Constraining theoretical corrections to Gamow-Teller transition rates (Toward Precision Tests of the Standard Model)

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Contents

Motivation

- Lee-Yang model of β decay

$$
\begin{aligned}
\mathscr{H}_{\rm LY} = \quad & +\bar{p}n\left(C_S\,\bar{e}\nu - C_S'\,\bar{e}\gamma_5\nu\right) && \text{scalar}\\
& +\bar{p}\gamma_\mu n\left(C_V\,\bar{e}\gamma^\mu\nu - C_V'\,\bar{e}\gamma^\mu\gamma_5\nu\right) && \text{vector}\\
& +\bar{p}\sigma_{\mu\nu} n\left(C_T\,\bar{e}\sigma^{\mu\nu}\nu - C_T'\,\bar{e}\sigma^{\mu\nu}\gamma_5\nu\right)/2 && \text{tensor}\\
& -\bar{p}\gamma_\mu\gamma_5 n\left(C_A\,\bar{e}\gamma^\mu\gamma_5\nu - C_A'\,\bar{e}\gamma^\mu\nu\right) && \text{axial-vector}\\
& +\bar{p}\gamma_5 n\left(C_P\,\bar{e}\gamma_5\nu - C_P'\,\bar{e}\nu\right) && \text{pseudoscalar}\\
& +\text{H.c.}
\end{aligned}
$$

- Non-relativistic limit

$$
\begin{array}{lcll}
\text{vector + scalar} & \propto & \tau^\pm, & \text{(Fermi)}\\
\text{axial-vector + tensor} & \propto & \sigma\tau^\pm, & \text{(Gamow-Teller)}\\
\text{pseudoscalar} & \propto & \mathscr{O}(|q|/m) &
\end{array}
$$

- Signatures of physics beyond the $V-A$ interaction
  1) Scalar currents lead to violation of CVC in F transitions (**nuclear structure calculations**)
  2) Tensor currents induce mirror asymmetries in GT transitions (**nuclear structure calculations**)
  3) Both also modify the β-spectrum shape (**angular correlation measurements**).

Probing the vector (and scalar) sectors

- Quark flavor mixing

$$V_{\text{CKM}} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

Current data indicate $|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 < 1$ (~95 % C.L.)
New degrees of freedom?

$|V_{ud}|$ (nuclear β decays), $|V_{us}|$ (kaon decays), $|V_{ub}|$ negligible

- Extraction of $|V_{ud}|$

1) Superallowed $0^+ \to 0^+$ nuclear β decay (pure Fermi process)

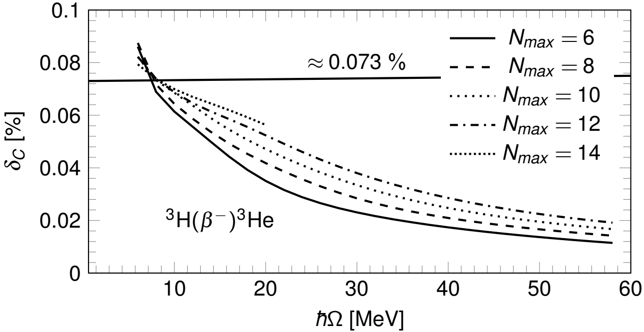
$$\mathscr{F}t = ft(1+\delta'_R)(1-\delta_C+\delta_{NS}) = \frac{K}{2G_F^2|V_{ud}|^2(1+\Delta_R^V)}$$

Experimental input: ft values measured with $\sim 0.1\,\%$ precision for 15 cases. Radiative corrections include the nucleus-independent term Δ_R^V, the outer correction δ'_R (dependent on Z and Q_β), and the structure-dependent correction δ_{NS}. Whereas, δ_C is the isospin-symmetry breaking correction.

2) Complementary data from mirror β transitions (admixture of Fermi and Gamow-Teller)

Towner and Hardy, PRC102, 045501 (2020); Severijns et al., PRC107, 015502 (2023); and Xayavong et al. (2016-present)

- A long-standing challenge in first-principles treatments of δ_C



NCSM w/o 3-body forces!

TBMEs: N3LO-EMN500, SRG evolved with λ =2 fm^{-1}.

