"How Good Are the Conversion Coefficients Now?"

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"How Good Are the CC's Now?"

- Recent Events
- Calculation of Averages
- Calculation of Experimental Averages
- Comparison of Experiment to Theory
- Open Questions
- New Experiments?

Recent Events

- Ratios of Internal Conversion Coefficients (2006Ra03)
  - Compilation of 1510 experimental ratios of internal conversion coefficients including 234 K/L or K/L1
  - Compared experiment to theory (Hager-Seltzer, BTNTR, and RNIT(1)
    - Pure transitions (excluding E1): RNIT(1) favored
    - Mixed transitions (excluding E1+M2): BTNTR favored. However, mixing ratios derived using BTNTR
- AveTools: Combines LWEIGHT v1.3, EV4, and Rajnew programs.

Recent Events (cont.)

- New Measurements:
  - α_K(^{134}Cs 128 keV E3)/α_K(^{137}Ba 662 M4) – 2006Ha36
  - α_{Tot}(109Ag 88 keV E3) – 2006Ko27
  - Updated cutoff date of survey to September 1, 2006 – About 12 new or revised values

Calculation of Averages

- Three statistical techniques (See Desmond McMahon's Trieste NSDD Workshop lecture notes for detailed description)
  - All require $N \geq 3$
  - Limitation of Relative Statistical Weight (LWM)
    - Marks possible outliers (3σ or Chauvenet's criteria)
    - If $\chi^2/(N-1) > \chi^2$(critical at 99% c.l.)
      - Uncertainties are increased until no entry has a relative weight >50%
      - If $\chi^2/(N-1) > \chi^2$(critical), weighted or unweighted average is adopted and the larger of the internal or external uncertainty is used. Uncertainty may be increased to span the most precise input value

Calculation of Averages (cont.)

- Normalized Residual Method (NRM)
  - If $\chi^2/(N-1) > \chi^2$(critical at 95% c.l.), uncertainties of discrepant values are adjusted based on the normalized residual

Calculation of Averages (cont)

- Rajeval Technique (RT)
  - Deviant values identified (and rejected) by comparing the absolute value of
    $$y_i = \frac{x_i - \mu_i}{\sqrt{\sigma_i^2 + \sigma_{\mu}^2}}$$
    to 1.96 where μ_i is the unweighted average excluding the i[th] value
    and $\sigma_{\mu i}$ is its associated standard deviation
  - Uncertainties on inconsistent values are adjusted until the standardized deviate is consistent with the central deviate
- If results from the three techniques agree, the input data can be considered consistent. Comparison of the detailed output from the three techniques may aid in an objective determination of deviant input data

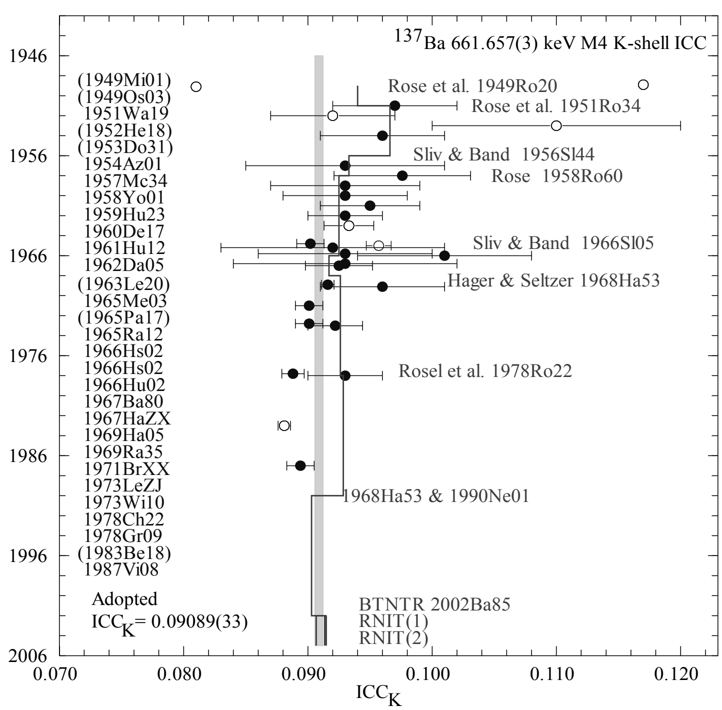
Calculation of Experimental Averages

- If an input value satisfies one of the following criteria, it is considered to be deviant:
  - Marked as an outlier by LWM and RT and adjusted by NRM
  - Marked as an outlier by LWM and significantly adjusted by NRM and RT
  - Marked as an outlier by RT and significantly adjusted by NRM
  - Significantly adjusted by NRM and RT
- Process is repeated until results from all three techniques agree or no value satisfies the above criteria

Calculation of Experimental Aver. (cont.)

