Are There X(5) Nuclei in the A~80 and A~100 Regions?

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Outline of my remarks

- *What is X(5)?*
- *What are the signatures of X(5)?*
- *Searching for X(5) nuclei in the N~90, A~80 and A~100 regions*
  - *E4/E2 ratio systematics*
  - *Yrast level systematics*
  - *Detailed comparisons with real nuclei*
- *Conclusions*
  - *Which are the best candidates?*
  - *What data are needed?*

What is X(5)?

- *A dynamical symmetry that describes the critical point of a phase transition between a spherical vibrator and an axial rotor*

- *Introduced by F. Iachello [Phys. Rev. Lett.* ***87****, 052502 (2001)]; the result of analytic solutions of differential equations which assume the nucleus consists of an infinite number of bosons*

What is special about X(5)?

- *Solutions are parameter independent except for energy and transition strength scale normalizations*
- *Level sequences are characterized by quantum numbers s=1,2,3…*

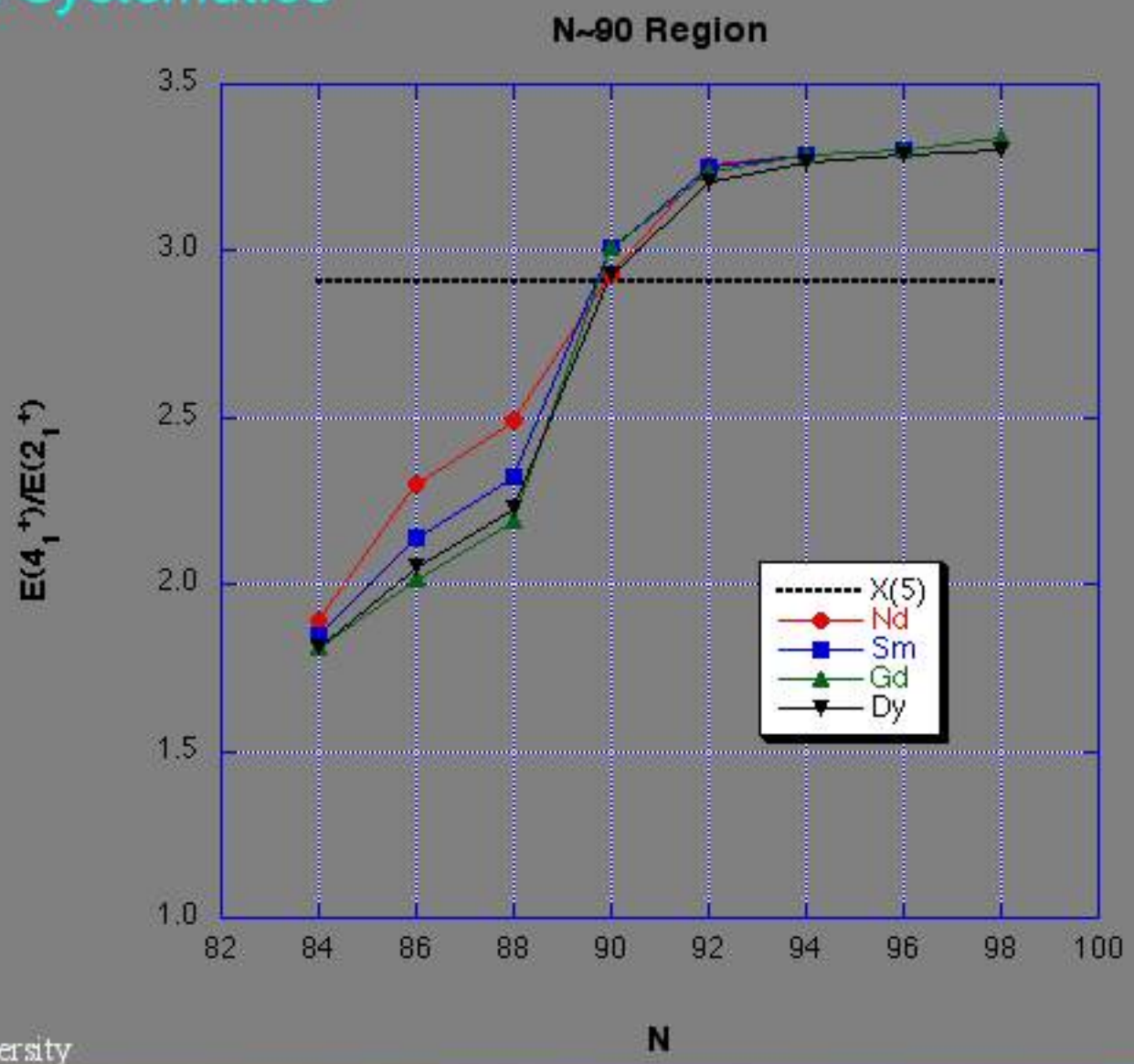
What are the signatures of X(5)?

- *Level energy ratios:*
- *E4/E2 = 2.91 E0/E2 = 5.67*
- *Yrast band energy sequences and B(E2: J+2 ->J) values are intermediate between those of a vibrator and rotor*
- *As s increases E4/E2 values decrease and intrasequence B(E2) values decrease*
- *Intersequence Δs=1 B(E2) values are characterized by a collective J -> J+2 transition*

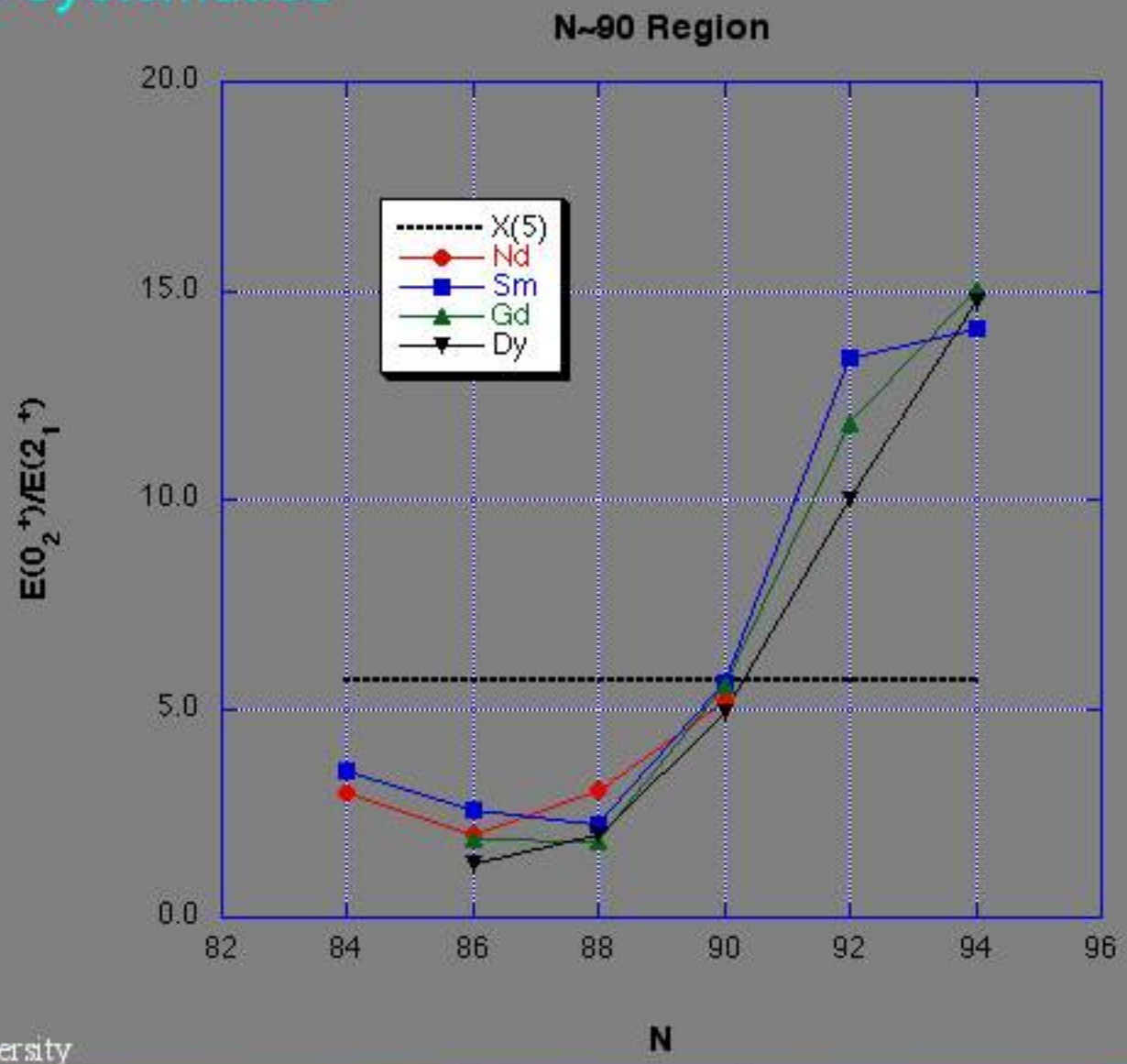
E4/E2 N~90 Region

Z \ N	84	86	88	90	92	94	96	98	100	102	104
74				2.48	2.68	2.82	2.95	3.06	3.15	3.20	3.24
72			2.31	2.56	2.79	2.97	3.11	3.19	3.25	3.27	3.28
70	1.85	2.13	2.33	2.63	2.92	3.11	3.23	3.27	3.29	3.31	3.31
68	1.83	2.08	2.31	2.74	3.10	3.23	3.28	3.29	3.31	3.31	3.31
66	1.81	2.05	2.23	2.93	3.21	3.27	3.29	3.30	3.31		
64	1.81	2.02	2.19	3.01	3.24	3.29	3.30	3.30			
62	1.85	2.14	2.32	3.01	3.25	3.29	3.30	3.30			
60	1.89	2.30	2.49	2.93	3.26	3.29	3.32				
58	1.90	2.36	2.59	2.86	3.15	3.23					
56	1.88	2.32	2.66	2.84	2.99						
54	1.82	2.21	2.40	2.55							
52	1.70	2.04									

