Odd Nuclei, "g_A Renormalization"

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Neutrino-Nucleus Differential Cross Section

From J.D. Walecka, *Semileptonic Weak Interactions*

$$\left(\frac{d\sigma}{d\Omega}\right)_{\substack{\nu \\ \bar{\nu}}}^{\mathrm{ERL}} = \frac{G^2\epsilon^2}{2\pi^2}\frac{4\pi}{2J_{\mathrm{i}}+1}\left\{\cos^2\frac{\theta}{2}\left[\sum_{J=0}^{\infty}\left|\langle J_{\mathrm{f}}\,||\,\hat{\mathfrak{M}}_J - \frac{q_0}{|\mathbf{q}|}\hat{\mathfrak{L}}_J\,||\,J_{\mathrm{i}}\rangle\right|^2\right]\right.$$

$$+\left[\frac{q^2}{2\mathbf{q}^2}\cos^2\frac{\theta}{2}+\sin^2\frac{\theta}{2}\right]$$

$$\times\left[\sum_{J\geq 1}^{\infty}\left(|\langle J_{\mathrm{f}}\,||\,\hat{\mathfrak{J}}_J^{\mathrm{mag}}\,||\,J_{\mathrm{i}}\rangle|^2 + |\langle J_{\mathrm{f}}\,||\,\hat{\mathfrak{J}}_J^{\mathrm{el}}\,||\,J_{\mathrm{i}}\rangle|^2\right)\right]$$

$$\mp\sin\frac{\theta}{2}\frac{1}{|\mathbf{q}|}\left(q^2\cos^2\frac{\theta}{2}+\mathbf{q}^2\sin^2\frac{\theta}{2}\right)^{1/2}$$

$$\left.\times\left[\sum_{J\geq 1}^{\infty}2\,\mathrm{Re}\langle J_{\mathrm{f}}\,||\,\hat{\mathfrak{J}}_J^{\mathrm{mag}}\,||\,J_{\mathrm{i}}\rangle\langle J_{\mathrm{f}}\,||\,\hat{\mathfrak{J}}_J^{\mathrm{el}}\,||\,J_{\mathrm{i}}\rangle^*\right]\right\}$$

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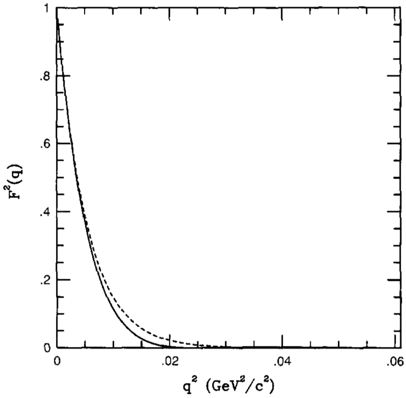
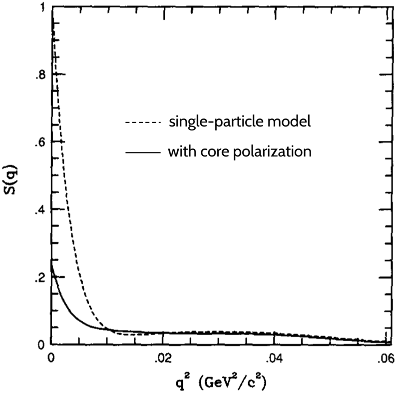
Doesn't contribute when $J_i = J_f = 0$.
But calculable in reasonable nuclear models.
$\mathcal{O}(1/A)$ in elastic scattering.

WIMP-Nucleus Elastic Scattering

$\tilde{B}$ on ^{131}Xe: a similar process



Spin-Independent (Coherent) Form Factor



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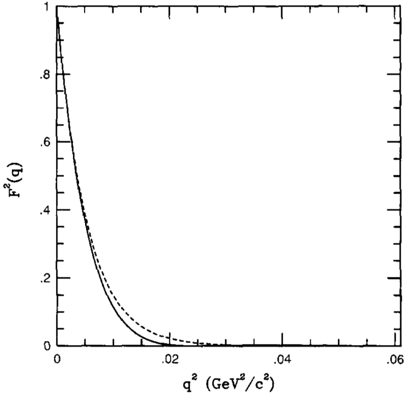

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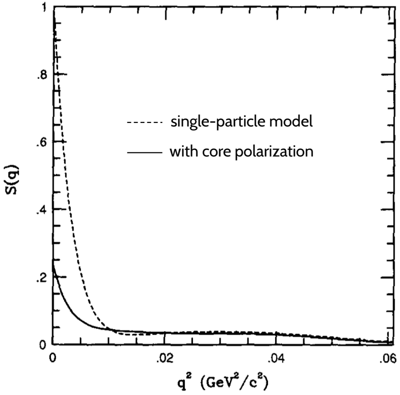


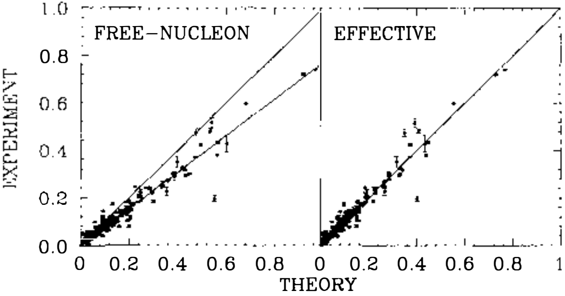
Spin-Dependent Form Factor

Spin-dependent scattering down by $1/A$ but has long tail.

g_A "Renormalization:" Gamow-Teller β Decay

Leading order decay operator is $\vec{\sigma}\tau_+$.

