

Constraining the $0\nu\beta\beta$ by global analysis of data

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$\beta\beta$ vs. 1β

What way of adjusting g_{pp} in QRPA is preferable?

Ideally, a nuclear structure method should describe experimental data and do that without adjustments

Usually: not possible to describe simultaneously $2\nu\beta\beta$ as well as β^- and β^+/EC decay of 1^+ g.s. of intermediate nucleus

Fixing g_{pp}

⇒ from $2\nu\beta\beta$ -decay $M^{2\nu}$

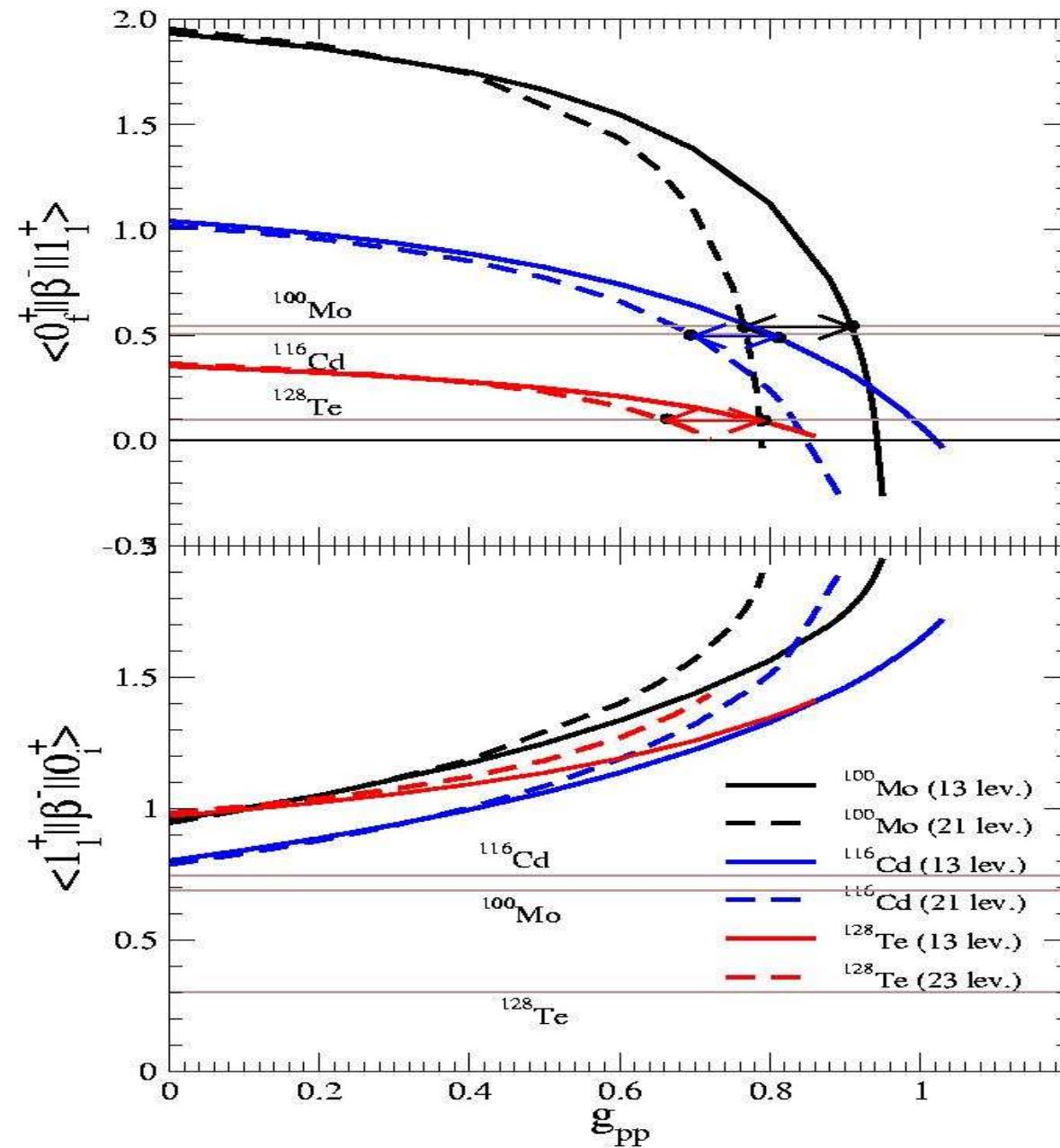
V. R., A. Faessler, F. Simkovic, P. Vogel, PRC ('03); NPA ('06,'07)

⇒ from single β -decays M_β

J. Suhonen, PLB 607 ('05)

(Famous table: $7 \times (+)$ pro $1\beta \Leftrightarrow 3 \times (+), 3 \times (-)$ pro 2β)

$\beta\beta$ vs. 1β



$\beta\beta$ vs. 1β

Not always fault of theoreticians!

