Effects of Orbital Occupations on the $0\nu\beta\beta$ Matrix Element of the ^{76}Ge Decay

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Starting Point

NEW (p,t) DATA

and

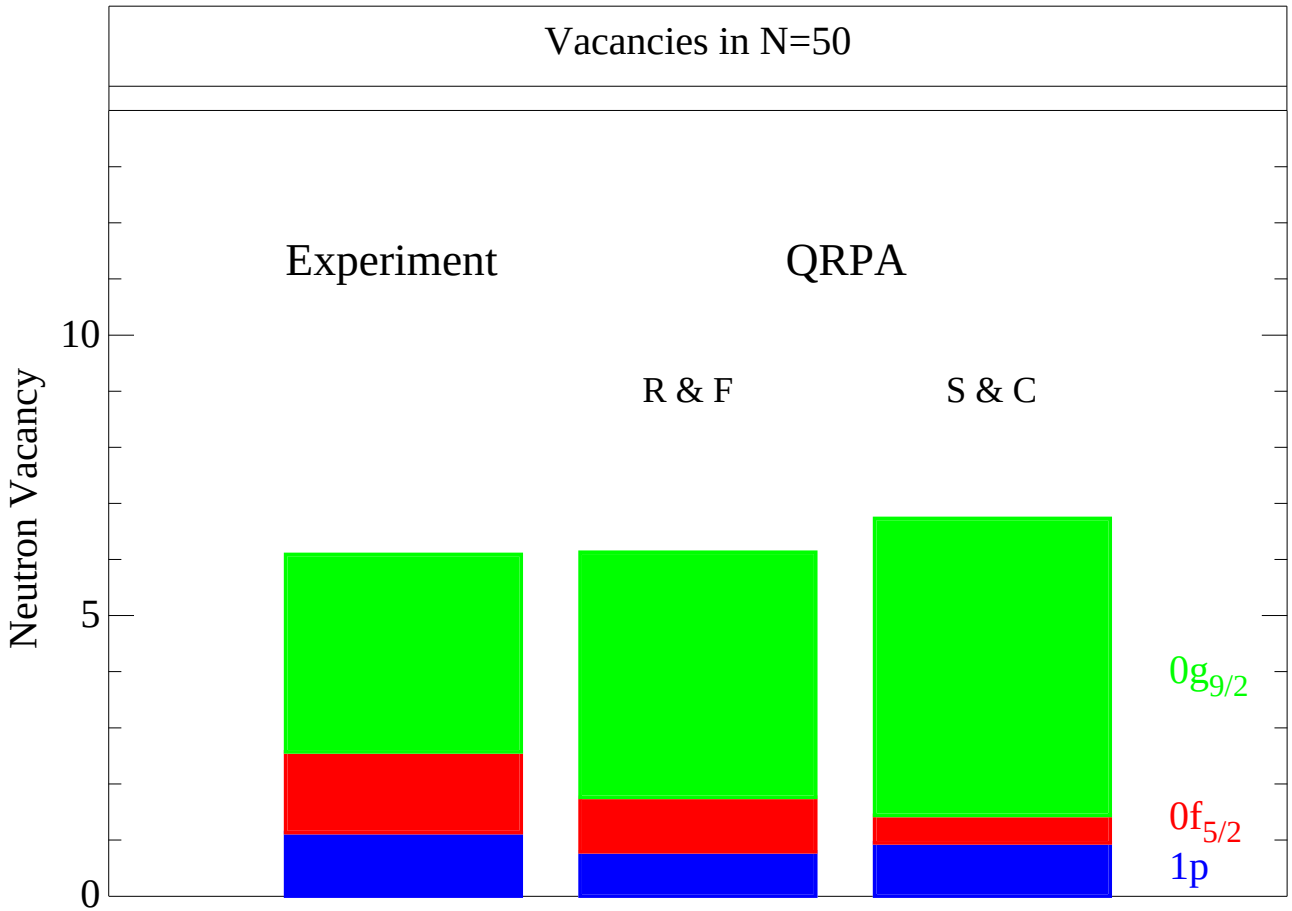
NEUTRON OCCUPATIONS