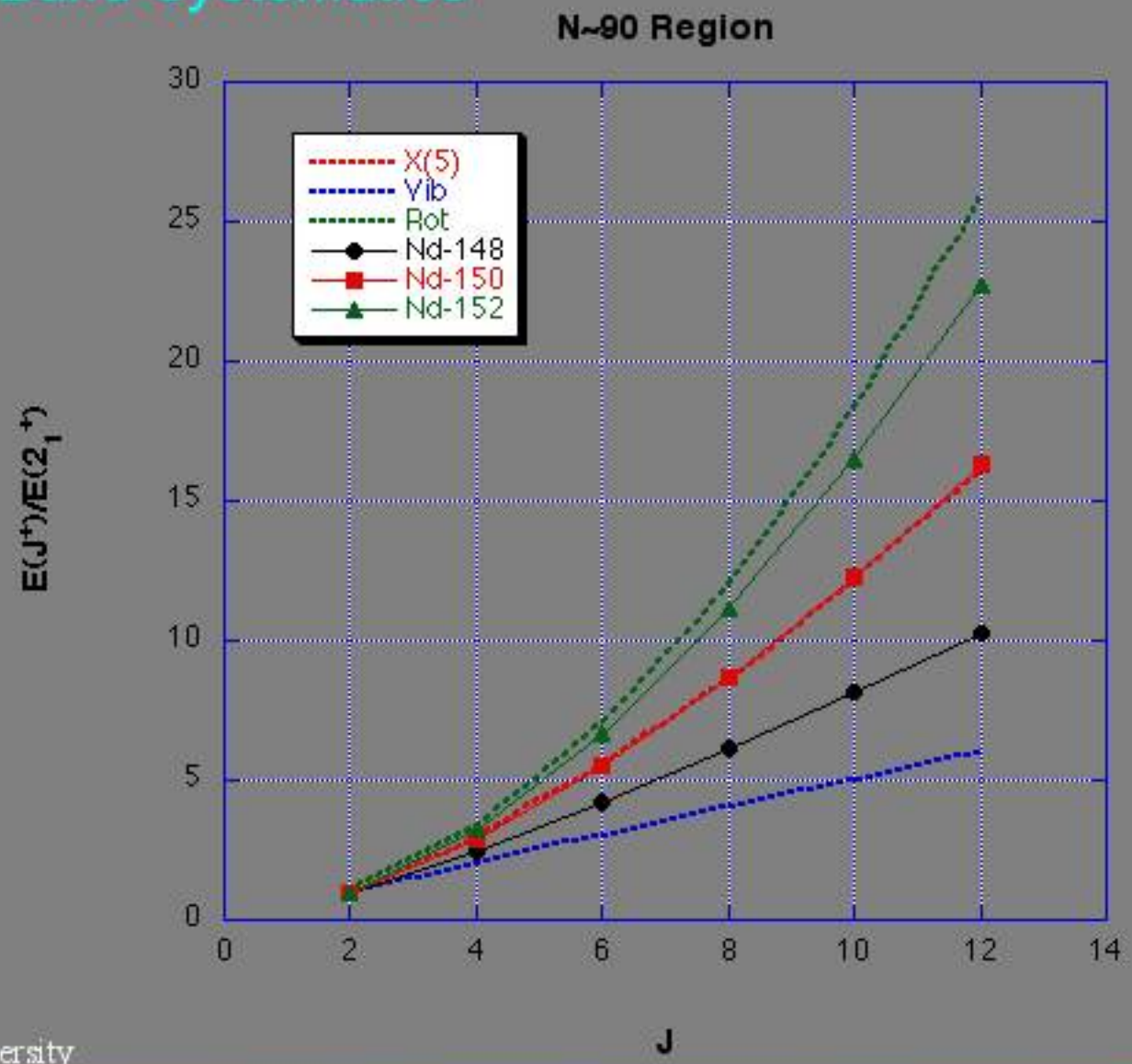
E4/E2 Systematics



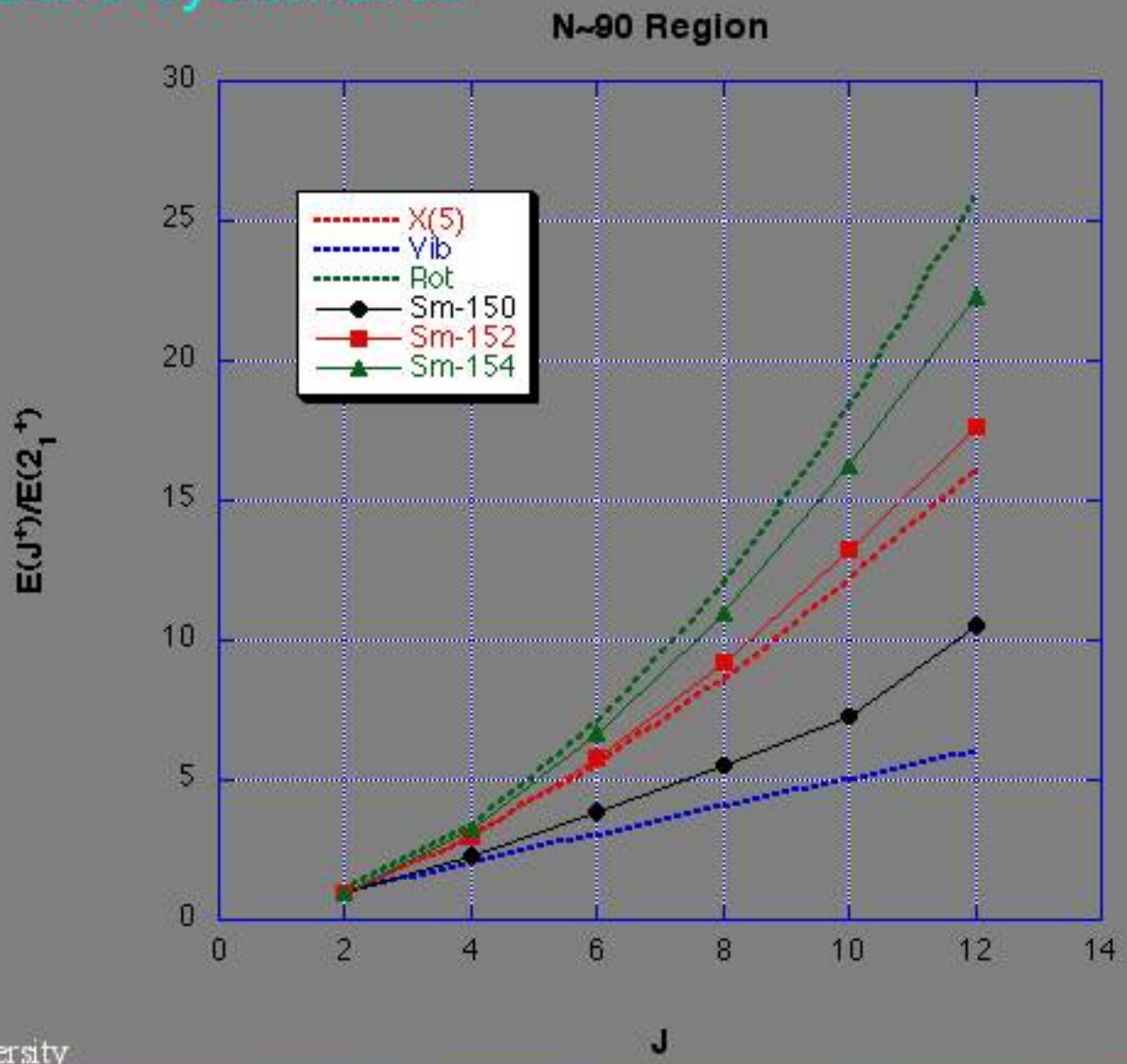
E0/E2 Systematics



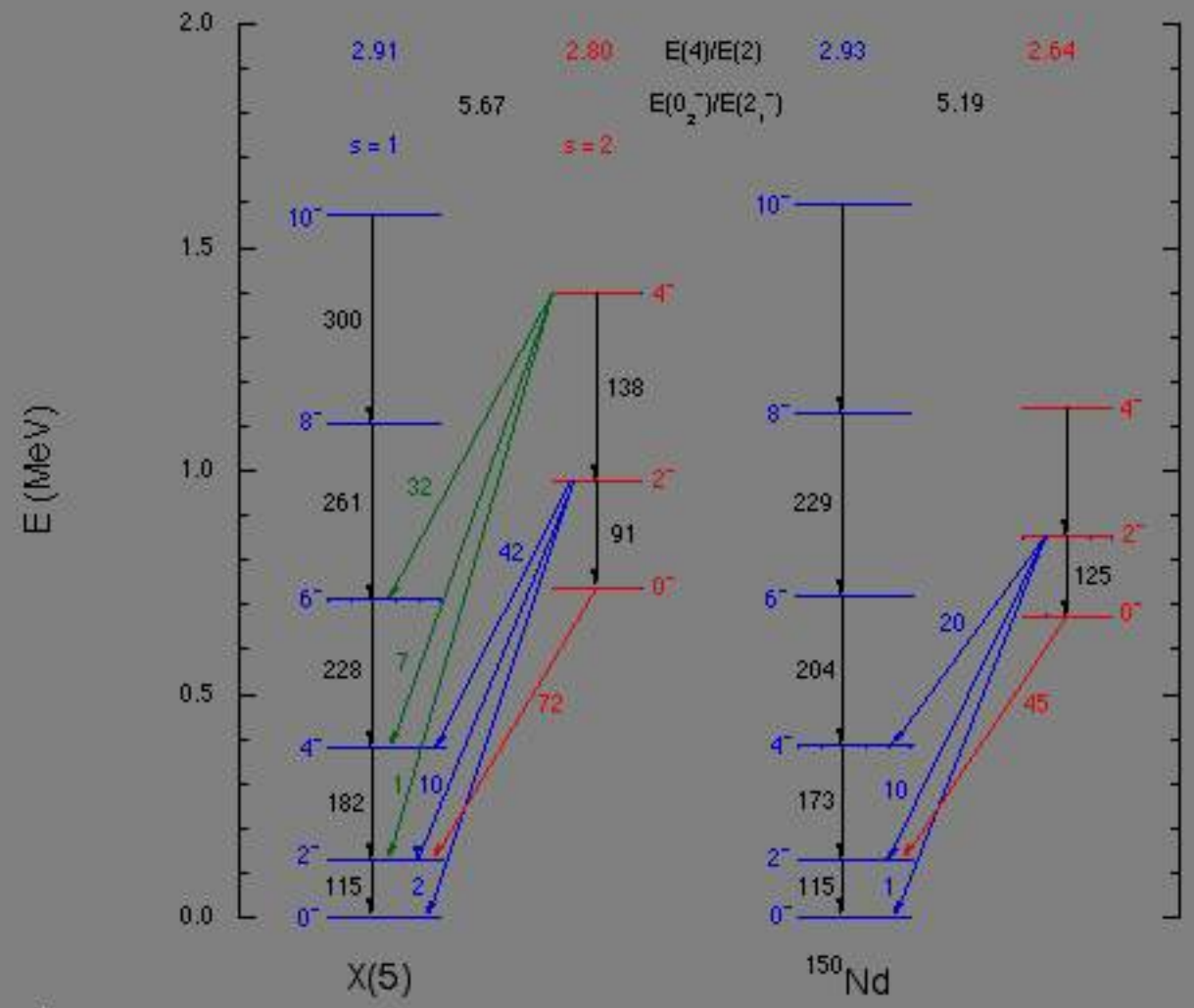
Yrast Band Systematics



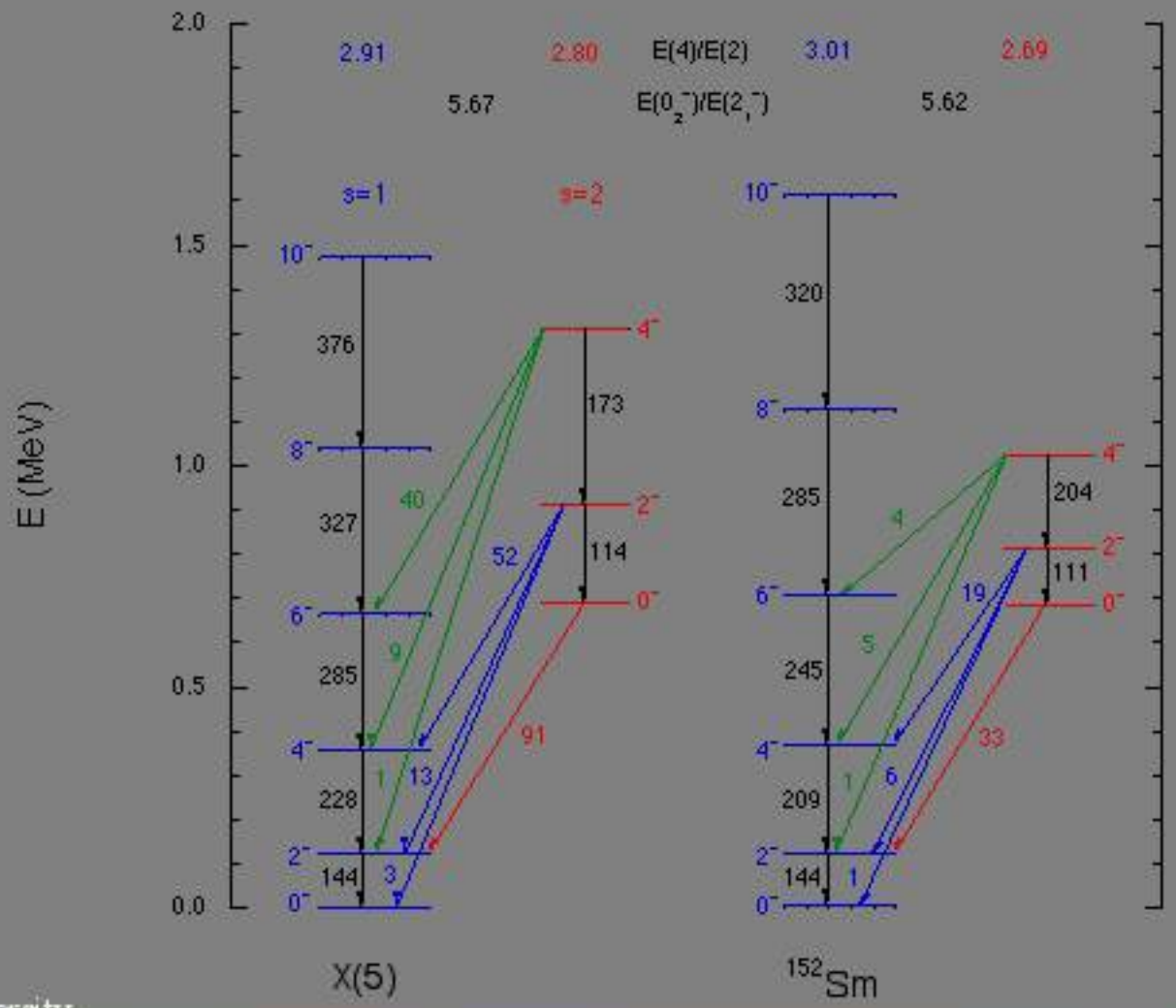
Yrast Band Systematics



^{150}Nd vs. X(5)


2.0
1.5
1.0
0.5
0.0
E (MeV)
2.91
2.80
E(4)/E(2)
2.93
2.64
5.67
E(0$_2^-$)/E(2$_1^-$)
5.19
s = 1
s = 2
10⁻
8⁻
