$^{1}H(^{14}Be,^{13}Be):2$ 2019Co12

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

2019Co12: XUNDL dataset compiled by TUNL 2020.

The authors populated resonances in the unbound ^{13}Be nucleus using (p,pn) quasi-free scattering reactions to knock-out a neutron from ^{14}Be nuclei.

A cocktail beam, including 265 MeV/nucleon ^{14}Be ions, was produced by fragmenting a ^{48}Ca beam at the RIKEN/BigRIPS fragment separator. The ^{14}Be ions were identified in the beam using time-of-flight techniques before impinging on the 15 cm thick liquid hydrogen target of the MINOS device that is surrounded by a charged-particle time projection chamber (TPC). Protons scattered out of the target were momentum analyzed using the TPC, a multi-wire drift chamber (MWDC) and an array of plastic energy detectors covering $\theta\approx30^\circ-65^\circ$; the quasi-free scattered neutron was momentum analyzed on the opposite side of the beam using the WINDS array of plastic scintillators that covered $\theta\approx20^\circ-60^\circ$.

The ^{13}Be products decayed in flight into a ^{12}Be+n pair; the heavy ^{12}Be fragment was momentum analyzed using the SAMURAI dipole magnet and a set of MWDCs for tracking while the associated neutron was momentum analyzed using the position-sensitive NEBULA array of plastic scintillators. Finally, 68 crystals from the DALI2 γ ray detection array partially covered $\theta=34^\circ-115^\circ$ to measure γ rays from ^{13}Be*→n+^{12}Be* decays.

Separate spectra for the n+^{12}Be*(0,2.1,2.7 MeV) components are obtained using the coincidence γ rays. Analysis of the spectra presented in figure 4 indicates ^{13}Be resonances at $S_n=-0.48$, −2.3, −5.1 and −5.7 MeV decaying to ^{12}Be*(0,2.1,2.7 MeV). A detailed analysis of the knocked−out neutrons associated with the low energy part of the n+^{12}Be relative energy spectrum is best fit assuming dominant p-wave strength rather than s-wave strength; this supports a $J^\pi=1/2^-$ assignment for the $S_n=-0.48$ MeV resonance. A significant discussion on the nature of the low-energy strength is included that compares the findings of (2010Ko17, 2013Ak01, 2013Ak02, 2018Ri05). The authors developed a three-body ^{12}Be+n+n model for the ^{14}Be projectile and analyzed the quasi-free neutron scattering reaction dynamics; the results are consistent with dominant p-wave strength at low energies with no need for significant contributions from a $J^\pi=1/2^+$ virtual state of ^{13}Be.

Measurement of the neutron pairing correlations obtained in this experiment are discussed in (2023Co13, 2024Ca06).

^{13}Be Levels

E(level)[#]	J^π[@]	E′ (MeV)[†‡]	Comments
0	$(1/2^-)$	0.48 *40*	Decays via $^{12}Be_{g.s.}$+n with $E_{rel.}$(n+^{12}Be)=0.48 MeV.
1.9×10^3	$(5/2^+)$	2.3 *9*	Decays via $^{12}Be_{g.s.}$+n and ^{12}Be*(2.1 MeV)+n.
4.7×10^3		5.1 *13*	Decays via ^{12}Be*(2.1 MeV)+n with $E_{rel.}$(n+^{12}Be*)=3.0 MeV.
5.3×10^3		5.7 *14*	Decays via ^{12}Be*(2.7 MeV)+n with $E_{rel.}$(n+^{12}Be)=3.0 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.

‡ Invariant mass resolution is $0.587\times(E_{res})^{-1/2}$.

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 distribution of (2019Co12).