$^{1}H(^{14}B,^{13}Be)$ 2018Ri05

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

2015Ri03: $^{1}H(^{14}B,^{13}Be)$. A beam of ^{14}B ions, produced by fragmenting a 490 MeV/nucleon ^{40}Ar beam at the GSI/FRS, impinged on a 9.7 mm thick CH_2 foil that was located at the ALADIN spectrometer target position. Quasi-free (p,2p) scattering reactions removed protons from ^{14}B and populated states in neutron-unbound ^{13}Be nuclei, which quickly break apart into ^{12}Be+n. At the exit of the spectrometer, the momenta of breakup ^{12}Be ions and associated neutrons were measured using a ΔE-ΔE-ToF array (for heavy particles) and the LAND neutron array (for neutrons). Additionally, an array of 162 NaI scintillator detectors surrounded the target with the aim of detecting any emitted γ rays, which is necessary to determine the contributions from $^{12}Be_{g.s.}$ and excited states. Data from this experiment is included in the analysis of (2018Ri05).

2018Ri05: XUNDL data set compiled by TUNL, 2018.

The present study aims to measure the full set of ^{12}Be+n system and γ-ray experimental observables for decay of ^{13}Be resonances.

A beam of 400 MeV/nucleon ^{14}B ions, from the GSI/FRS facility impinged on a 922 mg/cm^2 polyethylene target that was surrounded by the 159 NaI element Crystal Ball γ-ray detector array. The ^{13}Be nuclides, formed in single-proton removal reactions, immediately decayed into ^{12}Be+n; the decay neutrons were momentum analyzed using the 2 ×2 meter^2 LAND neutron wall, while the ^{12}Be core ejecta were identified and momentum analyzed using the ALADIN dipole along with a double sided ΔE strip detector and the "time-of-flight wall". Associated γ-rays were detected using the Crystal Ball.

The $E_{c.m.}(^{12}Be+n)$ relative energy spectrum is analyzed for ^{12}Be+n and ^{12}Be+n+γ data. Evidence for five groups is found. Notably, two groups are found in coincidence with the $^{12}Be^{*}(2.109\ MeV)\rightarrow{}^{12}Be(0)$ γ-ray transition: first from a neutron group at E_{res}<500 keV and second from a neutron group at E_{res}≈2 MeV. Overall, five neutron groups are identified in the present experimental work, with the three additional groups at E_{res}≈2.11, 2.92 and 4.0 associated with decay directly to $^{12}Be_{g.s.}$.

The authors highlighted the shortcomings of past experiments, due to incomplete collection of necessary information, and they aimed to give an explanation of the complete evidence on ^{13}Be level data. Results from proton knockout from ^{14}B at 35 MeV/nucleon (2014Ra07) and 400 MeV/nucleon (present), neutron knockout data from ^{14}Be at 69 MeV/nucleon (2010Ko17), 287 MeV/nucleon (2007Si24) and 304 MeV/nucleon (2013Ak02), and single charge exchange reactions with ^{13}B at 71 MeV/nucleon were considered in developing an overall interpretation. The analysis aimed to explain differences in peak positions and group widths by accounting for branching to $^{12}Be^{*}(2.109)$ and the differences in strengths for levels populated by the different reaction mechanisms and at different reaction energies.

In general, the present work identifies levels at S_n=−0.86, −2.11, −2.92 and −4.0 MeV that decay to $^{12}Be_{g.s.}$. In addition, the levels at S_n=−2.11 and −4.0 MeV also decay to $^{12}Be^{*}(2.109)$ with resonance energies around $E_{c.m.}(^{12}Be^{*}+n)$≈0.1 and 2.0 MeV; since there is overlap of the neutron groups, it is necessary to deconvolute ground state branches from the $^{12}Be^{*}(2.109)$ branches in order to obtain accurate state widths. Furthermore, the authors suggest that the different reactions/mechanisms result in different amplitudes for populating the levels, which further complicates an overall analysis.

A note in proof of (2016Fo07) details unpublished $^{1}H(^{14}B,2p)$ data where a $E_{res}(n+^{12}Be)$= 0.95 MeV group is connected to population of $^{12}Be^{*}(2.1\ MeV)$.

^{13}Be Levels

E(level)[#]	Jπ[@]	Γ	E′ (MeV)[‡]	Comments
0.41×10^3 *4*	1/2$^+$	1.70 MeV *15*	0.86 *4*	E(level): Decays via $^{12}Be_{g.s.}$+n.
1.66×10^3 *5*	5/2$^+$	0.4[†] MeV	2.11 *5*	E(level): Decays via $^{12}Be_{g.s.}$+n with E_{res}=2.11 MeV and $^{12}Be^{*}(2109)$+n with $E_{res}(n+^{12}Be^{*})$<0.1 MeV.
≈2.47×10^3[†]	5/2$^+$	0.4[†] MeV	2.92[†]	E(level): Decays via $^{12}Be_{g.s.}$+n.
≈3.6×10^3[†]	(3/2$^+$)	0.4[†] MeV	4.0[†]	E(level): Decays via $^{12}Be_{g.s.}$+n with E_{res}=4.0 MeV and $^{12}Be^{*}(2109)$+n with $E_{res}(n+^{12}Be^{*})$≈2.1 MeV.

[†] From (1992Os04, 1998Go30, 1998Be28).

[‡] 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.

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

[@] From analysis of the $n+^{12}Be$ energy distributions and associated γ rays of (2018Ri05).