

B(E2; $0^+_1 \rightarrow 2^+_1$) Evaluation for Cr, Fe, Ni and Zn

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Introduction

- Evaluation of $B(E2; 0^+_1 \rightarrow 2^+_1)$ was published by S. Raman in 2001 with cutoff date 11/2000 at Oak Ridge National Laboratory
- Since then, thanks to radioactive ion beam facilities, a large amount of new $B(E2)$ data have been published
- In 2004-2005, BNL assumed responsibility for the project and started $B(E2)$ data compilation online:
<http://www.nndc.bnl.gov/be2>
- In Fall 2009, BNL-McMaster collaboration was formed to work on $B(E2)$ data evaluation
- In 2010, Central Michigan University joined the effort by contributing shell model calculations for $B(E2)$ and $E(2^+_1)$
- Pilot project to update an important region of $Z=N \sim 28$ (Cr, Fe, Ni and Zn nuclei) is in progress and to seek feedback from the research community

Evaluation Policies

There are several classes of $B(E2) \uparrow$ measurements:

- Model-independent measurements: lifetime(τ), Coulomb Excitation (including intermediate-energy) and (γ, γ')
- Somewhat model-dependent measurements: (e, e') , muonic x-rays, Mössbauer
- Model-dependent measurements: inelastic scattering of light and heavy ions

Evaluation priorities:

- Deduce model-independent $B(E2) \uparrow$ values
- Deduce combined $B(E2) \uparrow$ values : model-independent + Somewhat model-dependent
- Compile model-dependent values from inelastic scattering data

Adopted (Recommended) Values

Adopted values for Cr

- Model-independent
- Assigned 5% m
- AveTools softw
- Updated existin

Example of Cr adopt
Zn):

- Transition ener
- $B(E2) \uparrow$ in e^2b^2
- τ in ps
- Deformation pa
- Comparison wi

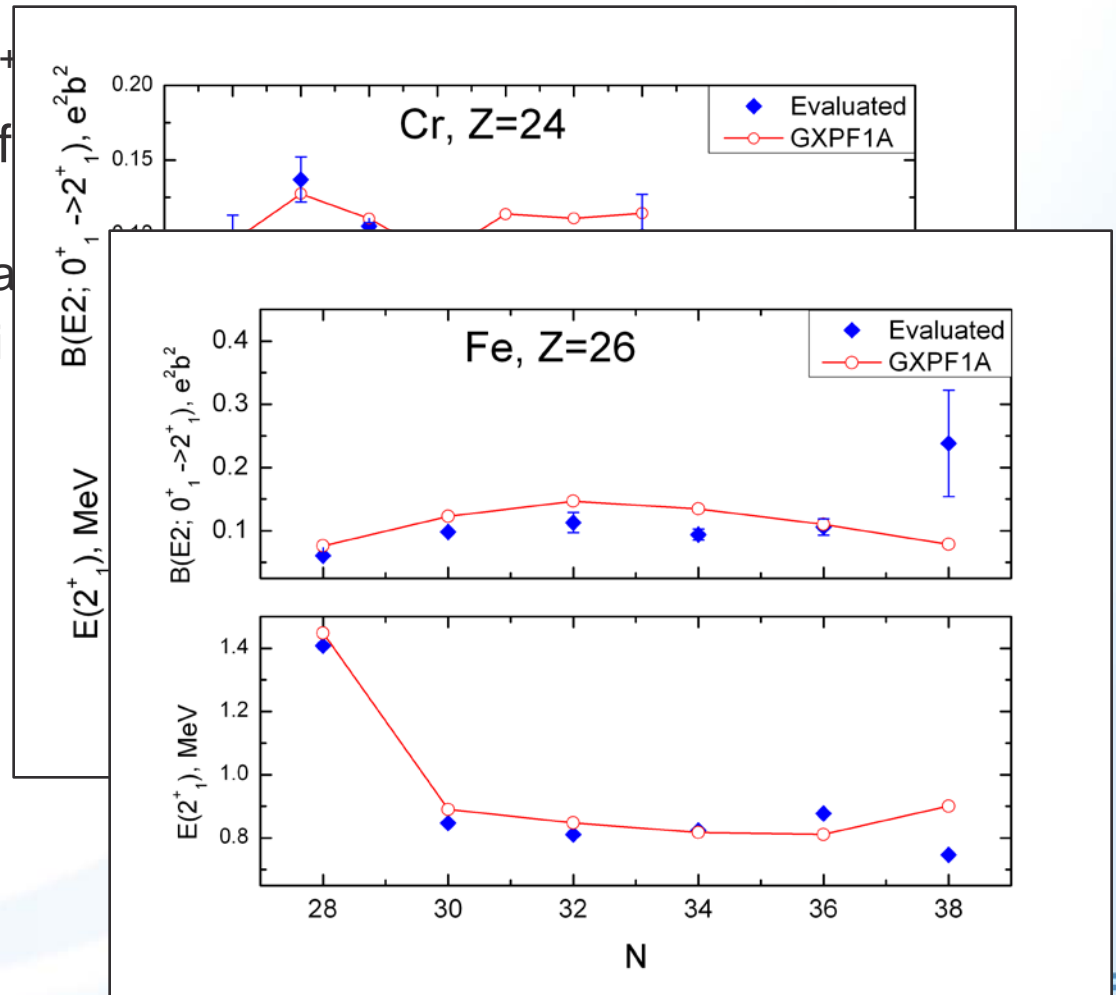
Table 1
Adopted (recommended) $B(E2) \uparrow$ -, τ - and β_2 -values for Cr, Fe, Ni and Zn isotopes. Model-independent, combined (*) and model-dependent (**) values are compared with S. Raman *et al.* [3] evaluation.

