phase space and NME

A. Smolnikov & P. Grabmayr, PRC81 (2010) 28502

PHYSICAL REVIEW C 81, 028502 (2010)

Conversion of experimental half-life to effective electron neutrino mass in $0\nu\beta\beta$ decay

Anatoly Smolnikov*
Joint Institute for Nuclear Research, Dubna, Russia, and
Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia

Peter Grabmayr†
Kepler Center for Astro and Particle Physics, Eberhard Karls Universität Tübingen, Germany
(Received 18 December 2009; published 23 February 2010)

O.Moreno, E. Moya de Guerra, P. Sarriguren, A.Faessler

arXiv:1002.1608v1 [nucl-th] 8 Feb 2010

some formulas

$$\frac{1}{T_{1/2}} = G^{0\nu}|\mathcal{M}^{0\nu}|^2 \left|\frac{\langle m_{\beta\beta}\rangle}{m_e}\right|^2 = F^{0\nu}|\mathcal{M}^{0\nu}|^2 m_{\beta\beta}^2$$

Phase space factor

$$G^{0\nu} = G_{01} = \frac{a_{0\nu}}{(m_e R_A)^2 ln 2} \int d\Omega_{0\nu} \; b(\varepsilon_1, \varepsilon_2)$$

$$a_{0\nu} = \frac{(G g_A)^4 \; m_e^9}{64\pi^5},$$

$$b(\varepsilon_1, \varepsilon_2) = F_0(Z, \varepsilon_1) F_0(Z, \varepsilon_2)$$

$$d\Omega_{0\nu} = \frac{p_1\varepsilon_1 \; p_2\varepsilon_2}{m_e^5} \; \delta(\varepsilon_1 + \varepsilon_2 + M_f - M_i) \; d\varepsilon_1 d\varepsilon_2 \, d\cos\theta$$

$$G^{0\nu} \sim g_A^4 \frac{1}{R_A^2}$$

radius

$R = 3,108 \times 10^{-3} A^{1/3} / m_e$	Doi
$R = 1.1 A^{1/3}$	Faessler
$R = 1.2 A^{1/3}$	Suhonen, Iachello, Poves

Author	Ref.	r_0 [fm]	$G^{0\nu} \times 10^{15}$ $[y^{-1}]$	$\mathcal{M}'^{0\nu}$	$s \times 10^{25}$ $[eV^2 \times y]^{-1}$	Comments
Claim	[3]	1.2	6.31	4.22	4.30	
Pantis	[11]	1.1	7.93	1.34	0.55	np pairing
Simkovic	[12]	1.1	7.93	2.80	2.38	RQRPA
Simkovic	[12]	1.1	7.93	3.60	3.94	RQRPA
Rodin	[13]	1.1	7.93	3.92	4.67	RQRPA
Simkovic	[14]	1.1	7.93	3.33	3.37	Jastrow[a]
Simkovic	[14]	1.1	7.93	4.68	6.65	Jastrow[b]
Simkovic	[14]	1.1	7.93	3.92	4.67	UCOM[a]
Simkovic	[14]	1.1	7.93	5.73	9.97	UCOM[b]
Caurier	[15]	1.2	6.31	2.22	1.19	SM
Barea	[16]	1.2	6.31	5.47	7.23	IBM2-I
Barea	[16]	1.2	6.31	4.64	5.20	IBM2-II
Suhonen	[18]	1.2	6.31	2.78	1.87	Jastrow[c]
Suhonen	[18]	1.2	6.31	2.28	1.26	Jastrow[d]
Suhonen	[18]	1.2	6.31	4.11	4.08	UCOM[c]
Suhonen	[18]	1.2	6.31	3.23	2.52	UCOM[d]
Menendez	[20]	1.2	6.31	3.00	2.17	SM gcn[e]
Menendez	[20]	1.2	6.31	3.52	2.99	SM rg[e]
Simkovic	[21]	1.1	7.93	5.44	8.99	RQRPA[e]
Simkovic	[21]	1.1	7.93	4.07	5.03	RQRPA[ae]
Simkovic	[21]	1.1	7.93	6.64	13.39	RQRPA[be]

