Adopted Levels 1992Ti02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. H. Kelley, D. R. Tilley, H. R. Weller and G. M. Hale	NP A541,1 (1992)	8-Oct-1991

$Q(\beta^-)=-2.290\times10^4$ *22*; $S(n)=2.058\times10^4$; $S(p)=1.981\times10^4$ 2012Wa38

Note: Current evaluation has used the following Q record −22.90E3 2120577.62 *119813*.85 *1* 1997Au07.

Ground state: due to non-central forces, the wave function for the $J^{\pi}=0^+$ ground state of ^{4}He can be a positive-parity mixture of three $^1s_0$, six $^3p_0$, and five $^5d_0$ orthogonal states (1967Be74). The symmetric s-wave component is the dominant part of the wavefunction, with significant d-wave and almost negligible p-wave contributions. Since the d-state admixture can be inferred from measurements such as the tensor analysing powers for ^{2}H(d,γ)^{4}He, it has been the subject of much experimental and theoretical attention since the previous compilation (1973Fi04), despite confusion stemming from the fact that in some cases the results refer to only part of the full d-state probability as calculated in 1988Ca19, 1990Ch06 and 1991Ar01.

Recent variational and Green Function Monte Carlo (gfmc) calculations (1988Ca19, 1991Ca35) using realistic nucleon-nucleon potentials have been highly succesful in reproducing the ground-state properties of light nuclei. These calculations for ^{4}He give d-state probabilities ranging from 15-17.5%, depending on the potential model (including 3-body forces) used, and p-wave probabilities that are much smaller (approx. 1%). Other theoretical and experimental estimates of the d-state percentage are considerably lower, but these inferences can be complicated by the presence of more than one multipole and other d-state effects. See further discussion in 1992Ti02.

Excited states: the unbound excited-state level structure presented here is based on the comprehensive, Coulomb-corrected, charge-independent R-matrix analysis discussed in 1992Ti02. This analysis takes its isospin-1 parameters from an analysis of p-^{3}He scattering data, but with eigenenergies shifted by the internal Coulomb energy difference ΔE(C)=−0.64 MeV and the p-^{3}h and n-^{3}He reduced-width amplitudes scaled by the isospin Clebsch-Gordon coefficient 0.7071. The isospin-0 parameters are then varied to fit the experimental data for the reactions among the two−body channels p+^{3}H, n+^{3}He and d+^{2}H, at energies corresponding to excitations in ^{4}He below approximately 29 MeV. In this fit, the T=0 nucleon-trinucleon reduced width amplitudes are constrained and a small amount of internal Coulomb isospin mixing is introduced (see 1992Ti02) to reproduce the differences between the two branches of the d+d reaction. The Breit−Wigner resonance parameters at channel radii a(p−t)=a(n−^{3}He)=4.9 fm and a(d-d)=7.0 fm are given. See further discussion in 1992Ti02.

Estimated uncertainties on the resonance parameters given for ^{4}He are as follows: at excitation energies below 26 MeV, the positions are uncertain by 20 keV or less, except for the (1^-, T=0) level at 24.25 MeV, which is uncertain by 150 keV. At excitation energies between 26 and 30 MeV, the uncertainties in the positions are generally less than 90 keV, with that of the (1^-, T=0) level at 28.37 MeV level less than 10 keV. The widths of the levels (partial and total) are generally known to about 10%. See further discussion in 1992Ti02.

^{4}He Levels

Cross Reference (XREF) Flags

A	^{2}H(d,n)	E	^{3}He(n,p)	I	^{4}He(^{3}He,^{3}He)
B	^{2}H(d,p)	F	^{4}He(γ,X)	J	^{4}He(α,α), ^{4}He(α,α')
C	^{2}H(d,d)	G	^{4}He(e,e′)	K	^{4}He(n,t)
D	^{3}H(p,γ)	H	^{4}He(n,n)	L	^{4}He(p,^{3}He), ^{4}He(P,P+D)

E(level)†	J^{π}	$T_{1/2}$	XREF	Comments
0.0	0^+	stable		T=0
20210	0^+	0.50 MeV	E GHI K	%p=100 T=0 Γ_p=0.50 MeV
21010	0^-	0.84 MeV	H	%p=76; %n=24 T=0 Γ_p=0.64 MeV; Γ_n=0.20 MeV
21840	2^-	2.01 MeV	H J	%p=63; %n=37 T=0 Γ_p=1.26 MeV; Γ_n=0.75 MeV

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Adopted Levels 1992Ti02 (continued)

^{4}He Levels (continued)

E(level)†	J^{π}	$T_{1/2}$	XREF	Comments
23330	2^-	5.01 MeV		%p=53; %n=47 T=1 Γ_p=2.64 MeV; Γ_n=2.37 MeV
23640	1^-	6.20 MeV		%p=55; %n=45; %IT=? T=1 Γ_p=3.44 MeV; Γ_n=2.76 MeV Strength is primarily $^3p_1$.
24250	1^-	6.10 MeV	AB	%p=50; %n=47; %d=3 T=0 Γ_p=3.08 MeV; Γ_n=2.87 MeV Γ_p and Γ_n are primarily $^3p_1$ and Γ_d=0.15 MeV.
25280	0^-	7.97 MeV		%p=52; %n=48 T=1 Γ_p=4.12 MeV; Γ_n=3.85 MeV
25950	1^-	12.66 MeV	D	%p=52; %n=48; %IT=? T=1 Γ_p=6.52 MeV; Γ_n=6.14 MeV Strength is primarily $^1p_1$.
27420	2^+	8.69 MeV	C I L	%p=3; %n=3; %d=94 T=0 Γ_p=0.25 MeV; Γ_n=0.23 MeV Γ_d=8.21 MeV and is primarily $^5s_2$.
28310	1^+	9.89 MeV		%p=48; %n=47; %d=5 T=0 Γ_p=4.72 MeV; Γ_n=4.66 MeV Γ_d=0.51 MeV.
28370	1^-	3.92 MeV	ABC I	%p=2; %n=2; %d=96 T=0 Γ_p=0.07 MeV; Γ_n=0.08 MeV Γ_d=3.77 MeV.
28390	2^-	8.75 MeV	ABC	%p=0.2; %n=0.2; %d=99.6 T=0 Γ_p=0.02 MeV; Γ_n=0.02 MeV Γ_d=8.71 MeV.
28640	0^-	4.89 MeV	C	%d=100 T=0 Γ_d=4.89 MeV.
28670	2^+	3.78 MeV	C F	%IT=?; %d=100 T=0 Γ_d=3.78 and is primarily $^1d_2$.
29890	2^+	9.72 MeV	I	%p=0.4; %n=0.4; %d=99.2 T=0 Γ_p=0.04 MeV; Γ_n=0.04 MeV Γ_d=9.64 and is primarily $^5d_2$.

† Level energies from an R-matrix calculation.