6⁻
4⁻
2⁻
0⁻
300
261
228
182
115
138
91
125
229
204
173
115
32
7
1
10
2
42
72
20
10
1
45
X(5)
^{150}Nd

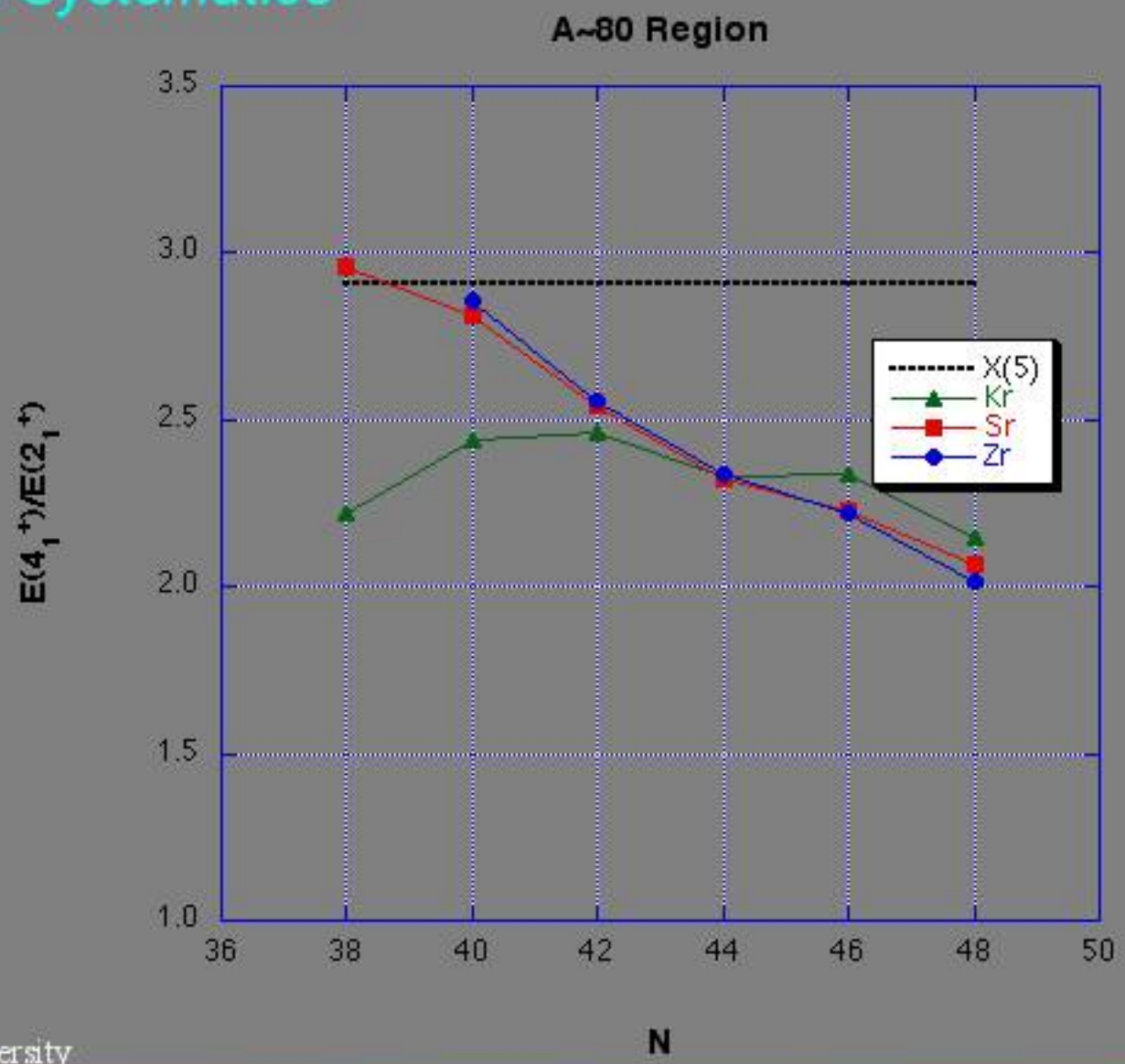
^{152}Sm vs. X(5)


2.0
1.5
1.0
0.5
0.0
E (MeV)
2.91
2.80
E(4)/E(2)
3.01
2.69
5.67
E(0$_2^+$)/E(2$_1^+$)
5.62
s=1
s=2
10⁻
8⁻
6⁻
4⁻
2⁻
0⁻
376
327
285
228
144
173
114
91
40
9
1
13
3
52
320
285
245
209
144
204
111
33
4
5
1
6
1
19
X(5)
^{152}Sm