- If results from the three techniques do not agree, the arithmetic mean of NRM and RT is adopted and the larger of the uncertainties from NRM and RT is used.

Calculation of Experimental Aver. (cont)



Comparison of Experiment to Theory

- $\Delta(\text{exp:the})=100\times(\alpha_{exp}-\alpha_{the})/\alpha_{the}$
  $\delta\Delta(\text{exp:the})=100\times\sqrt{}(\Delta\alpha_{exp}/\alpha_{the})^2+(\alpha_{exp}\Delta\alpha_{the}/\alpha_{the}{}^2)^2$
- Three Dirac-Fock methods:
  - BTNTR: No hole
  - RNIT(1): Self consistent
  - RNIT(2): Frozen orbital
- If an input value meet the criteria described earlier for all three methods, it was considered deviant
- Process repeated until all three statistical techniques agreed or there were no data satisfying the above criteria
- Adopt LWM value and its associated uncertainty

Comparison of Exp. to Theory (cont).

- Δ, $\delta\Delta$, and $\chi^2/(N-1)$ *vs.* χ^2(critical) and comparison of differences between LWM, NRM, and RT aided in judgment of method
- 18 datasets used: one containing all data, 16 subsets based on multipolarity and shell, and one containing all data with $\delta\Delta(\text{exp:the})\leq 1.5\%$

Comparison of Experiment to Theory (cont)

- Results:
  - 182 sets of ratios accepted
  - RNIT(1) or RNIT(2) preferred over BTNTR for eight datasets
  - BTNTR preferred over RNIT(1) and RNIT(2) for three datasets
  - RNIT(2) preferred over BTNTR and RNIT(1) in two cases
  - Some indications that RNIT(1) is preferred over RNIT(2) – Still needs further analysis

Comparison of Exp. to Theory (cont.)

	N	BTNTR			RNIT(1)			RNIT(2)		
		Δ	$\delta\Delta$	R/C	Δ	$\delta\Delta$	R/C	Δ	$\delta\Delta$	R/C
All	182	0.58	0.68	1.6	-0.63	0.13	0.8	-0.92	0.13	0.8
Total&K	124	0.71	0.81	1.8	-0.47	0.14	0.8	-0.77	0.14	0.7
K M4	18	1.68	1.49	4.7	-0.13	0.29	0.9	-0.83	0.29	0.3
$\delta\Delta \leq 1.5\%$	26	0.68	0.79	4.5	-0.60	0.23	1.2	-0.92	0.16	0.8
K/L E2	28	-0.14	0.39	0.5	-1.66	0.38	0.5	-1.92	0.39	0.6

Open Questions

- RNIT(1) *versus* RNIT(2)?
- K/L E2, Total for all shells, and Total M4 seem to favor BTNTR?
- <u>L≥3</u>: Are the Dirac-Fock methods overestimating α?
- E1, M1, and M2: Excluded in survey?
- Other transition energy dependent problems?

New Experiments?

"Ideal"								
	Exper.		BTNTR		RNIT(1)		RNIT(2)	
^{193}Ir 80 M4 K (3)	103.0	*8*	92.18	*12*	99.63	*12*	103.45	*12*
		0.8%	+11.7%	*9*	+3.4%	*8*	-0.4%	*8*

New Experiments? (cont)

Possible Candidates										
	Exper.		BTNTR		RNIT(1)		RNIT(2)	
^{58}Co 25 M3+E4 K δ<0.014 (3)	1860	*69* 3.7%	1756 +6%	*8* *4*	1824 +2%	*8* *4*	1842 +1%	*8* *4*
^{73}Se 26 E3 K/L (1)	0.290	*14* 4.8%	0.275 +6%	*3* *5*	0.286 +1%	*3* *5*	0.290 -0.1%	*3* *49*
^{73}Ge 13 E2 K (2)	297	*20* 6.7%	264.87 +12%	*3* *8*	288.80 +3%	*1* *7*	298.65 -0.6%	*2* *70*
^{83}Kr 32 E3 K (1)	455	*18* 4.0%	458.02 -0.7%	*4* *39*	477.03 -5%	*4* *4*	483.02 -6%	*4* *4*
^{96}Tc 34 M3 K (2)	1766	*51* 2.9%	1591 +11%	*4* *3*	1688 +6%	*4* *3*	1690 +4%	*4* *3*
^{103}Rh 40 E3 K (8)	134.1	*35* 2.6%	127.31 +5.3%	*7* *27*	133.15 +0.7%	*7* *26*	135.11 -0.7%	*8* *26*