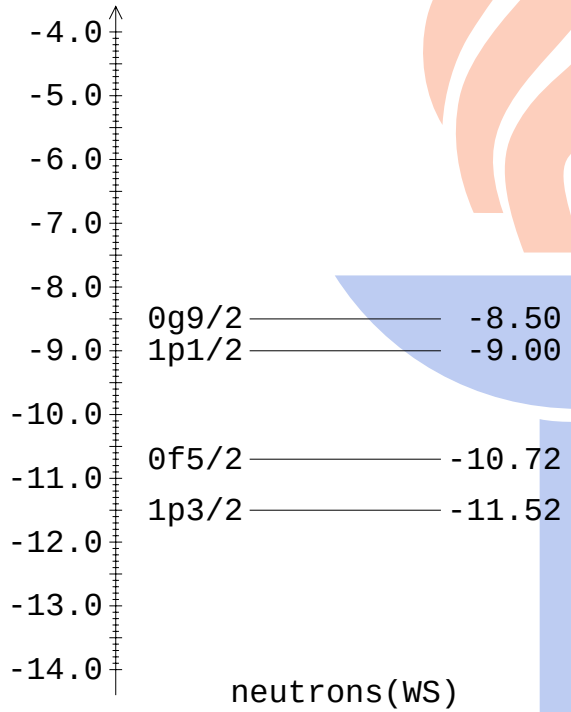
for

$A = 76$

Neutron Vacancies in the 1p-0$f_{5/2}$-0$g_{9/2}$ Shells for ^{76}Ge

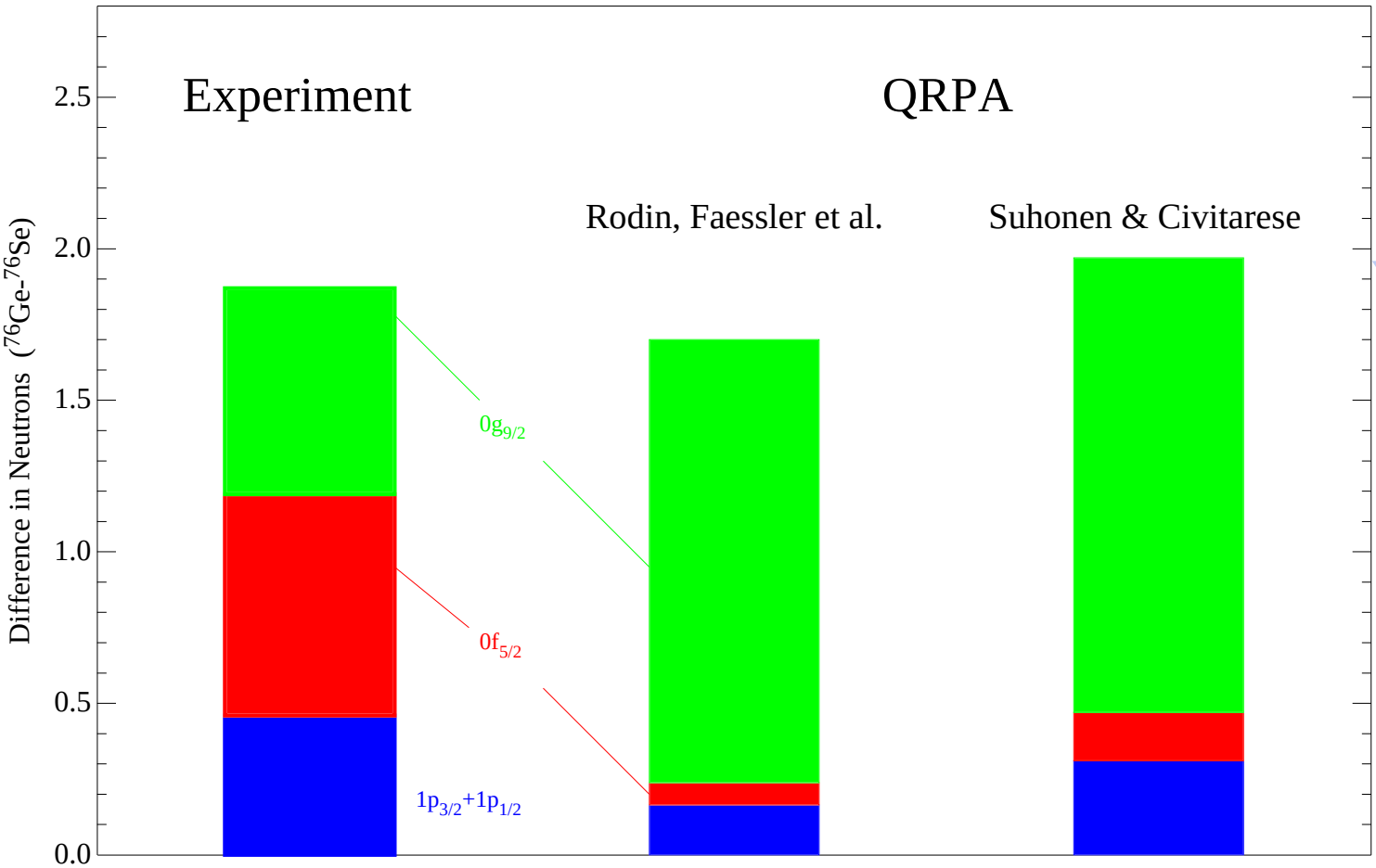
(p,t) pair removal reaction by John Schiffer et al.