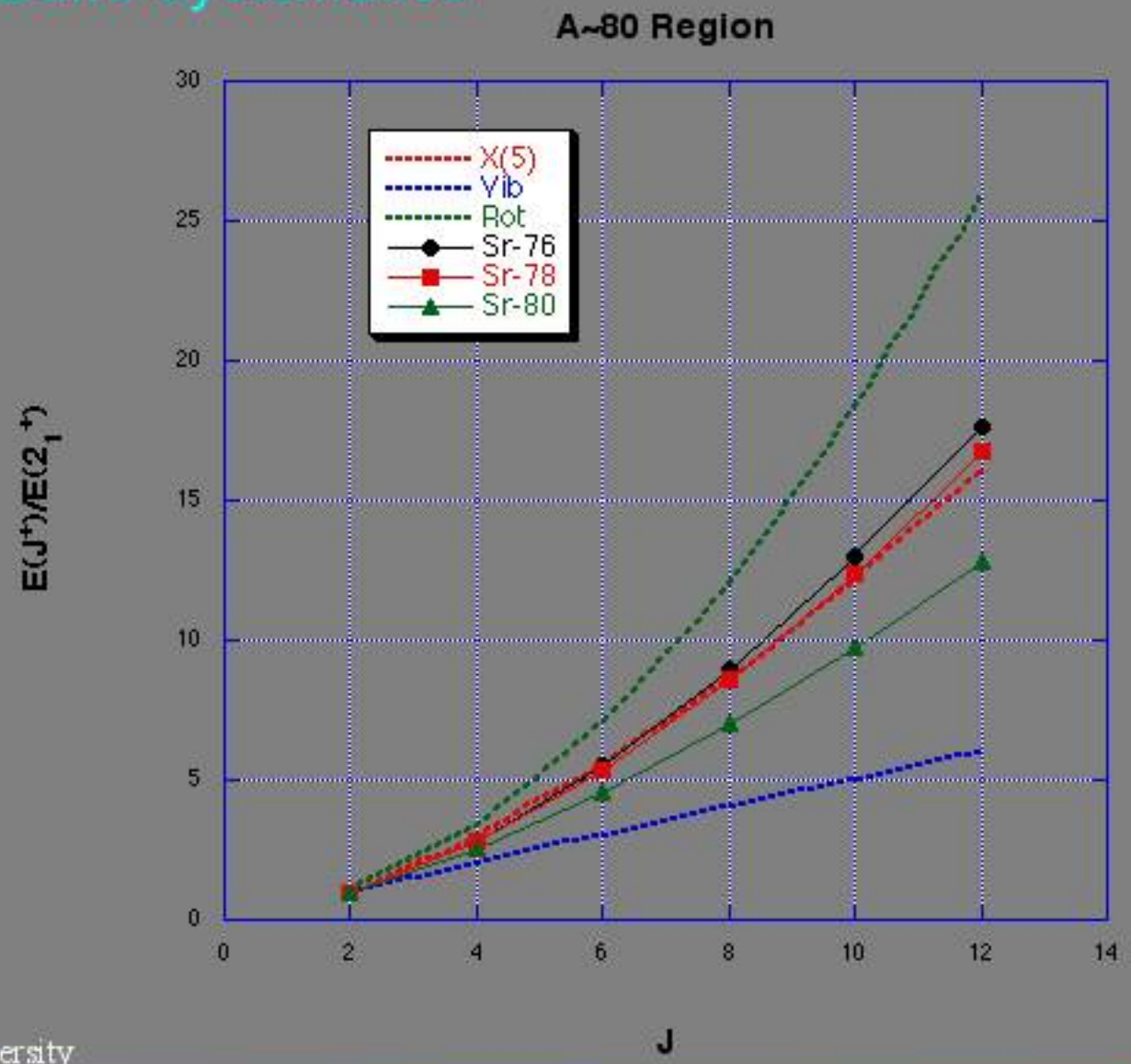
E4/E2 A~80 Region

Z \ N	30	32	34	36	38	40	42	44	46	48
42								2.34	2.23	2.11
40						2.86	2.56	2.34	2.22	2.02
38					2.85	2.81	2.54	2.32	2.23	2.07
36				1.86	2.22	2.44	2.46	2.14	2.34	2.38
34			2.28	2.16	1.90	2.15	2.38	2.45	2.37	2.65
32		2.28	2.27	2.23	2.07	2.07	2.46	2.50	2.54	2.64
30	2.18	2.29	2.32	2.36	2.24	2.02				

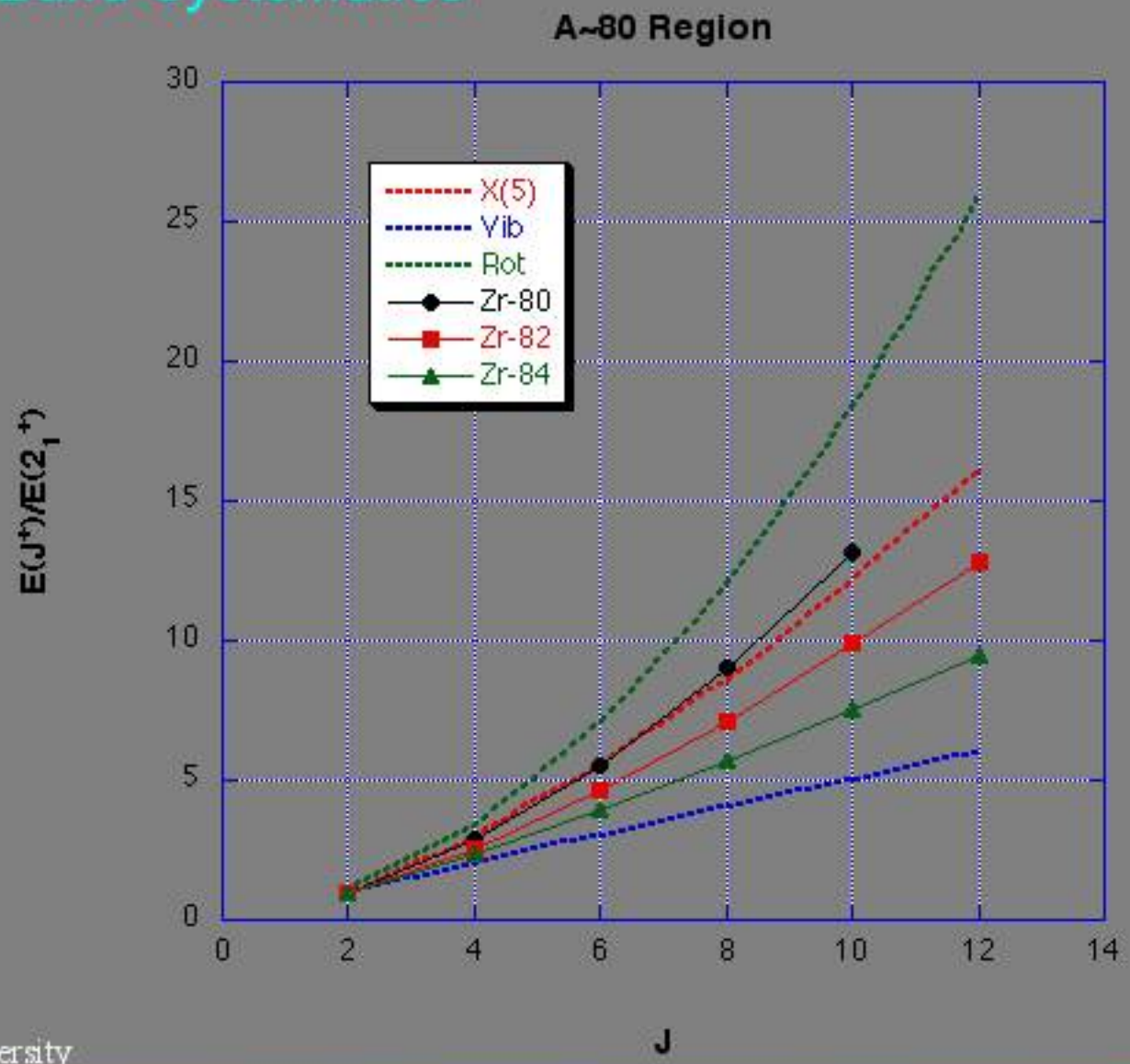
E4/E2 Systematics



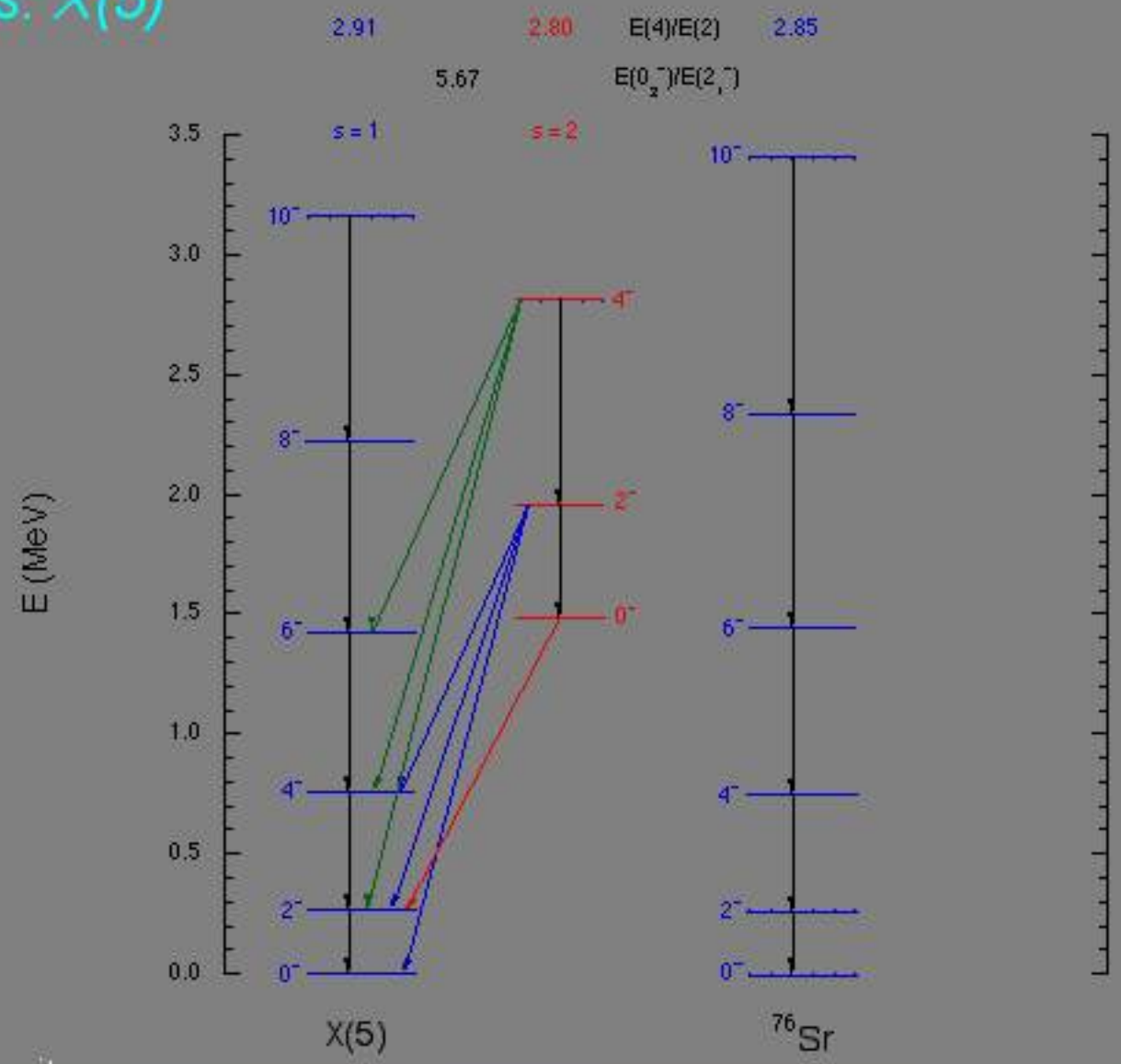
Yrast Band Systematics



Yrast Band Systematics



^{76}Sr vs. X(5)