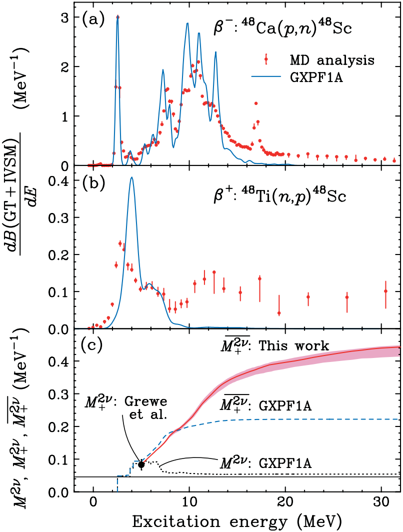
40-Year-Old Problem: Effective g_A needed in all calculations of shell-model type.



Lots of suggestion about the cause but no consensus until quite recently.

Other Tests of $\vec{\sigma}\tau$ Strength Also Show Suppression

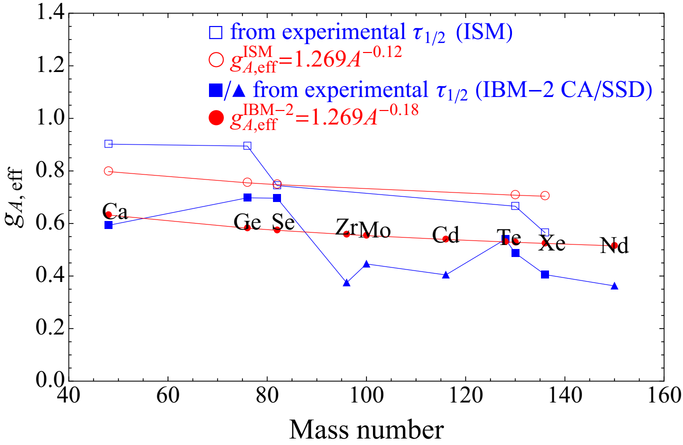
From Yako et al., PRL 103, 012503 (2009)



Only about 2/3 of theoretically expected strength observed.

And $2\nu\beta\beta$ Decay…

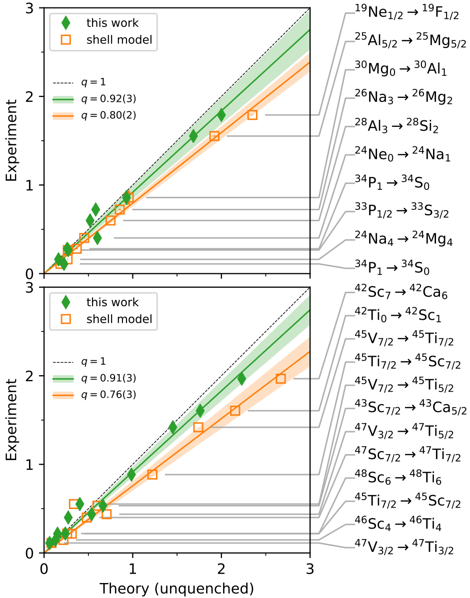
From F. Iachello



If quenching is this severe in 0ν decay, experimentalists will not be happy.

Ab-Initio Calculations in the *sd*-Shell

Explains Most of Quenching



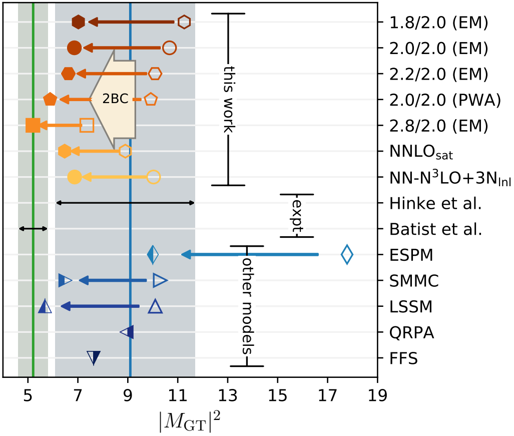
Recent ab-initio work, Holt et al, preliminary

Shell model seems to include some correlations. Quenching comes from additional correlations and "meson-exchange currents" (roughly speaking).

…And in ^{100}Sn

Another Ab-Initio Calculaltion

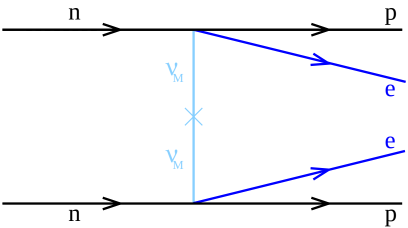
Hagen et al, unpublished



Again, most of the quenching from correlations, meson-exchange currents.

Quenching increases with mass.

Neutrinoless Double-Beta Decay



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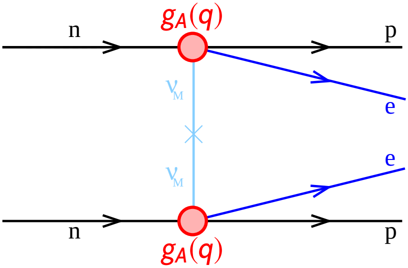

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The End. Thanks.