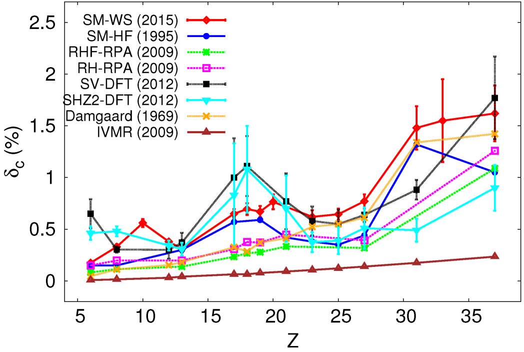
Xayavong et al., PRC113, 034317 (2026)
Miyagi, EPJA59, 150 (2023)
Johnson et al., arXiv:1801.08432

Similar convergence issues also arise in IMSRG calculations.
Stroberg, Particles 4, 521-535 (2021)

The Coulomb interaction induces strong coupling across oscillator shells
Stetcu et al., PRC71, 044325 (2005)

Probing the vector (scalar) sectors

- While computationally tractable, phenomenological approaches yield diverse predictions



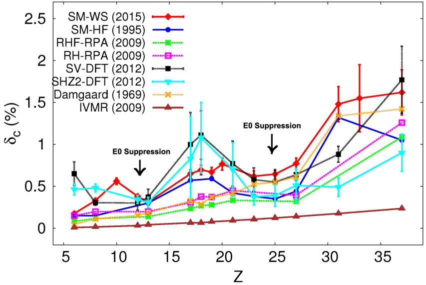
Towner and Hardy, PRC102, 045501 (2020); Ormand and Brown, PRC52, 2455 (1995); Liang et al., PRC79, 064316 (2009); Satula et al., PRC86, 054316 (2012); Damgaard, NPA130, 233 (1969), Auerbach, PRC79, 035502 (2009); Xayavong, Smirnova, Lim et al., PRC112, 055503 (2025); PRC113, 034317 (2026); PRC109, 014317 (2024); PRC105, 044308 (2022); PRC97, 024324 (2018)

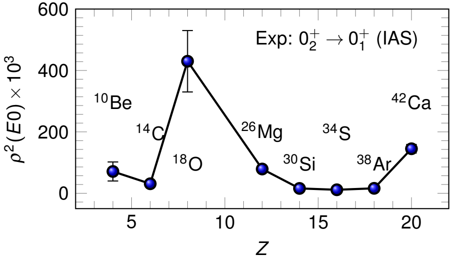
Several constraints have been proposed. For example, low-energy contribution to δ_C can be extracted from isospin-forbidden Fermi transitions.

Further independent constraints are still needed.

Probing the vector (scalar) sectors

- Possible anti-correlation between δ_C and $E0$-transition strengths





- For further insight, we are analyzing $-2\hat{T}^{(1)}(E0) = [F_{\mp}, [\hat{T}(E0), F_{\pm}]]$. The expectation value relation is not immediately transparent, but is highly isospin protected:

$$\begin{aligned} -2\langle a|\hat{T}^{(1)}(E0)|a\rangle \quad &= \sum_{bb'} \langle a|F_{\mp}|b\rangle \langle b|\hat{T}(E0)|b'\rangle \langle b'|F_{\pm}|a\rangle - \sum_{ba'} \langle a|F_{\mp}|b\rangle \langle b|F_{\pm}|a'\rangle \langle a'|\hat{T}(E0)|a\rangle \\ &- \sum_{ca'} \langle a|\hat{T}(E0)|a'\rangle \langle a'|F_{\pm}|c\rangle \langle c|F_{\mp}|a\rangle + \sum_{cc'} \langle a|F_{\pm}|c'\rangle \langle c'|\hat{T}(E0)|c\rangle \langle c|F_{\mp}|a\rangle , \end{aligned}$$

In the two-state mixing limit, we indeed recover $\delta_C \propto 1/\rho^2(E0)$.