Auxiliary variable s

$$\frac{1}{T_{1/2}} = G^{0\nu}|\mathcal{M}^{0\nu}|^2 \left|\frac{\langle m_{\beta\beta}\rangle}{m_e}\right|^2 = F^{0\nu}|\mathcal{M}^{0\nu}|^2 m_{\beta\beta}^2$$

$$s = G^{0\nu}|\mathcal{M}'^{0\nu}|^2 m_e^{-2} \quad [\mathrm{eV}^2 y]^{-1}$$

$$\langle m_{\beta\beta}\rangle = (s T_{1/2})^{-1/2}$$

Masses in [meV]

$$s = G^{0\nu} |\mathcal{M}'^{0\nu}|^2 m_e^{-2} \quad [eV^2 y]^{-1}$$

Author	Ref.	$s \times 10^{25}$ $[eV^2 \times y]^{-1}$	$T_{1/2} \times 10^{-25}$ [y]				
			1.2	2.2	3	15	20
			Claim	Phase I		Phase II	
Menendez	[20]	2.99	528	390	334	149	129
Suhonen	[18]	4.08	452	334	286	128	111
Rodin	[13]	4.67	422	312	267	119	103
Barea	[16]	7.23	340	251	215	96	83
Simkovic	[21]	8.99	304	225	193	86	75

recommendation

Experimental sensitivity	Ref.	$T_{1/2}$ $[10^{-25}\ y]$	$\langle m_{\beta\beta} \rangle$ [eV]
Claim	[3]	1.2	0.30–0.53
GERDA Phase I	[1]	2.2	0.23–0.39
GERDA Phase II	[1]	15.0	0.09–0.15

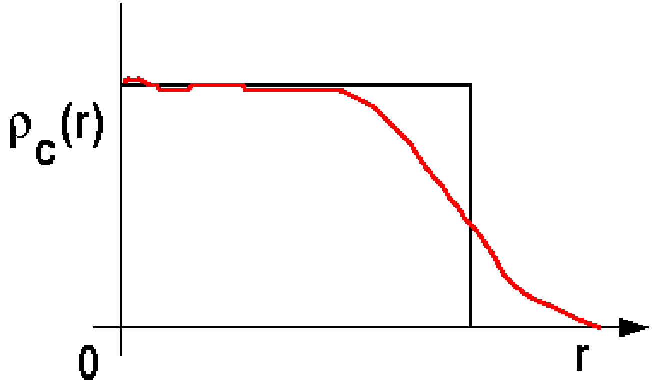
open problem

Fermi function F_0 & integrand $b(\varepsilon_1,\varepsilon_2)$

$$b(\varepsilon_1, \varepsilon_2) = F_0(Z, \varepsilon_1) F_0(Z, \varepsilon_2)$$

assumes: 1. 2e emission
2. distortion by same Z-distribution

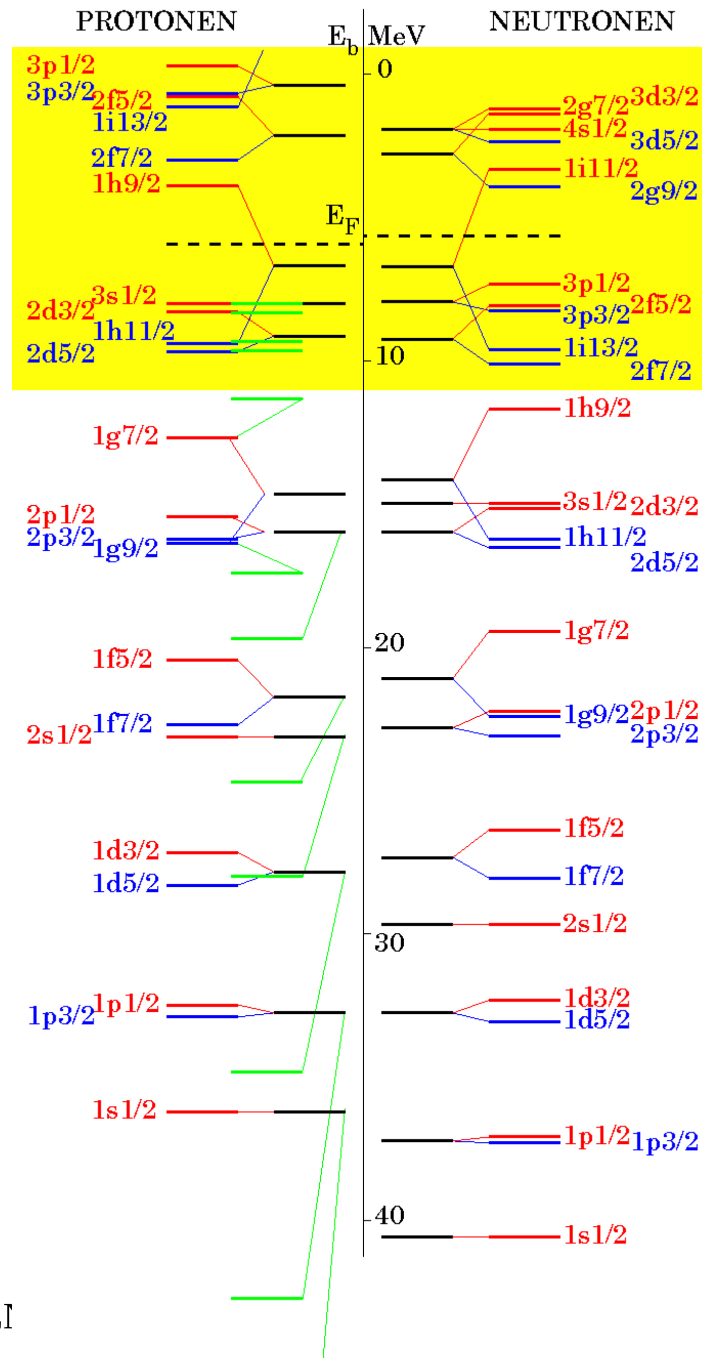
F_0 calculated from hard sphere distribution