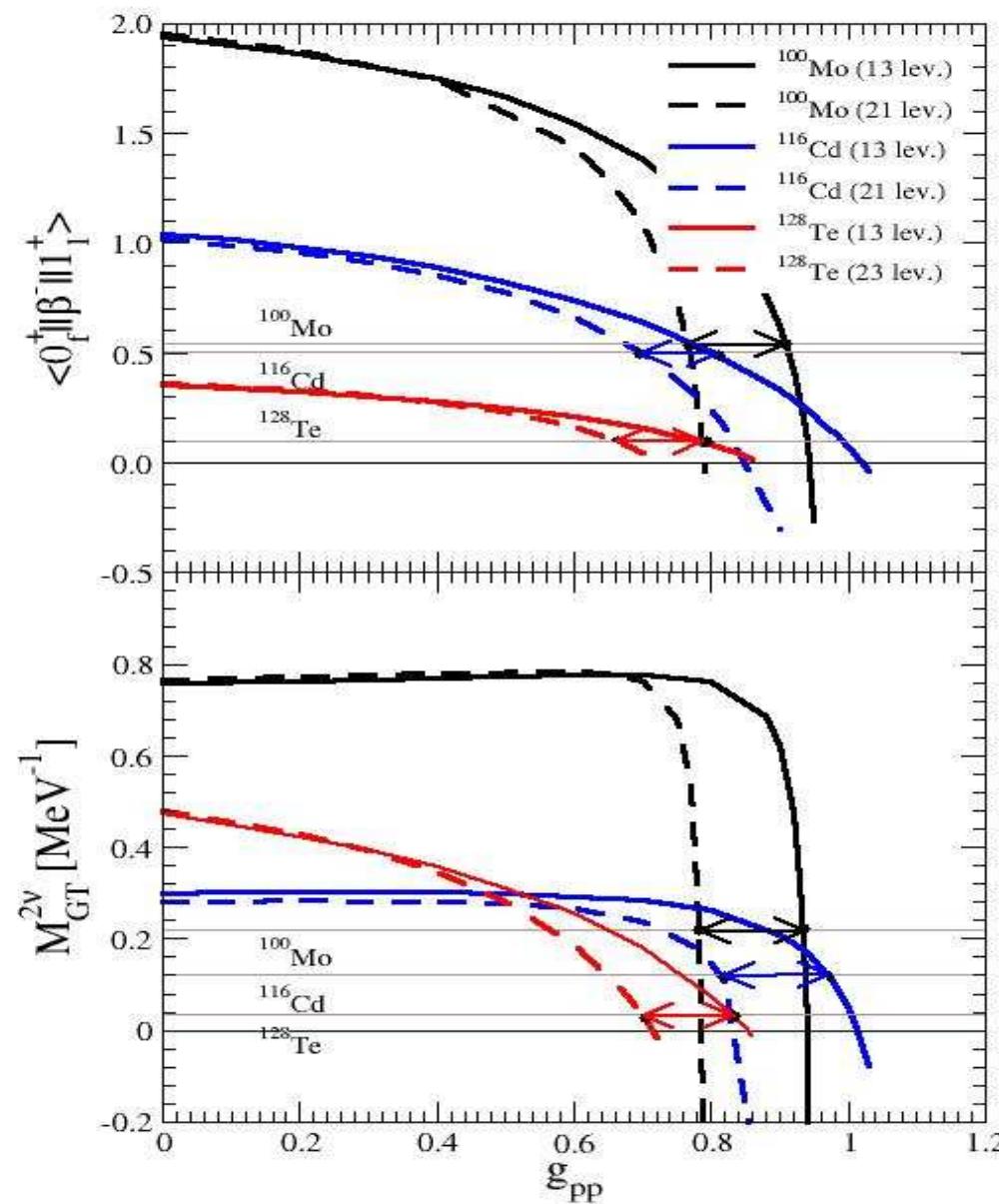
^{100}Tc , EC (first leg):

$B(\text{GT}) = 0.66 \pm 0.33$ (A. Garcia et al., PRC 47 (1993))

$B(\text{GT}) = 2.01 \pm 0.45$ (S. Sjue et al., talk at NNR'05 (2005))

One needs accurate experimental data on β^- -decay and *EC*!