Nuclide	E_{2^+} (keV)	$B(E2) \uparrow$		τ (ps)	β_2	$B(E2) \uparrow$ [3] (e^2b^2)
		(e^2b^2)	(W.u.)			
^{46}Cr	892.16(10)	0.093(20)	19.0(41)	16.7(36)	0.288(31)	
^{48}Cr	752.19(11)	0.137(15)	26.4(29)	12.4(14)	0.340(19)	0.136(21)
^{50}Cr	783.30(9)	0.1057(23) 0.1034 (26)*	19.32(42) 18.90(48)*	13.10(29) 13.39(34)*	0.2903(32)	0.108(6)
^{52}Cr	1434.094(14)	0.0627(18) 0.0626(16)*	10.88(31) 10.85(27)*	1.073(30) 1.076(27)*	0.2179(31)	0.0660(30)
^{54}Cr	834.855(3)	0.0865(45) 0.0889(40)*	14.27(74) 14.67(66)*	11.63(61) 11.31(51)*	0.0250(65)	0.0870(40)
^{56}Cr	1006.61(20)	0.055(19)	8.7(30)	7.1(25)	0.195(34)	
^{58}Cr	880.7(2)	0.099(28)	14.8(42)	7.8(22)	0.254(37)	
^{60}Cr	646(1)					
^{62}Cr	447(4)					
^{64}Cr	420(7)					

Shell-model Calculations

$E(2^+)$ and $B(E2; 0^+_1 \rightarrow 2^+_1)$ model with GXPF1A eff

- Results for Cr and 0.5e for neutrons a
- Calculations for Ni



Experimental Values

- We went back and reanalyzed all publications on the subject
- We have added many
- We provided exact m
- We fixed a few typos
- We extended the exper
- We extended the exper beam and beam ener information on particu
- We actively used NSR
- We kept NSR keynum
- Example of experime

Table 3
Experimental values for $B(E2)$ -, τ - and β_2 -values in Cr, Fe, Ni and Zn isotopes (^{a,d} or * - Superseded, duplicate or above the Coulomb barrier [12] experiments). Beam energy units are in MeV or (A)-MeV/nucleon. NSR keynumbers [13] are shown in the reference column.