Difference in Neutron Numbers Between ^{76}Ge and ^{76}Se

(p,t) pair removal reaction by John Schiffer et al.



Measured and Calculated Neutron Vacancies

	^{76}Ge		^{76}Se	
Orbital	Exp.	WS	Exp.	WS
$\nu 1p_{1/2}$	-	0.195	-	0.282
$\nu 1p_{3/2}$	-	0.162	-	0.213
$\nu 1p_{1/2} + \nu 1p_{3/2}$	1.13	0.357	1.59	0.495
$\nu 0f_{5/2}$	1.44	0.500	2.17	0.618
$\nu 0g_{9/2}$	3.52	5.43	4.20	7.06

New Calculational Procedure

Procedure:

Experimental neutron occupatios
Proton occupations $\leftrightarrow$ neighboring proton-odd nuclei
$\downarrow$
pnQRPA calculation

$\Downarrow$

Goal:

DBD nuclear matrix element for ^{76}Ge decay:

pnQRPA $\leftrightarrow$ nuclear shell model

Results for the $0\nu\beta\beta$ N.M.E.'s

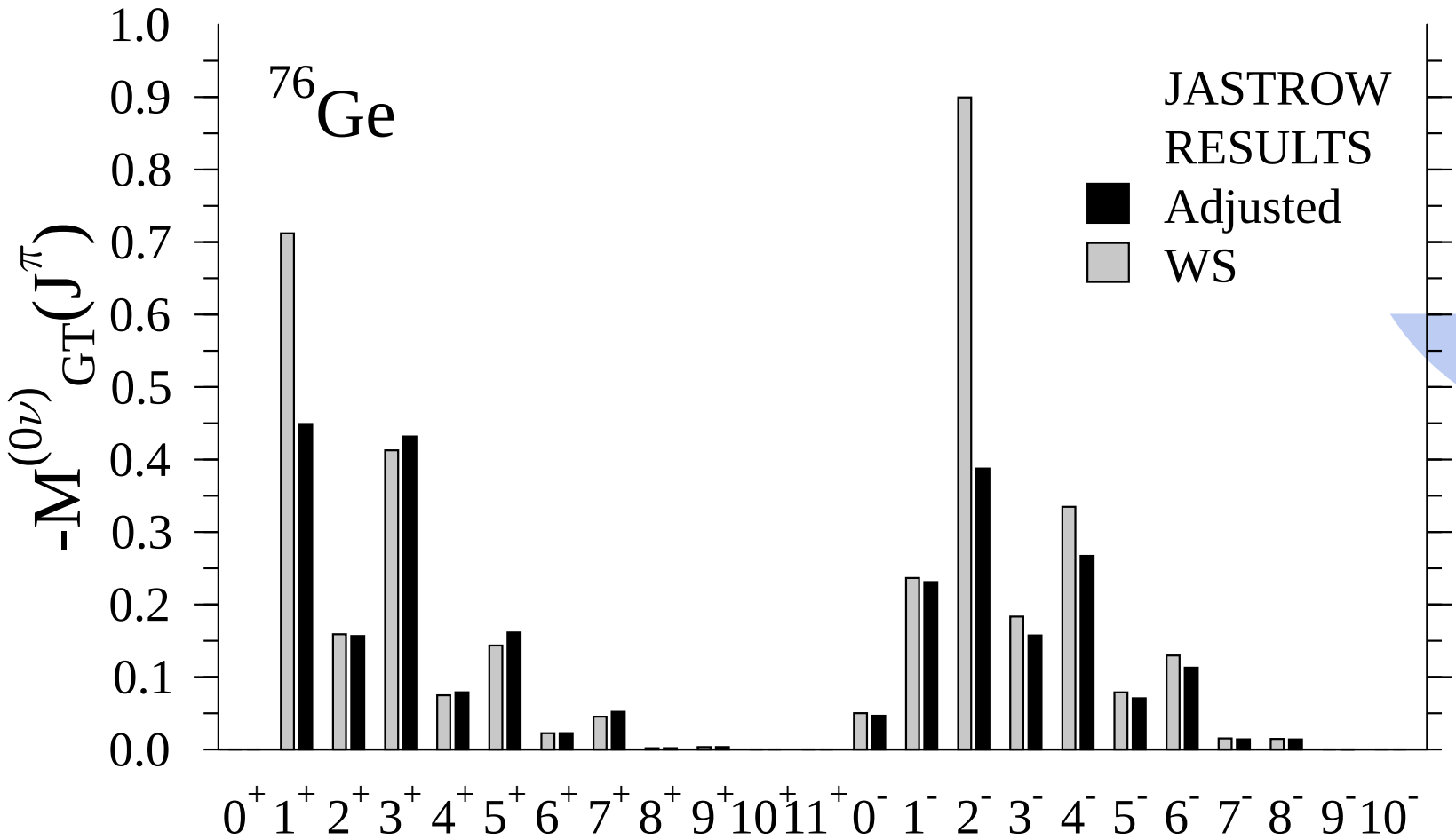
		Jastrow			UCOM		
g_A	g_{pp}	$M_{GT}^{(0\nu)}$	$M_F^{(0\nu)}$	$M^{(0\nu)}$	$M_{GT}^{(0\nu)}$	$M_F^{(0\nu)}$	$M^{(0\nu)}$
1.25	1.12	2.288	−0.772	2.779	3.385	−1.143	4.112

Values of $M^{(0\nu)}$ in some other recent works. J=Jastrow and U=UCOM

g_A	(J)[1]	(U)[1]	(J)[2,3]	(U)[3]	(J)[4]]	(U)[4]
1.25	4.029	5.355	4.68	5.73	2.30	2.81

[1] M. Kortelainen and J. Suhonen, PRC 75 (2007) 051303(R)
[2] V.A. Rodin et al., NPA 793 (2007) 213 (Erratum)
[3] F. Šimkovic et al., arXiv:0710.2055 [nucl-th]