$\beta\beta$ vs. 1β



Global Analysis

Can $2\nu\beta\beta$ and 1β be reconciled within a single QRPA calculation?

Use g_A as an additional fit parameter

$\log(ft) \rightarrow \log(ft/g_A^2)$ for EC and β^-

$\log(T_{1/2}^{2\nu}) \rightarrow \log(T_{1/2}^{2\nu}/g_A^4)$ for $2\nu\beta\beta$

Global Analysis

Exp. refs for nuclear systems of interest

A	Z	$Z + 1$	$Z + 2$	$2\nu 2\beta$	EC	$(^3\text{He}, t)$	(p, n)	β^-	$(d, ^2\text{He})$	μC
76	Ge	As	Se	[1]			[5]			[10]
82	Se	Br	Kr	[1]			[5]			
96	Zr	Nb	Mo	[1]						[10]
100	Mo	Tc	Ru	[1]	[2,3]	[4]			[7]	
116	Cd	In	Sn	[1]	[6]	[4]	[8]	[7]	[9]	[10]
128	Te	I	Xe	[1]	[7]		[5]	[7]		
130	Te	I	Xe	[1]			[5]			
136	Xe	Cs	Ba	[1]						[10]

Global Analysis

- 1 A.S. Barabash, arXiv:hep-ex/0608054
- 2 A. García *et al.*, PRC (1993)
- 3 J.F. Wilkerson, *NNR'05* Workshop (Osaka, Japan, 2005)
www.springer.or.jp/ext/en/appeal/nnr05
- 4 H. Akimune *et al.*, PLB (1997)
- 5 R. Madey *et al.*, PRC (1989)
- 6 M. Bhattacharya *et al.*, PRC (1998)
- 7 Eval. Nucl. Str. Data File, www.nndc.bnl.gov/ensdf
- 8 M. Sasano *et al.*, NPA (2007)
- 9 S. Rakers *et al.*, PRC (2005)
- 10 T. Suzuki *et al.*, PRC (1987)
μC: natural isotopic mixture of the $Z + 2$ nuclei