Nuclide	B(E2) (e^2b^2)	τ (ps)	β_2	Target	Beam	Energy (MeV)	Method	Reference
⁴⁶ Cr	0.093(20)			²⁰⁸ Pb	⁴⁶ Cr	44 A	CE*	[2005Ya26]
⁴⁸ Cr		10.6(11)		³⁶ Ar	¹⁴ N	28-35	TRDM	[1979Ek03]
⁴⁸ Cr		16.7(22)		³⁴ S	¹⁶ O	30-36	TRDM	[1975Ha04]
⁴⁸ Cr		9.7(26)		⁴⁰ Ca	¹⁰ B	19-25	TRDM	[1973Ku10]
⁵⁰ Cr		13.2(4)		¹² C	⁵⁰ Cr	110-120	CE*	[2000Er01]
⁵⁰ Cr	0.093(5)			⁵⁰ Cr	e	30-400	EE	[1983Li02]
⁵⁰ Cr	0.102(5)			⁵⁰ Cr	³² S	62	CE*	[1975To06]
⁵⁰ Cr		12.6(21)		⁴⁰ Ca	¹⁶ O	47	TDSA	[1974Br04]
⁵⁰ Cr		12.1(12)		⁴⁰ Ca	¹² C	28	TRDM	[1973De09]
⁵⁰ Cr		10(2)		⁵² Cr	p	31.4	TDSA	[1972Ra14]
⁵⁰ Cr	0.115(10)			⁵⁰ Cr	³⁵ Cl	54	CE	[1972Ra14]
⁵⁰ Cr	0.092(10)			⁵⁰ Cr	¹⁶ O/ ³⁵ Cl	21-79	CE*	[1971DaZM]
⁵⁰ Cr	0.115(8)			⁵⁰ Cr	⁴ He		CE?	[1961Mc18]
⁵² Cr		1.13(3)		C	⁵² Cr	110-120	CE*	[2000Er01]
⁵² Cr	0.0632(40)			⁵² Cr	e	30-400	EE	[1983Li02]
⁵² Cr	0.0687(13)			⁵² Cr	γ		GG	[1981Ah02]
⁵² Cr	0.080(8)			⁵² Cr	e	90, 120, 226	EE	[1978Po04]
⁵² Cr	0.0634(39)			⁵² Cr	e	40-110	EE	[1976Li19]
⁵² Cr	0.0660(30)			⁵² Cr	³² S	60	CE*	[1975To06]
⁵² Cr	0.076(8)			⁵² Cr	e	50,60,80,90	EE	[1975DeXW]
⁵² Cr		0.86(13)		⁵² Cr	¹⁶ O/ ³⁵ Cl	21-79	TDSA	[1972WaYZ]
⁵² Cr	0.071(9)			⁵² Cr	e	150	EE	[1971Pe11]
⁵² Cr		0.99 ⁺⁴⁵ ₋₂₅		⁵¹ V	³ He	11	TDSA	[1971Sp12]
⁵² Cr	0.072(8)			⁵² Cr	¹⁶ O/ ³⁵ Cl	21-79	CE*	[1971DaZM]
⁵² Cr	0.043(9)			⁵² Cr	¹² C	36.8	CE*	[1967A f03]
⁵² Cr	0.048(2)			⁵² Cr	¹⁶ O	31-41	CE*	[1965Si02]
⁵² Cr	0.0520(40)			⁵² Cr	e	150-180	EE	[1964Be32]
⁵² Cr		1.02(13)		⁵² Cr	γ	0.5-3	GG	[1964Bo22]
⁵² Cr	0.073(7)			⁵² Cr	⁴ He		CE?	[1961Mc18]
⁵² Cr	0.060(15)			⁵² Cr	¹⁶ O	39	CE*	[1960A d01]
⁵² Cr		0.8(2)		⁵² Cr	γ	j2	GG	[1959Of14]
⁵⁴ Cr	0.095(5)			⁵⁴ Cr	e	30-400	EE	[1983Li02]
⁵⁴ Cr	0.0850(30)			⁵⁴ Cr	³² S	62	CE*	[1975To06]
⁵⁴ Cr	0.096(9)			⁵⁴ Cr	³⁵ Cl	54	CE	[1970MiZQ]
⁵⁴ Cr	0.106(7)			⁵⁴ Cr	⁴ He		CE?	[1961Mc18]
⁵⁴ Cr	0.057(11)			⁵⁴ Cr	¹⁴ N	16.3, 26	CE	[1960A n07]
⁵⁴ Cr	0.079(20)			⁵⁴ Cr	¹⁴ N	15.9-35	CE	[1959A195]
⁵⁶ Cr	0.055(19)			¹⁹⁷ Au	⁵⁶ Cr	100 A	CE*	[2005Bu29]
⁵⁸ Cr	0.099(28)			¹⁹⁷ Au	⁵⁸ Cr	100 A	CE*	[2005Bu29]
⁶⁰ Cr			0.23(3)	p	⁶⁰ Cr	63 A	IN-EL	[2009A o01]
⁶² Cr			0.27(3)	p	⁶² Cr	63 A	IN-EL	[2009A o01]

Conclusion & Outlook

- Pilot project for B(E2) evaluation of Cr, Fe, Ni and Zn nuclei has been completed ~90%
- Results will be published as BNL report, arXiv and submitted to Atomic Data and Nuclear Data Tables to seek further comments from nuclear physics community
- These comments will be studied and taken into account for further B(E2) evaluation of all even-even nuclei
- Final evaluation will be submitted to a journal and will be made available on NNDC webpage at <http://www.nndc.bnl.gov/be2>