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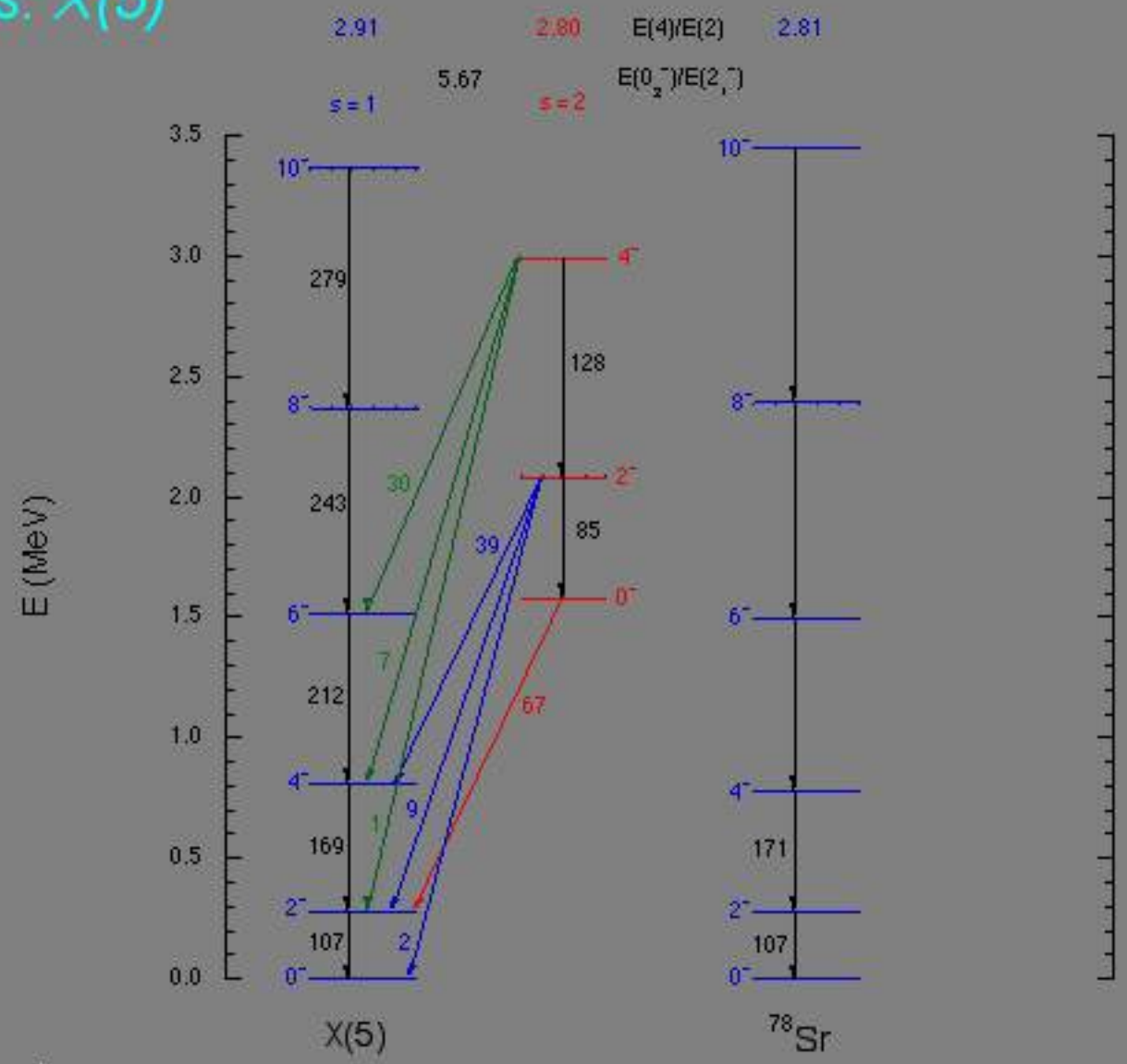
^{78}Sr vs. X(5)



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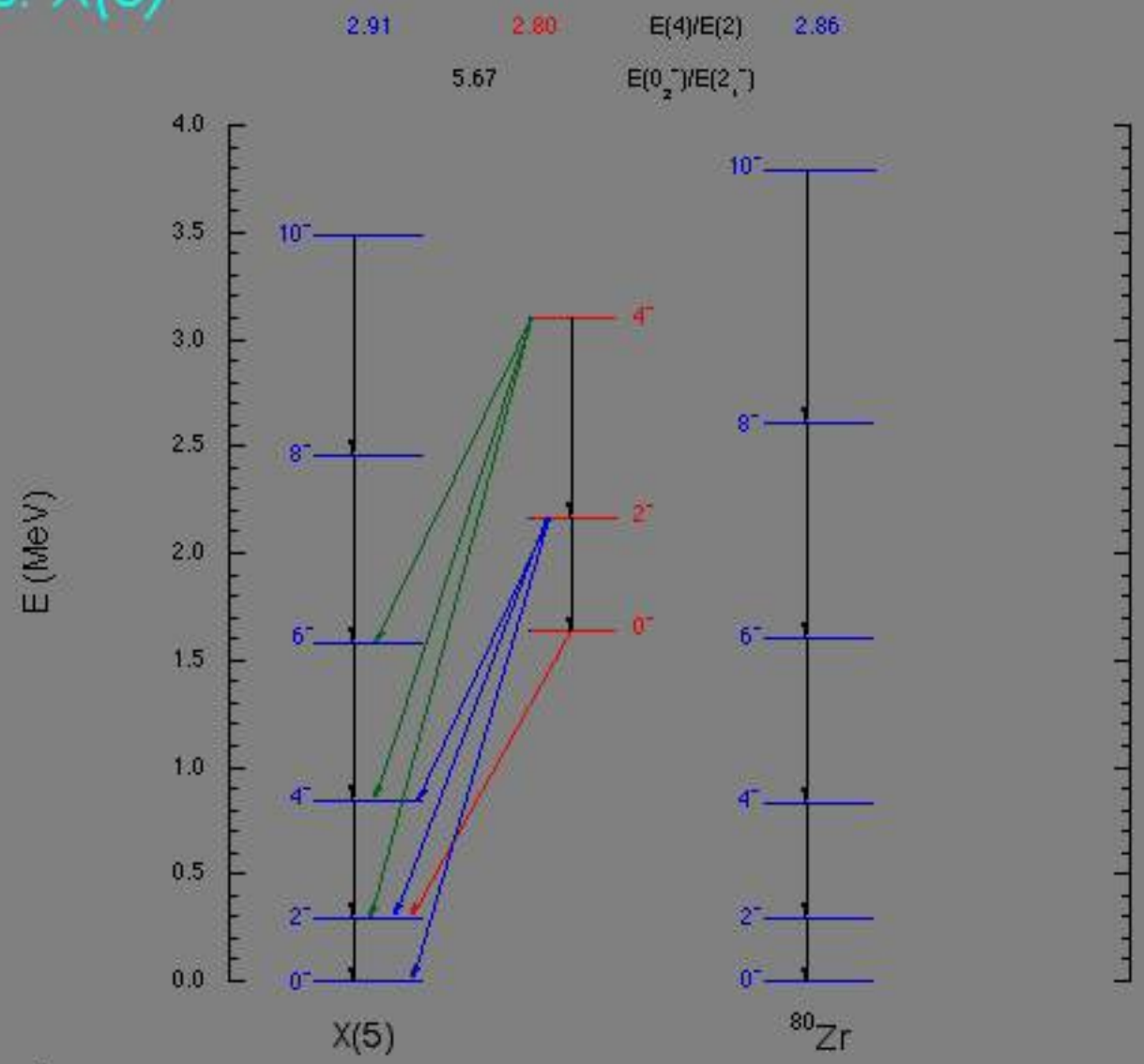
^{80}Zr vs. X(5)