A NCSM study of this behavior using natural (transition) orbital basis is in progress

Probing the axial-vector (and tensor) sectors

- Gamow-Teller transitions

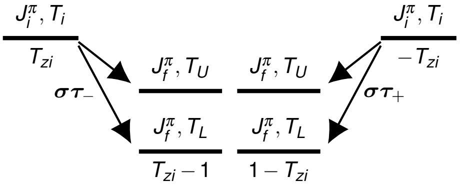
$$(ft)^{x\pm}(1+\delta_R'^{x\pm})(1+\delta_{NS}^{x\pm}-\delta_C^{x\pm}) = \frac{K}{G_F^2|V_{ud}|^2(g_A^{eff})^2|\mathscr{M}^x|^2(1+\Delta_R^A)}$$

where $x = L$ or U. Here, $\mathscr{M}^x$ and q_A^{eff} are isoscalar quantities, and can be eliminated through the following ways:

1) combining the mirror $\beta^\pm$ transitions

$$\Delta_I^x = \left[\frac{(ft)^{x+}}{(ft)^{x-}} - 1\right] - (\delta_C^{x+} - \delta_C^{x-}) \approx 0$$

applicable separately for the L and U branches



2) combining the L and U branches

$$\Delta_{II}^\pm = \left(\frac{\mathscr{M}^U}{\mathscr{M}^L}\right)^2 - \frac{(ft)^{L\pm}}{(ft)^{U\pm}}\left[1-\left(\delta_C^{L\pm}-\delta_C^{U\pm}\right)\right] \approx 0$$

applicable separately for the β^+ and β^- decays

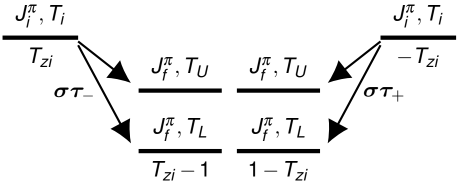
3) combining all the 4 transitions

$$\begin{aligned}\Delta_{III} &= \left[(ft)^{L-}/(ft)^{L+} \times (ft)^{U+}/(ft)^{U-} - 1\right] \\ &\quad + \left(\delta_C^{L+}-\delta_C^{L-}\right) + \left(\delta_C^{U+}-\delta_C^{U-}\right) \approx 0\end{aligned}$$

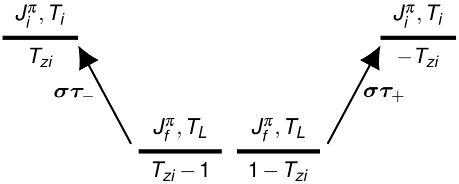
The radiative corrections are mostly isoscalar. The finiteness of Δ_I^x, $\Delta_{II}^\pm$, and Δ_{III} may be attributed to tensor currents

Probing the axial-vector (and tensor) sectors

- **Weak** $\beta^{\pm}$ decays



- **Strong** charge-exchange reactions in reverse directions



In many cases, daughter nuclei are stable or long-life isotopes. Therefore, the mirror asymmetry can also be studied using nuclear reactions. This could be am alternative way to calibrate GT unit cross sections.

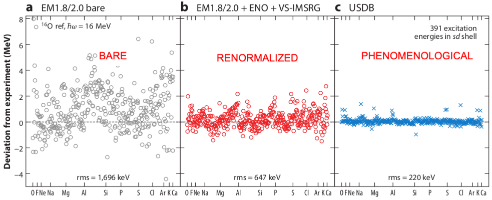
Shell-model calculations

- Solution to $H|\Psi_i\rangle = E_i|\Psi_i\rangle$ using the shell model

1) HO basis
   Orthogonality, integrability, symmetries, ...
2) Valence space
   - $0\hbar\omega$: *p*, *sd*, *pf*, ...
   - $N\hbar\omega$: ZBM, *psd*, ZBM2, *sdpf*, ...
3) Effective interactions

Configuration-interaction method

Inputs		Efficient Code		Outputs
$\Psi_i = \sum_n C_{in}\Phi_n$ $H_{ij} = \langle\Phi_j\|H\|\Phi_i\rangle$	$\Rightarrow$	$\begin{pmatrix} H_{11} & H_{12} & \cdots & H_{1N} \\ H_{21} & H_{22} & \cdots & H_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ H_{N1} & H_{N2} & \cdots & H_{NN} \end{pmatrix}$	$\Rightarrow$	E_i, Ψ_i