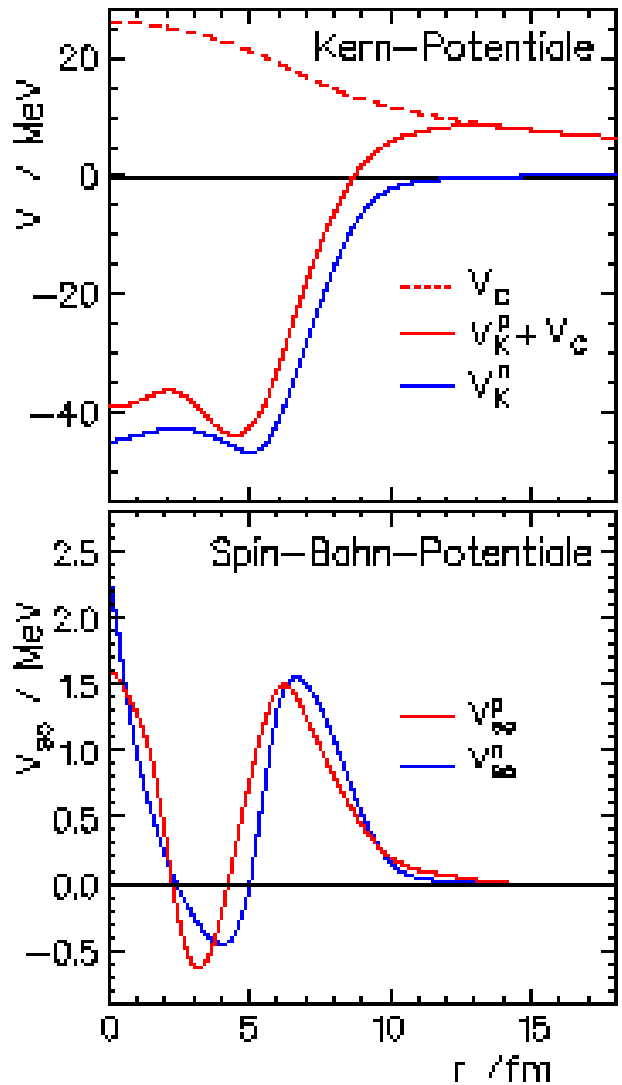


solve Dirac eq. in potential due to $\rho_c(r)$

argued by Doi etc: not important (few %) (comp ^{12}B)