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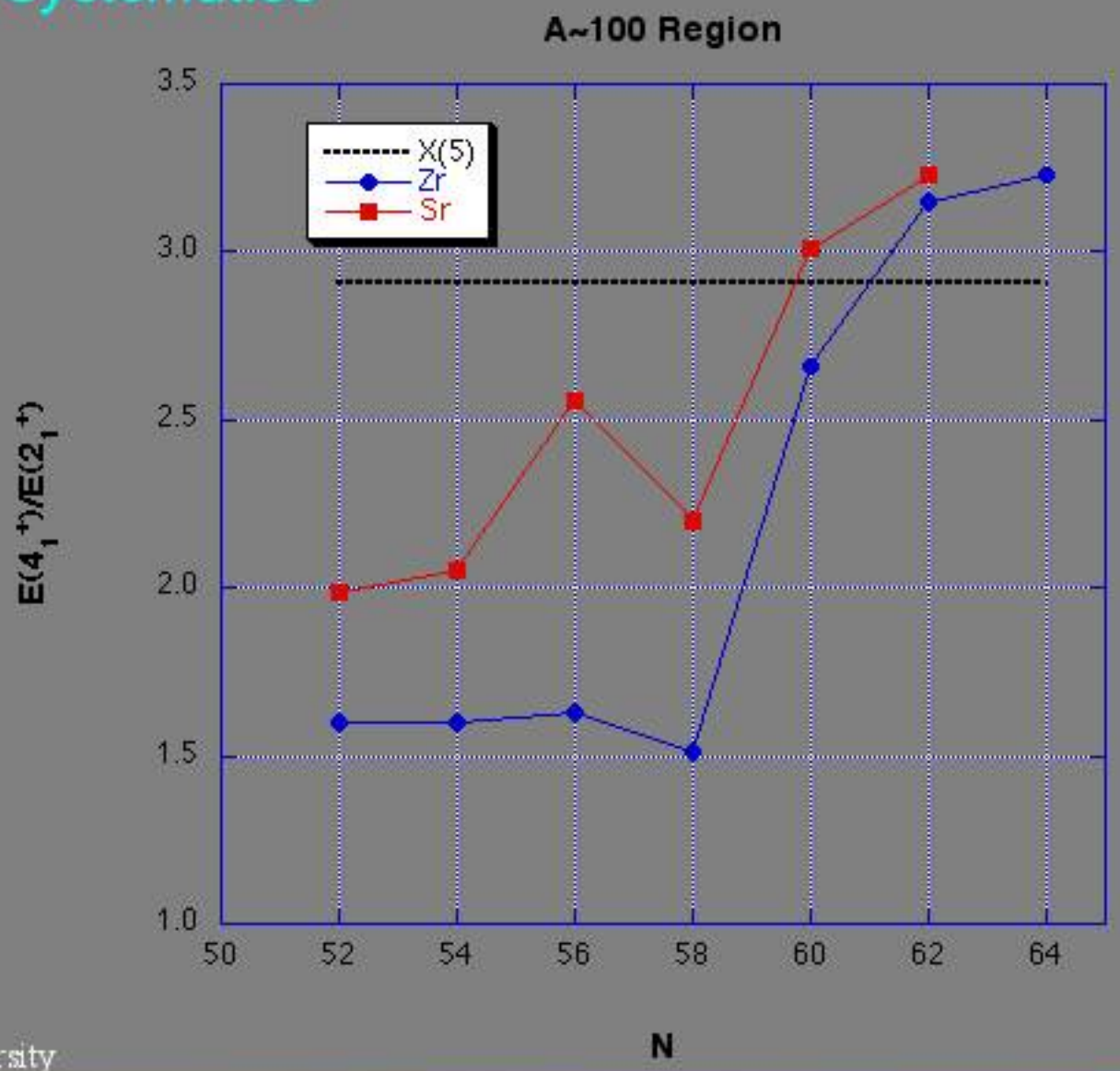
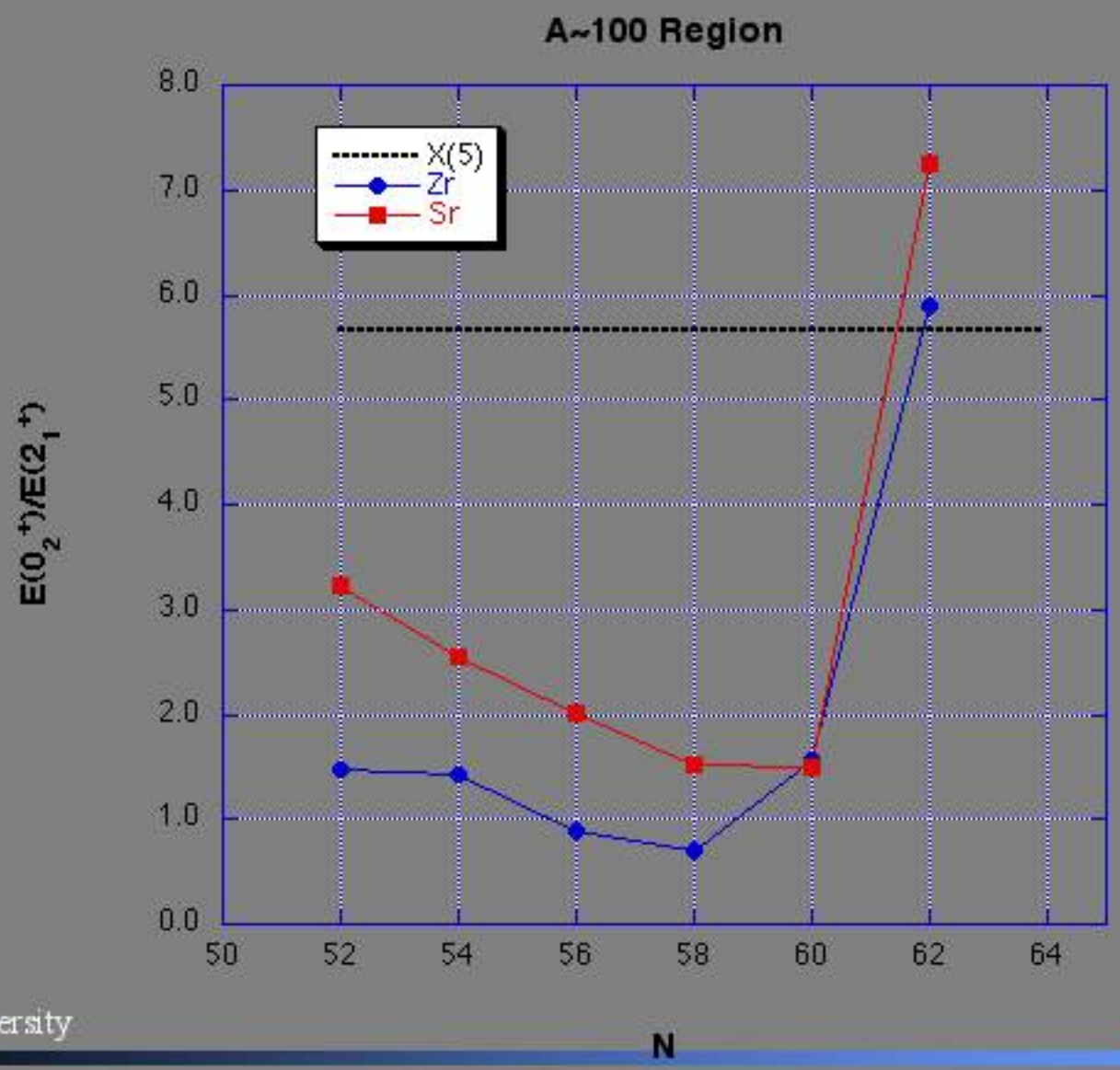
E4/E2 A~100 Region

Z \ N	52	54	56	58	60	62	64	66	68	70
48	1.79	2.11	2.27	2.36	2.38	2.34	2.29	2.30	2.38	2.39
46	1.79	2.13	2.29	2.38	2.40	2.42	2.43	2.53	2.56	2.58
44	1.82	2.14	2.27	2.33	2.48	2.65	2.75	2.76	2.73	
42	1.81	2.09	1.92	2.12	2.51	2.92	3.04			
40	1.60	1.60	1.63	1.51	2.66	3.15	3.23			
38	1.99	2.05		2.20	3.01	3.23				
36	2.12	1.93	2.34	2.28						
34										
32										