Masses	Spaces	Interactions
8-14	*p* shell	CKPOT, CKI, CKII
		PJP, PJT, PMOM
15-24	ZBM	REWIL
25-35	*sd* shell	USD, USDA, USDB

Stroberg, Annu. Rev. Nucl. Part. Sci. 2019. 69:307-62

Shell-model calculations

Conventional INC interaction model

The full Hamiltonian can be decomposed as

$$H = H_0 + V_{INC}, \quad [V_{INC}, T] \neq 0$$

where V_{INC} is parametrized as

$$\begin{aligned} V_{INC} &= \sum_{k=0}^{2} V_{INC}^{(k)} \\ &= \sum_{k=0}^{2} \left[C^{(k)} V_C(\mathbf{r}) + P^{(k)} V_\pi(\mathbf{r}) + R^{(k)} V_\rho(\mathbf{r}) \right] I^{(k)} \end{aligned}$$

with $V_C(\mathbf{r})$ is the Coulomb, and $V_\pi(\mathbf{r})/V_\rho(\mathbf{r})$ are Yukawa pots. Whereas C^k, P^k and R^k are adjustable parameters.

Lam et al., PRC87, 054304 (2013)
Ormand and Brown, NPA440 (1985) 174; NPA491, 1 (1989)

Conventional constraints

Isobaric multiplet mass equation (IMME)

$$M(\alpha, T, T_z) = a(\alpha, T) + b(\alpha, T) T_z + c(\alpha, T) T_z^2$$

where

$$a(\alpha, T) = \frac{\langle \Psi || V_{INC}^{(0)} || \Psi \rangle}{\sqrt{2T+1}} - \frac{T(T+1) \langle \Psi || V_{INC}^{(2)} || \Psi \rangle}{(2T+1)\sqrt{T(T+1)(2T-1)}}$$

$$b(\alpha, T) = \frac{\langle \Psi || V_{INC}^{(1)} || \Psi \rangle}{\sqrt{T(2T+1)(T+1)}}$$

$$c(\alpha, T) = \frac{3 \langle \Psi || V_{INC}^{(2)} || \Psi \rangle}{(2T+1)\sqrt{T(T+1)(2T-1)}}$$

where $b(\alpha, T)$ is important, because the isovector interaction is dominant

Possible issue: off-diagonal elements remain unconstrained!

For this study, we simply adopt the INC interactions from

Ormand and Brown, NPA491, 1 (1989)

Evaluation of the isospin corrections

- With a spherical basis, GT matrix element can be written as

$$M_{GT} = \sum_{k_\alpha k_\beta} \langle k_\alpha || \boldsymbol{\sigma\tau}_\pm || k_\beta \rangle \times \mathrm{OBTD}(k_\alpha k_\beta i f \lambda)$$

where $k \equiv nlj\tau$ (without m), $\lambda = 1$ (the rank of $\sigma\tau_\pm$). The transition densities are defined as

$$\mathrm{OBTD}(k_\alpha k_\beta i f \lambda) = \frac{\langle f || [c^\dagger_{k_\beta} \otimes \tilde{c}_{k_\alpha}]^{(\lambda)} || i \rangle}{\sqrt{2\lambda + 1}}$$

where $\tilde{c}_{j,m} = (-1)^{j-m} c_{j,-m}$. The SPME can be broken into

$$\langle k_\alpha || \boldsymbol{\sigma\tau}_\pm || k_\beta \rangle = \xi_{\alpha\beta} \theta_{\alpha\beta} \Omega_{\alpha\beta}$$

with

$$\begin{aligned}
\xi_{\alpha\beta} &= \langle \tau_\alpha | \tau_\pm | \tau_\beta \rangle , && \text{charge changing} \\
\theta_{\alpha\beta} &= (-1)^{l_\alpha + j_\alpha + \frac{3}{2}} \sqrt{6} \hat{j}_\alpha \hat{j}_\beta \left\{ \begin{array}{ccc} \frac{1}{2} & \frac{1}{2} & 1 \\ j_\beta & j_\alpha & l_\alpha \end{array} \right\} \delta_{l_\alpha l_\beta} , && l \text{ is conserved} \\
\Omega_{\alpha\beta} &= \int_0^\infty R_{k_\alpha}(r) R_{k_\beta}(r) r^2 dr , && \text{radial mismatch}
\end{aligned}$$

