^{12}C(p,p′),(α,α′) 2012Fr05

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. H. Kelley, J. E. Purcell and C. G. Sheu	NP A968,71 (2017)	1-Jan-2017

2012Fr05: XUNDL dataset compiled by TUNL, 2012.

The authors simultaneously analyzed the ^{12}C(p,p′) data of (2009Fr07) and the ^{12}C(α,α′) data of (2011It08) using an R-matrix approach in order to find a more consistent description of the 2^+ excitation of the $J^\pi=0^+$, $E_x=7.65$ MeV "Hoyle" state of ^{12}C.

Experimental details are found in (2009Fr07,2011It08); the emphasis of this work is the level parameters for the $J^\pi=2^+_2$ state.

2009Fr07: XUNDL dataset compiled by TUNL, 2009.

The authors measured ^{12}C(p,p′) at $E_p=66$ and 200 MeV. The motivation was a search for the $J^\pi=2^+$ excitation of so-called 0^+ "Hoyle State" at 7.65 MeV. The 2^+ excitation of the Hoyle state is expected near 1-4 MeV above $E_x=7.65$ MeV.

Angular distributions were measured at $\theta=10°$, 16° and 28° for $E_p=66$ MeV and $\theta=7°$, 10°, 13°, 16° and 20° for $E_p=200$ MeV. The data were analyzed using the code FRESCO to perform coupled-channels calculations. For $E_p=66$ MeV the search focused near $\theta=16°$ where the influence of the broad $E_x=10.3$ MeV $J^\pi=0^+$ state is minimal. The authors suggest evidence for a new $J^\pi=2^+$ state.

2011Zi01: XUNDL dataset compiled by TUNL, 2011.

The authors measured the ^{12}C(p,p′) reaction at $E_p=25$ MeV in search of evidence supporting the $J^\pi=2^+_2$ state that was first reported by (2009Fr07) at $E_x\approx9.6$ MeV.

A beam of 25 MeV protons from the Yale tandem impinged on a 40 μg/cm^2 ^{nat}C target (and an enriched ^{13}C target). The proton recoils were detected by an Enge Split Pole Spectrometer at $\theta=20°$, 35° and 45° for the excitation energy range 7 MeV≈<E_x≈<13 MeV. The instrumented resolution (FWHM) of 37.0 keV was determined from the observed widths of the 7.65 and 12.71 MeV states of ^{12}C. Broad tails on the sides of the $J^\pi=3^-$ state at $E_x=9.64$ MeV are interpreted as evidence supporting the $J^\pi=2^+_2$ state at $E_x\approx9.6$ MeV. Contributions from the $J^\pi=0^+_3$, $E_x=10.3$ MeV level, with $\Gamma\approx3$ MeV, are observed to be small. No evidence was found for an 11.1×10^3 *2*, 2^+ resonance suggested in (2010Hy01).

2011It08: XUNDL dataset compiled by TUNL, 2012.

Inelastic α-particle scattering on a ^{12}C target was analyzed in a search for the $J^\pi=2^+_2$ excitation in ^{12}C which is thought to be strongly coupled to the so called "Hoyle state" having $J^\pi=0^+_2$ $E_x=7.65$ MeV.

A beam of E=386 MeV α-particles from the RCNP Osaka Cyclotron impinged on a 2.84 mg/cm^2 ^{nat}C target, and the inelastically scattered α-particles were detected between $0°\le\theta_{lab}\le15'$ in the Grand Raiden spectrometer covering the range 3 MeV≤E_x ≤30 MeV. The data were analyzed both: by evaluating the peaks in the excitation spectra, as well as, via a multipole decomposition analysis. In addition to the known states in the region of interest, evidence for new states at $E_x=9.84$ and 9.93 MeV is found; discussion suggests these are the $J^\pi=2^+_2$ and 0^+_3 states in ^{12}C. Higher-lying states are visible in the spectrum, but no analysis is presented.

^{12}C Levels

E(level)†	Jπ†	$T_{1/2}$†	L	Comments
0	0^+			
4.44×10^3	2^+	10.8×10^{-3} eV *6*		B(E2)=37×10^{-4} e^{2}b^2 *1* (2011It08).
7654	0^+	9.3 eV		
9641	3^-	46 keV	3	B(E3)=251×10^{-6} e^{2}b^3 *10* (2011It08).
9.75×10^3 *15*	2^+	0.75 MeV *15*		E(level),Jπ,$T_{1/2}$: From simultaneous R-matrix analysis of (p,p′) and (α,α′) data. Analysis indicates the reduced width is close to the Wigner limit, implying a highly clustered structure.(2012Fr05). In (2009Fr07) the $J^\pi=2^+$ state is reported at $E_x=9.6$ MeV *1* with Γ=0.60 MeV *10*. In (2011Zi01) broad wings on the tails of ^{12}C*(9.64) at $E_x=9.6$ MeV with Γ≈600 keV are interpreted as evidence in support of the 2^+ state which is suggested as the member of a rotational band that is built upon the $E_x=7.65$ MeV, $J^\pi=0^+$ level of ^{12}C (the Hoyle state). In (2011It08), the $J^\pi=2^+$ state is reported at $E_x=9.84$ MeV *6* with Γ=1.01 MeV *15*. The state is a candidate for the excited state of the 0^+ Hoyle resonance at 7654 and also the α-particle condensate state.

Continued on next page (footnotes at end of table)

^{12}C(p,p′),(α,α′) 2012Fr05 (continued)

^{12}C Levels (continued)

E(level)†	Jπ†	$T_{1/2}$†	L	Comments
				B(E2)=1.6×10^{-4} e^{2}b^2 *2* (2011It08).
9.93×10^3 *3*	0$^+$	2.71 MeV *8*	0	E(level),Jπ,$T_{1/2}$: Reported in (2011It08). Possible 0^+_3+0^+_4 doublet.
10.85×10^3	1$^-$	273 keV	1	
11828	2$^-$	230 keV		

† From Adopted Levels, except where noted.