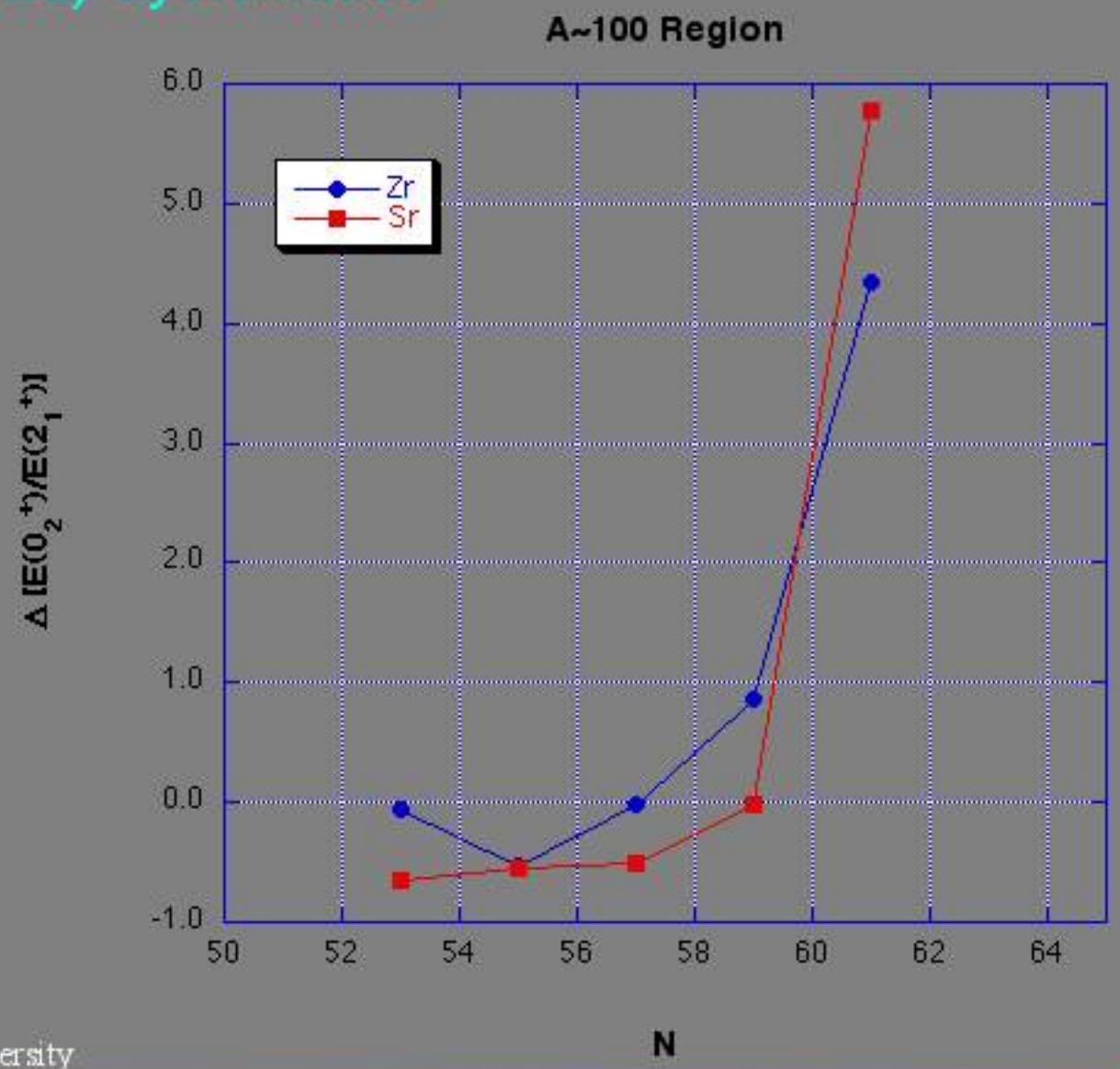
E4/E2 Systematics



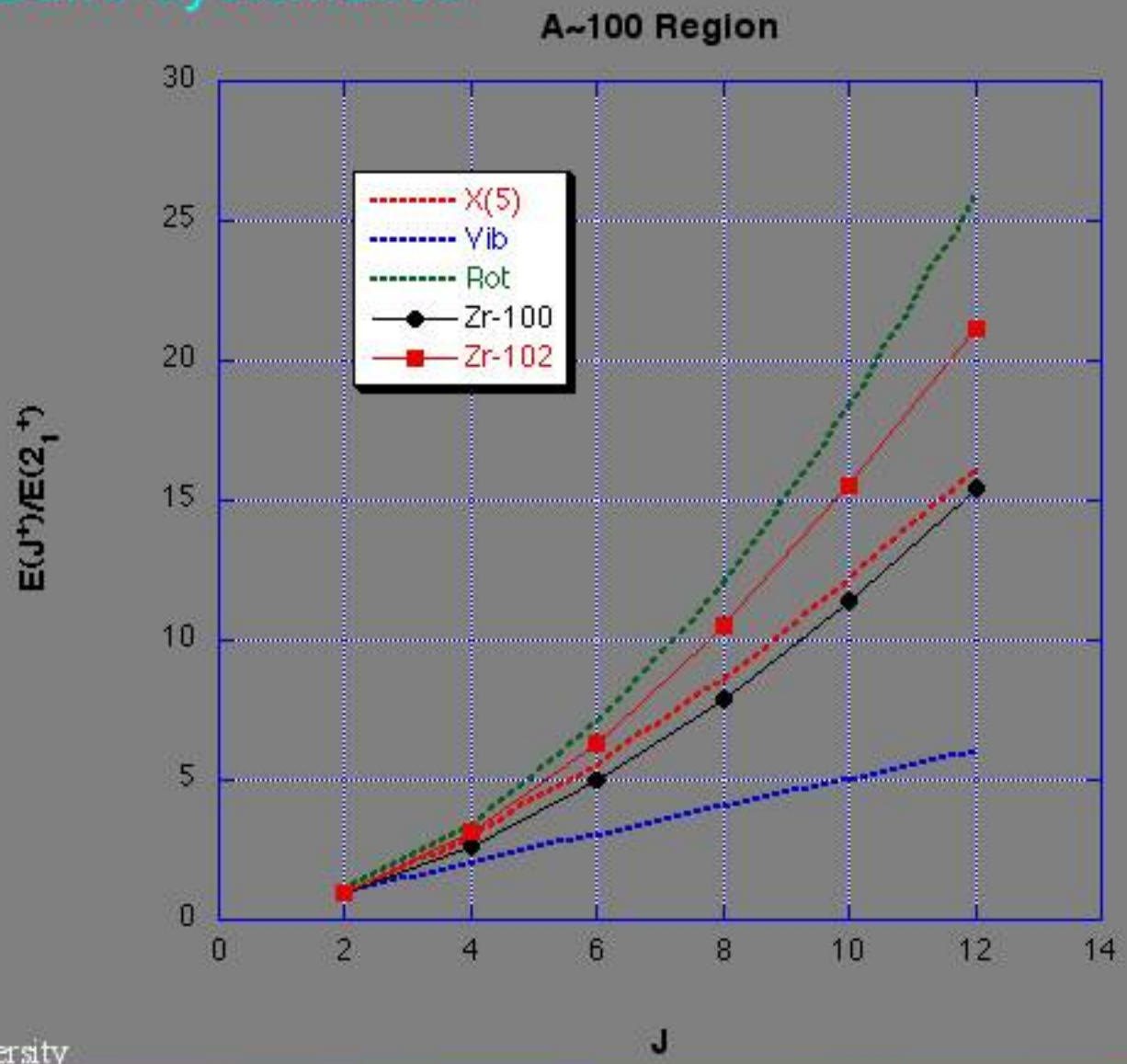
E0/E2 Systematics



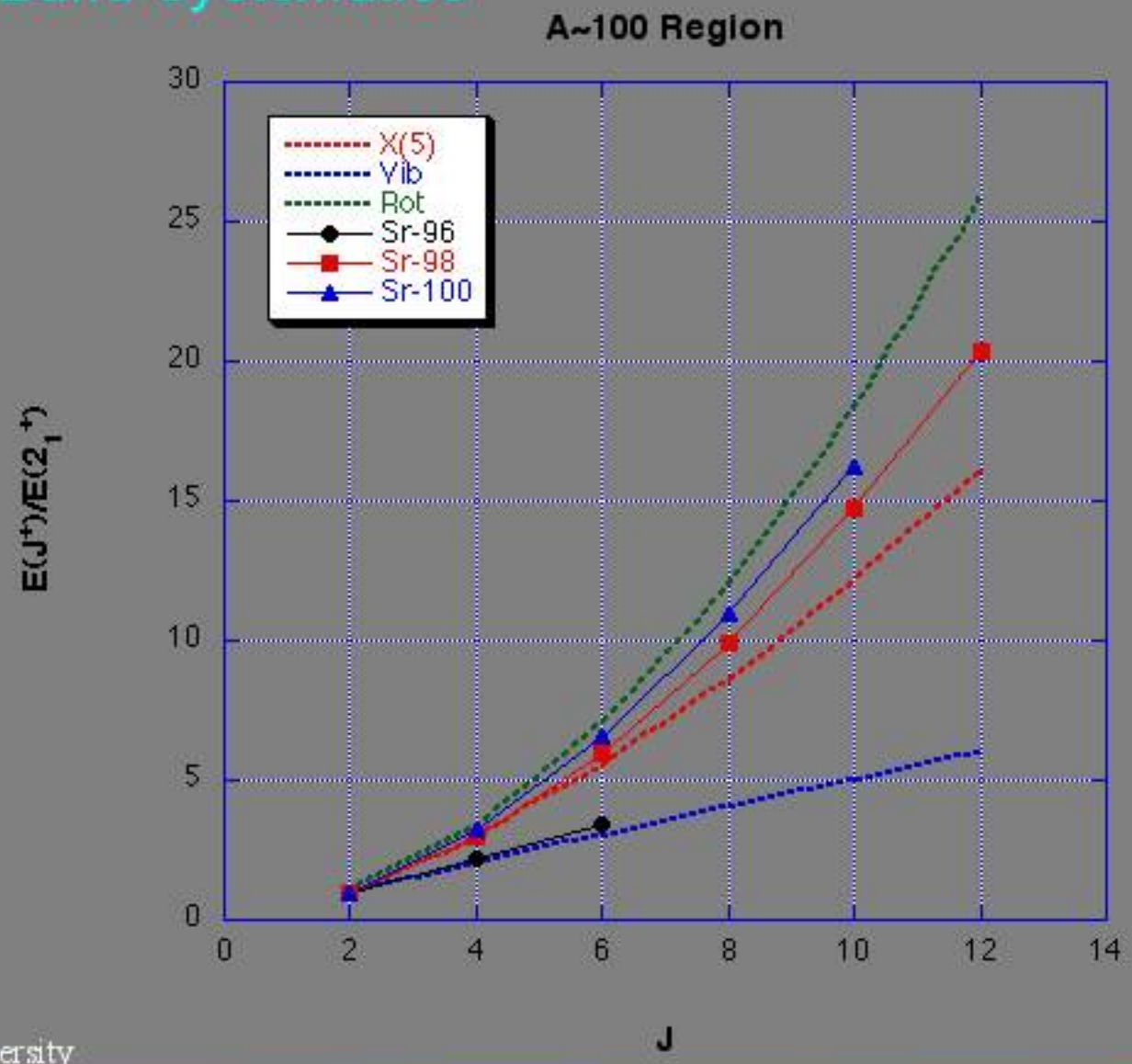
Δ (E0/E2) Systematics



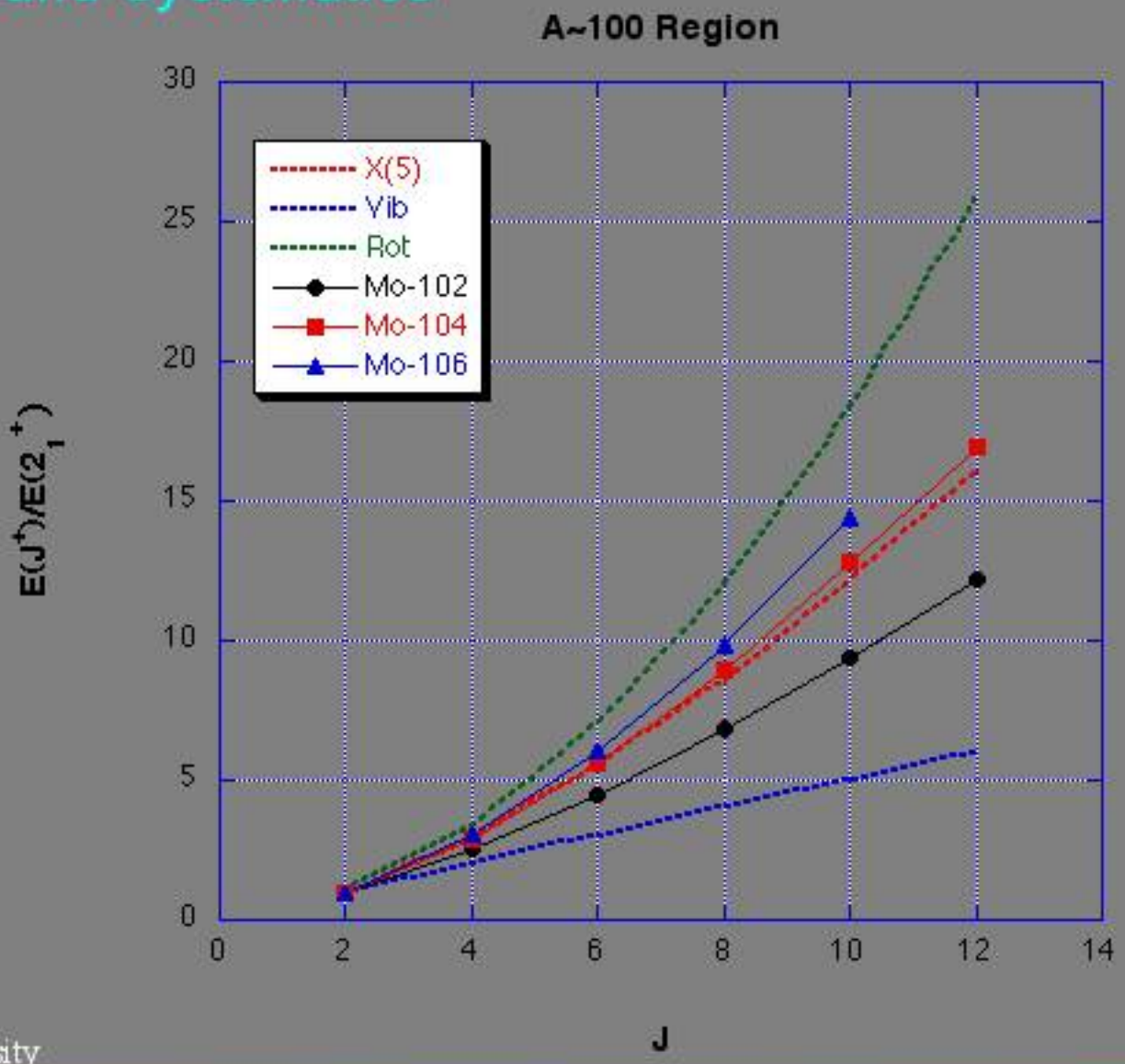
Yrast Band Systematics



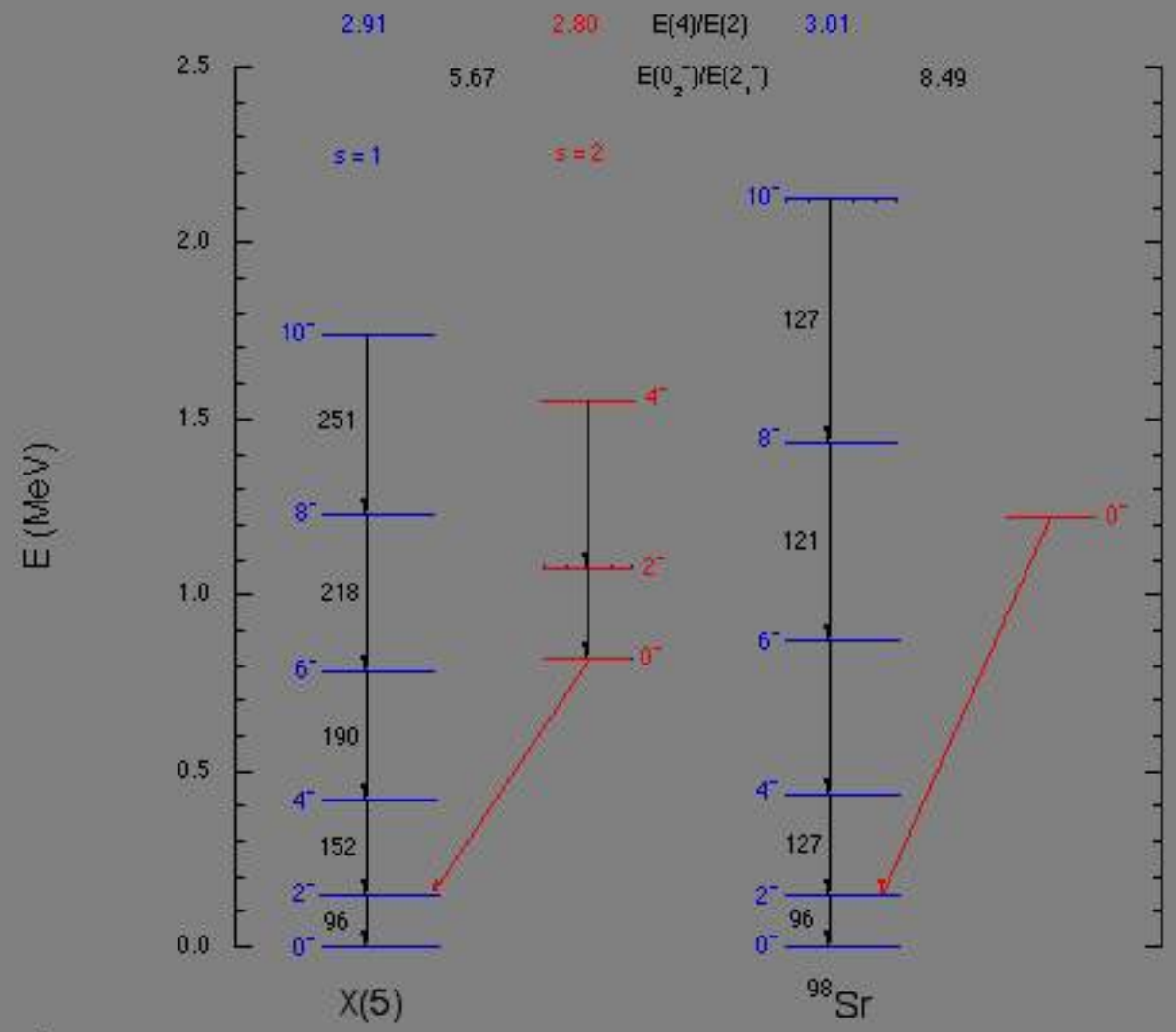
Yrast Band Systematics



Yrast Band Systematics



^{98}Sr vs. X(5)


2.91
2.80
E(4)/E(2)
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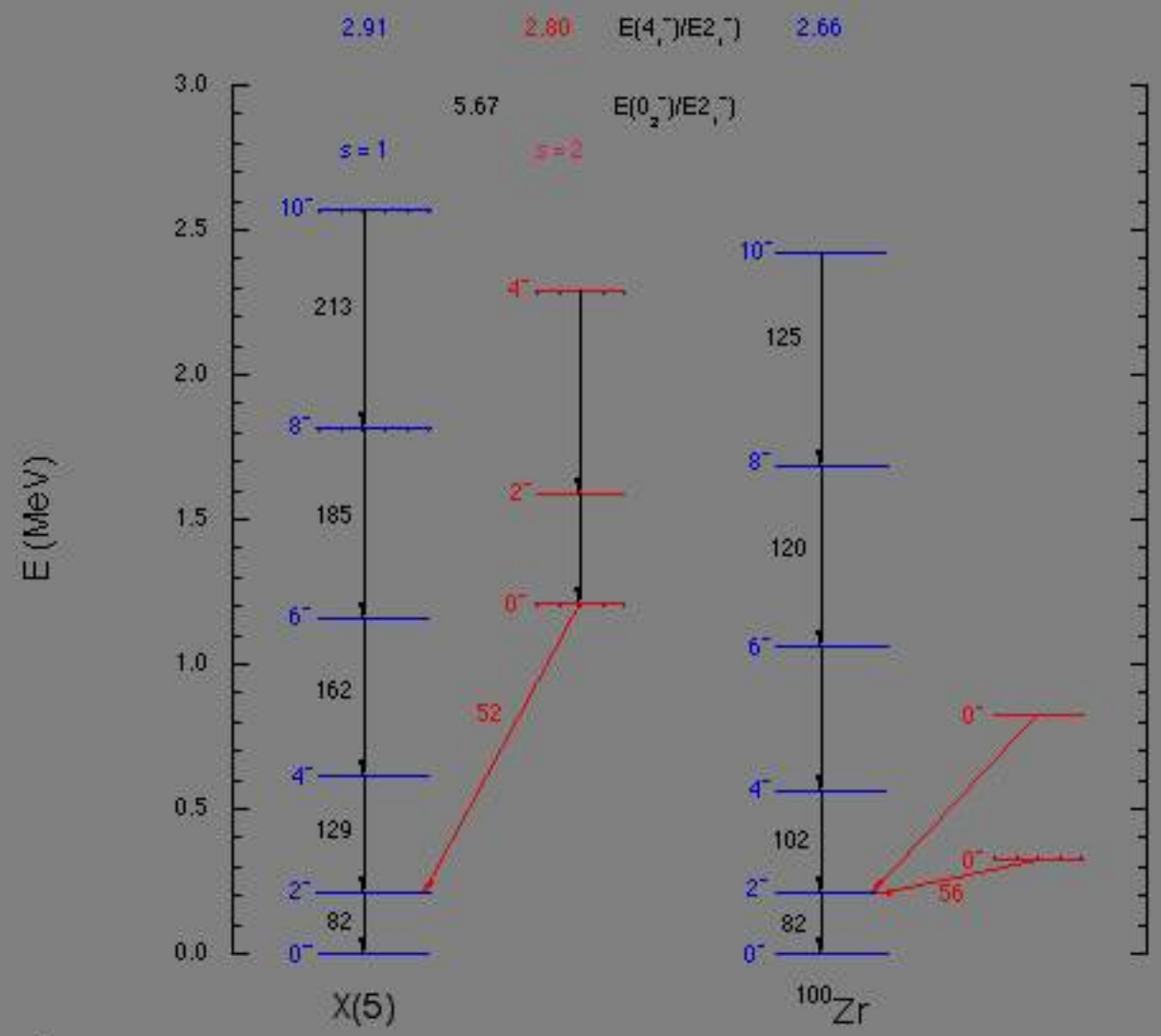
E(0$_2^+$)/E(2$_1^+$)
8.49
s = 1
s = 2