This formalism allows one to mimic shell-model transition densities with realistic radial wave functions

Evaluation of the isospin corrections

- WS potential (flexible and realistic choice for shell-model basis)

$$\begin{aligned} U(r) &= -V_0 f(r, a_0, r_0) - \frac{V_0 \lambda \hbar^2}{4\mu^2 c^2} \frac{1}{r} \frac{d}{dr} f(r, a_s, r_s) \langle \boldsymbol{l} \cdot \boldsymbol{\sigma} \rangle \\ &+ V_g \frac{1}{r} \frac{d}{dr} f(r, a_s, r_s) + V_{coul}(r) \end{aligned}$$

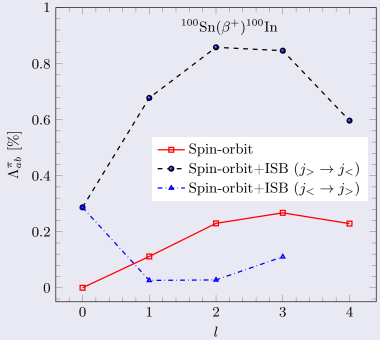
  where V_g and r_0 are constrained with S_p/S_n and $\langle \boldsymbol{r}^2_{ch} \rangle$, respectively

- Problem with HO basis. According to Thomas precession, one has

$$U_{SO}(r) \propto \frac{1}{r} \frac{d}{dr} U_{HO}(r) \langle \boldsymbol{\sigma} \cdot \boldsymbol{l} \rangle = m\omega^2 \langle \boldsymbol{\sigma} \cdot \boldsymbol{l} \rangle$$

  Therefore, WS eigenfunctions corrects for both ISB and SO effects (GT can link spin-up to spin-down and vice-versa).

Role of the spin-orbit potential



HF eigenfunctions are generally more realistic, but they lack flexibility, and hence unsuitable for precision applications

Xayavong and Smirnova, PRC105, 044308 (2002)

Evaluation of the isospin corrections

- From the definition $M_{GT}^2 = \mathscr{M}_{GT}^2(1-\delta_C)$, one can write $\delta_C = \sum_{i=1}^{6} \delta_{Ci}$ where

$$\delta_{C1} = \frac{2}{\mathscr{M}_{GT}} \sum_{k_\alpha k_\beta} \theta_{\alpha\beta}\xi_{\alpha\beta} D(k_\alpha k_\beta if\lambda), \qquad \text{LO}$$

$$\delta_{C2} = \frac{2}{\mathscr{M}_{GT}} \sum_{k_\alpha k_\beta} \theta_{\alpha\beta}\Lambda_{\alpha\beta}\xi_{\alpha\beta}\mathrm{OBTD}_0(k_\alpha k_\beta if\lambda), \qquad \text{LO}$$

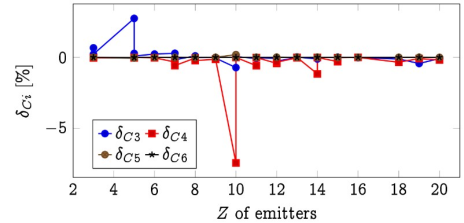
$$\delta_{C3} = -\frac{2}{\mathscr{M}_{GT}} \sum_{k_\alpha k_\beta} \theta_{\alpha\beta}\Lambda_{\alpha\beta}\xi_{\alpha\beta} D(k_\alpha k_\beta if\lambda), \qquad \text{NLO}$$

$$\delta_{C4} = -\frac{1}{4}(\delta_{C1}+\delta_{C2})^2, \qquad \text{NLO}$$

$$\delta_{C5} = -\delta_{C3}\sqrt{|\delta_{C4}|}, \qquad \text{N}^2\text{LO}$$

$$\delta_{C6} = -\frac{1}{4}(\delta_{C3})^2, \qquad \text{N}^3\text{LO}$$

Higher-order contributions



Xayavong and Lim, PRC111, 015501 (2025)
PRC112, 014313 (2025)

Here, we define $D = OBTD_0 - OBTD$ and $\Lambda = 1-\Omega$ as isospin-perturbation parameters. Unlike Fermi, $\mathscr{M}_{GT}$ is not model-independent. Furthermore, δ_C could be constructive. At LO, the isospin-mixing (δ_{C1}) and radial mismatch (δ_{C2}) contributions are decoupled.

