5[#] MeV	3.02 *9*	See also S_n=−2.98 MeV *4* in (2013Ak02) analysis of (2010Ko17) data. E(level): Decays to $^{12}Be_{g.s.}$ with $E_{res}(n+^{12}Be)$=3.02 MeV.
4.75×10^3	$(3/2^-,5/2^+)$	1.4 MeV *2*	5.2 *1*	E(level),Γ: From (2013Ak02) analysis of (2010Ko17) data. E(level): Decays to $^{12}Be^*$(2.71 MeV) with $E_{res}(n+^{12}Be^*)$=2.5 MeV.

[†] E′ is a relative excitation energy scale with E′=0 at the neutron separation energy. We use this scale because most articles report level energies with respect to the $n+^{12}Be_{g.s.}$ center of mass energy.

[‡] From (2013Ak02) analysis of $n+^{12}Be$ relative energy spectra measured in (2010Ko17) and (2013Ak02).

[#] In the fit, the width of these states was held fixed, based on details discussed in the text of (2013Ak02).

[@] The ground state is taken as $E_{c.m.}(n+^{12}Be_{g.s.})$=0.45 MeV *1*; see Adopted Levels.