E (MeV)
2.5
2.0
1.5
1.0
0.5
0.0
10$^+$
8$^+$
6$^+$
4$^+$
2$^+$
0$^+$
251
218
190
152
96
4$^+$
2$^+$
0$^+$
127
121
127
96
X(5)
^{98}Sr

^{100}Zr vs. X(5)



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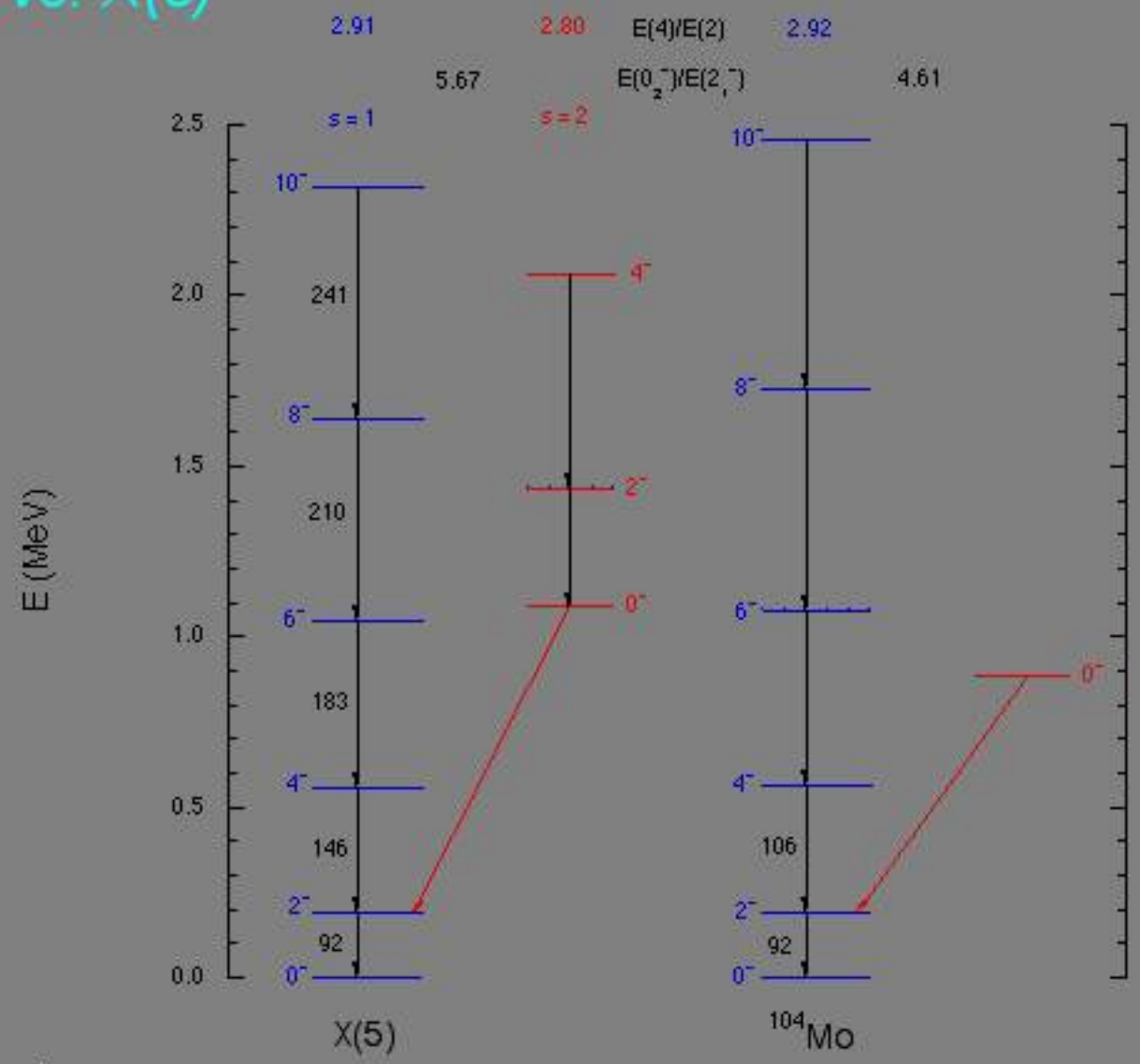
^{104}Mo vs. X(5)



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Which are the best candidates?

- *A~80 region*
  - *^{76}Sr, ^{78}Sr, and ^{80}Zr*
- *A~100 region*
  - *Probably none*

What data are needed?

- *Lifetime measurements*
- *Detailed spectroscopy*