T = 3/2 states in ^{13}C

V. Z. Goldberg, R. E. Tribble, B. B. Skorodumov,[1] G. V. Rogachev,[2] A. Aprahamian,[1] J. J. Kolata,[1]
S. Almaraz,[1] H. Amro,[3] L. O. Lamm,[1] M. Quinn,[1] A. Teymurazyan,[1] and A. Woehr[1]
[1]*Institute for Structure and Nuclear Astrophysics,University of Notre Dame, Notre Dame, Indiana 46556*
[2]*Physics Department, Florida State University, Tallahassee, Florida 32306*
[3]*Physics Department, University of Michigan, Ann Arbor, Michigan 48109*

The level scheme of T = 3/2 states in A = 13 nuclei is important to estimate the prediction quality of contemporary shell model calculations for exotic nuclei [1]. It is also has impact on super massive star evolution [2]. It can be expected that several low-lying excited states with T = 3/2 in this mass region should have substantial $2s_{1/2}$ and $1d_{5/2}$ single-particle reduced widths. However, a spin-parity assignment of $J^{\pi} = 1/2^{+}$ has only recently been made for the first excited state in ^{13}O [3], while other levels with large predicted single-particle widths were not observed in this work.

The intent of this experiment was to obtain data on T = 3/2 states in A=13 nuclei over a broader energy region than was available in Ref. [3]. In the present work, the first results from an investigation of ^{12}B+p resonance elastic scattering are given.

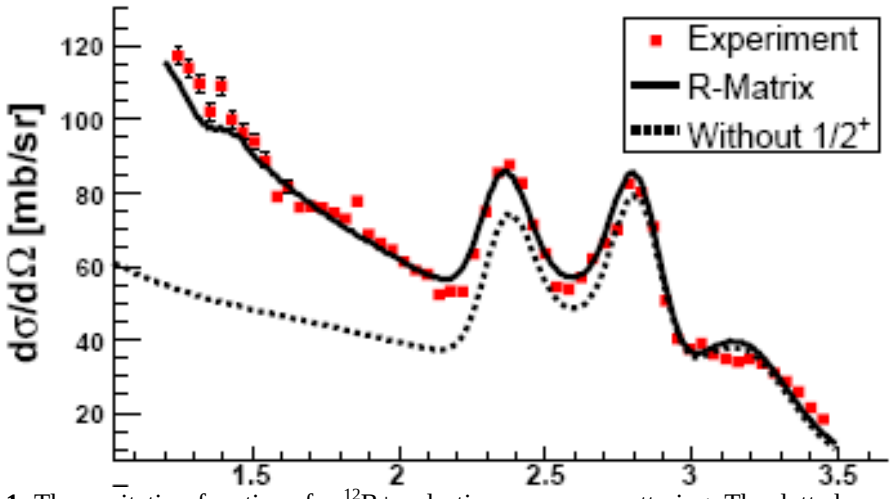

Figure 1. The excitation functions for ^{12}B+p elastic resonance scattering. The dotted curve shows an R-matrix fit without the $1/2^{+}$ resonance. To convert the *c.m.* energy to the excitation energy in ^{13}C, add 17.53 MeV.

Fig.1 presents cm excitation function for the ^{12}B+p elastic scattering obtained at 7.5^{0} lab. system (165^{0} c.m.) at the N. D. tandem. (Excitation functions were obtained and analyzed at different angles.) Table 1 presents the resonance parameters of the levels in the fit together with predictions of the shell

Table I: Resonance parameters for levels in ^{13}C.

L	J^{π}	$E_{c.m.}$	E_{ex} MeV	Γ_{exp} MeV	$S_{s.p.}$ keV	*Shell*	S_{OXBASH} (WBT)	S_{OXBASH} (PSDMK)
0	$1/2^+$	1.05	18.58	411	0.89	2s1/2	0.67	0.75
						1d3/2	0.013	0.014
(1)	$(1/2^-)$	1.36	18.89	10	0.07	1p1/2	0.06	0.009
	$(3/2^+)$	2.36	19.89	109				
0				71	0.04	2s1/2	0.27	0.47
2				40	0.51	1d3/2	0.09	0.03
						1d5/2	0.30	0.28
2	$(5/2^+)$	2.84	20.37	98	0.48	1d3/2	0.03	0.017
						1d5/2	0.21	0.49
(2)	$(7/2^+)$	3.24	20.77	457	0.99	1d5/2	0.29	0.48

model (Oxbash) calculations. As a result of the investigation, we can state the following. Evidence was found for five new T = 3/2 resonances in this region, and tentative spin-parity assignments were given for all these states. All have very small widths for decay through isospin violating channels. The dominant configurations of the levels are in qualitative agreement with shell-model predictions. However, disagreements with theoretical predictions of the non- dominant configurations, as well as with the relative excitation energies of the levels, were observed. We have considered existing data on T = 3/2 states in the mirror nuclei, ^{13}C and ^{13}N, obtained in T-violating resonance scattering. Several unreliable T = 3/2 assignments were noted. No anomalies related to the manifestation of T = ½ states were observed. Still a mystery should be solved: the known density of levels (of unknown spins) in ^{13}B is much higher than what we found for T=3/2 states in ^{13}C.

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