realistic potentials ^{208}Pb





G.Mairle & P. Grabmayr
EPJA 9 (2000) 313

difference in occupancies

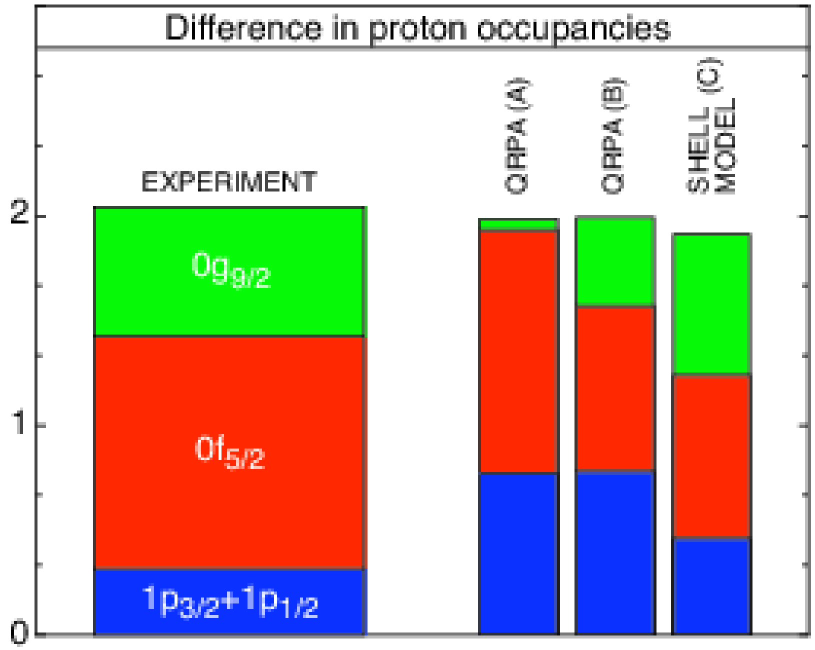
JP Schiffer et al., PRL 100 (2008) 112501

$\Delta n = -2 \qquad \Delta p = +2$

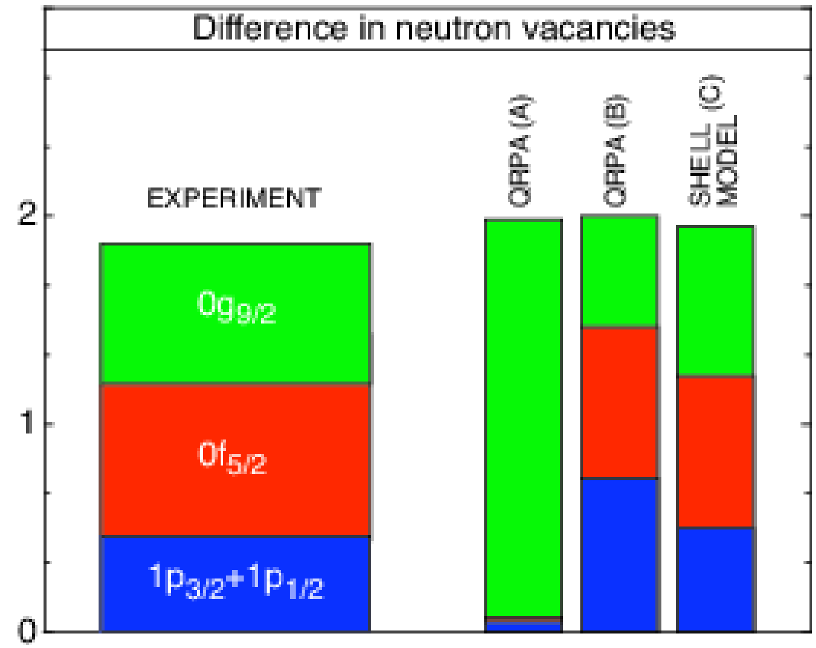
PHYSICAL REVIEW C **79**, 021301(R) (2009)

Nuclear structure relevant to neutrinoless double β decay: The valence protons in ^{76}Ge and ^{76}Se

B. P. Kay,[1] J. P. Schiffer,[1] S. J. Freeman,[2] T. Adachi,[3] J. A. Clark,[4] C. M. Deibel,[4] H. Fujita,[3] Y. Fujita,[5] P. Grabmayr,[6] K. Hatanaka,[3] D. Ishikawa,[3] H. Matsubara,[3] Y. Meada,[7] H. Okamura,[3] K. E. Rehm,[1] Y. Sakemi,[8] Y. Shimizu,[9] H. Shimoda,[10] K. Suda,[3] Y. Tameshige,[3] A. Tamii,[3] and C. Wrede[4]



protons



neutrons

Summary

There a more uncertainties in the theoretical results

than just the nuclear matrix elements.

Importance of support experiments.

Moreno et al

Deformation of Ge & Se