[4] J. Menéndez et al., arXiv:0801.3760 [nucl-th]

Multipole decomposition of the Gamow–Teller $0\nu\beta\beta$ N.M.E. (with Jastrow s.r.c.'s)



The 2_1^- is the Overwhelming 2^- Contribution!

Test of the quality of the 2_1^- wave function:

β^- transition $2^-_{\text{g.s.}}(^{76}\text{As}) \rightarrow 0^+_{\text{g.s.}}(^{76}\text{Se})$

Final state	$0^+_{\text{g.s.}}$	2^+_1	0^+_2	2^+_2	4^+_1
Experiment	9.7	8.1	10.3	8.2	11.1
Present calculation	9.7	7.4	9.0	8.4	10.7
Kortelainen et al.	9.0	7.7	9.2	8.7	10.9

For the one- and two-phonon final states
also the phonon structure is relevant

Conclusions

- Analysis of the results of the (near) future large-scale $\beta\beta$-decay experiments needs the input of **nuclear matrix elements**
- Recent advances in nuclear matrix element calculations encouraging! But: work is still needed to clarify the differences in the results of the SM and the pnQRPA
- The corrected occupation amplitudes seem to drive the pnQRPA calculated $0\nu\beta\beta$ N.M.E. towards that of the shell-model, at least for ^{76}Ge decay
- We need more pair-removal reaction data (proton data for $A = 76$, and proton and neutron data for other $0\nu\beta\beta$ nuclear systems)