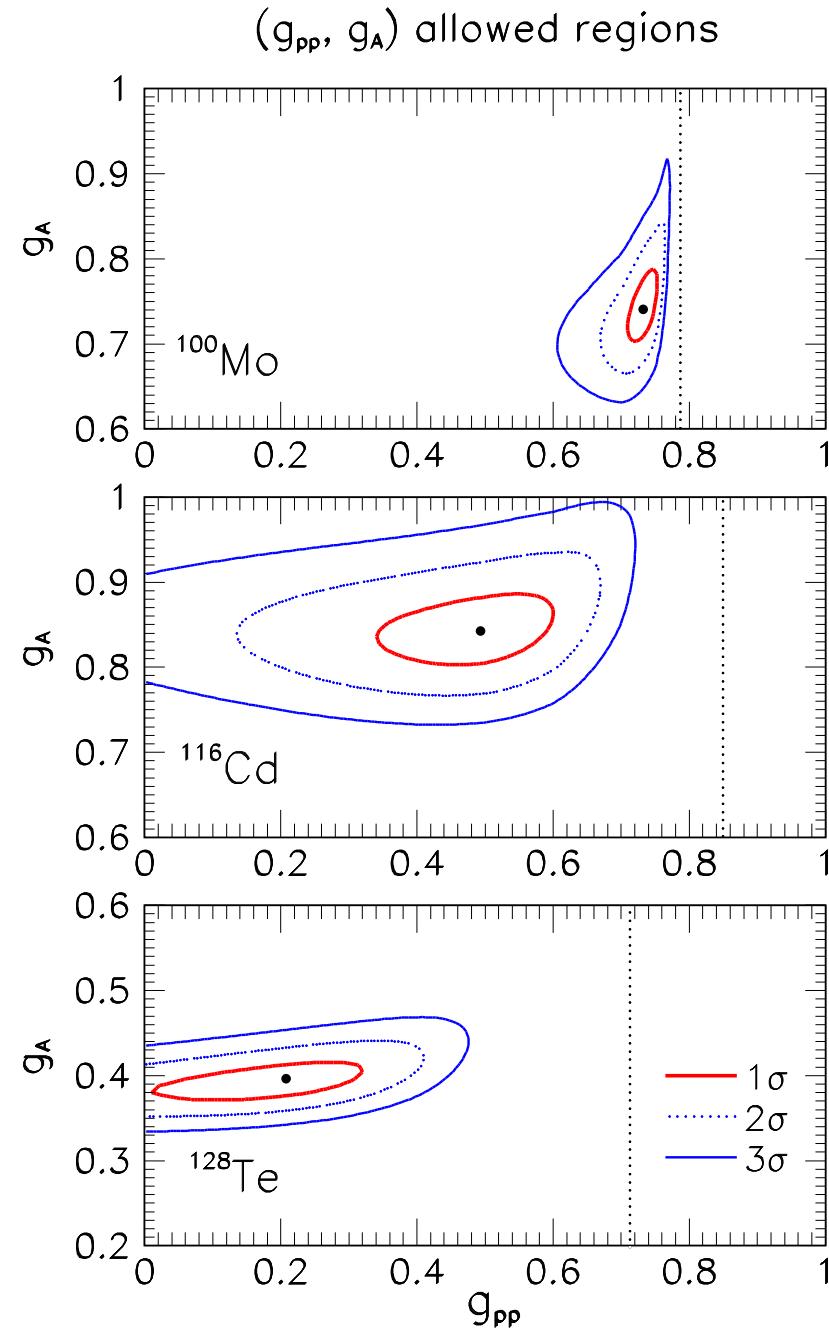
Global Analysis

Exp. input: Measured lifetimes ($\pm 1\sigma$)

Nucleus	$\log(T_{1/2}^{2\nu}/\text{y}) \pm \sigma_{\text{expt}}$		$\log ft(\text{EC}) \pm \sigma_{\text{expt}}$		$\log ft(\beta^-) \pm \sigma_{\text{expt}}$	
^{100}Mo	18.85 ± 0.03	[1]	$3.96^{+0.11}_{-0.09}$	[3]	4.60 ± 0.01	[7]
^{116}Cd	19.48 ± 0.03	[1]	$4.39^{+0.10}_{-0.15}$	[6]	4.662 ± 0.005	[7]
^{128}Te	24.40 ± 0.06	[1]	5.049 ± 0.007	[7]	6.06 ± 0.05	[7]

Global Analysis

$N\sigma$ regions in
 (g_{pp}, g_A) plane
(QRPA, large basis)



Global Analysis

Nuclear transition	$M'^{0\nu}$				g_A this work	
	RFSV-0607		this work			
	$g_A = 1.25$	$g_A = 1.0$	l.b.	s.b.		
$^{100}\text{Mo} \rightarrow ^{100}\text{Ru}$	3.34(0.19)	2.71(0.14)	$2.66^{+0.15}_{-0.14}$	$2.45^{+0.16}_{-0.15}$	0.74	
$^{116}\text{Cd} \rightarrow ^{116}\text{Sn}$	2.74(0.19)	2.18(0.16)	$2.44^{+0.23}_{-0.18}$	$2.15^{+0.20}_{-0.16}$	0.84	
$^{128}\text{Te} \rightarrow ^{128}\text{Xe}$	3.64(0.13)	2.85(0.08)	$2.58^{+0.25}_{-0.19}$	$2.59^{+0.27}_{-0.23}$	0.39	

Global Analysis

F. Nowacki, IDEA meeting, Heidelberg, 2004

β decay systematics

Nucleus	^{128}Sn	^{130}Sn	^{132}Sb	^{132}Te	^{133}Te
Transition	$0^+ \rightarrow 1^+$	$0^+ \rightarrow 1^+$	$4^+ \rightarrow 3, 4, 5^+$	$0^+ \rightarrow 1^+$	$\frac{3}{2}^+ \rightarrow \frac{1}{2}, \frac{3}{2}, \frac{5}{2}^+$
$T_{1/2}$ exp.	59.07m	3.72m	2.79m	3.2d	12.5m
$T_{1/2}$ calc. (0.74)	32.21m	2.47m	1.56m	1.73d	6.42m
Renorm.	0.54	0.6	0.55	0.54	0.53
<hr/>					
	^{134}Te	^{135}Xe	^{136}Cs		
	$0^+ \rightarrow 1^+$	$\frac{3}{2}^+ \rightarrow \frac{1}{2}, \frac{3}{2}, \frac{5}{2}^+$	$5^+ \rightarrow 4, 5, 6^+$		
	41.8m	9.14h	13.16d		
	29.19m	7.07h	8.1d		
	0.62	0.63	0.57		

Our valence space leads to a renormalization of the $\sigma\tau$ operator of a factor 0.57

Conclusions

- $2\nu\beta\beta$ and single β data can all be described within QRPA, if one allows for strong quenching $g_A < 1$ (usual in the shell-model calculations).
- Negative branch of the $2\nu\beta\beta$ m.e. can be excluded
- Calculated $M^{0\nu}$ are rather close to the previous ones for $g_A = 1$