Contributions from radial excitations are not included.
Xayavong et al., PRC113, 034317 (2026)

Radial mismatch corrections

- As an essence of the shell-model approach, one can expand OBTDs in terms of intermediate states

$$\mathrm{OBTD}(k_\alpha k_\beta i f \lambda) = \sum_\pi \Theta^{\pi\lambda}_{\alpha\beta if} \langle i || c^\dagger_{k_\beta} || \pi \rangle \langle f || c^\dagger_{k_\alpha} || \pi \rangle \,,$$

where $\Theta^{\pi\lambda}_{\alpha\beta if} = (-1)^{J_f + J_\pi + j_\alpha + \lambda} \left\{ \begin{array}{ccc} J_i & J_f & \lambda \\ j_\beta & j_\alpha & J_\pi \end{array} \right\}$

Subsequently, δ_{C2} and δ_{C3} can be evaluated as

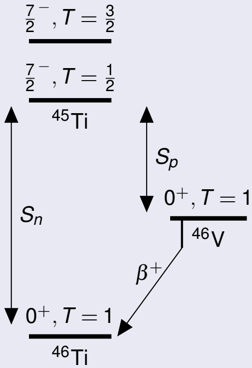
$$\delta_{C2} = \frac{2}{\mathscr{M}_{GT}} \sum_{k_\alpha k_\beta \pi} \theta_{\alpha\beta} \Lambda^\pi_{\alpha\beta} \xi_{\alpha\beta} \Theta^{\pi\lambda}_{\alpha\beta if} \mathscr{A}(f;\pi k_\alpha) \mathscr{A}(i;\pi k_\beta),$$

$$\tilde{\delta}_{C3} = \frac{2}{\mathscr{M}_{GT}} \sum_{k_\alpha k_\beta \pi} \theta_{\alpha\beta} \Lambda^\pi_{\alpha\beta} \xi_{\alpha\beta} \Theta^{\pi\lambda}_{\alpha\beta if} A(f;\pi k_\alpha) A(i;\pi k_\beta)$$

where $\tilde{\delta}_{C3} = \delta_{C3} + \delta_{C2}$. Whereas $A(i;\pi k_\beta)$, $A(f;\pi k_\alpha)$ are spectroscopic amplitudes and $\mathscr{A}(i;\pi k_\beta)$, $\mathscr{A}(f;\pi k_\alpha)$ the respective isospin-symmetry limit.

This expansion indicates that the g_A quenching may be related to the quenching of spectroscopic factors

Schematic rep.



This approach is non-standard, but provides an efficient means of capturing contributions outside the model space through radial mismatch

Towner and Hardy, PRC77, 025501 (2008)

Radial mismatch corrections

- Isospin structure of δ_{C2} when $T_i = T_f$

$$\begin{aligned}\delta_{C2} \quad &= \frac{2}{\mathscr{M}_{GT}} \sum_{k_\alpha k_\beta} \theta^{\lambda}_{\alpha\beta}\xi_{\alpha\beta}\left[\sum_{\pi'}|C_{\pi'}|\Theta^{\pi'\lambda}_{\alpha\beta fi}\Lambda^{\pi'}_{\alpha\beta}\frac{(f|||c^{\dagger}_{k_\alpha}|||\pi')}{\hat{J}_f\hat{T}_f}\frac{(i|||c^{\dagger}_{k_\beta}|||\pi')}{\hat{J}_i\hat{T}_i}\right.\\ &\left. -\sum_{\pi''}|C_{\pi''}|\Theta^{\pi''\lambda}_{\alpha\beta fi}\Lambda^{\pi''}_{\alpha\beta}\frac{(f|||c^{\dagger}_{k_\alpha}|||\pi'')}{\hat{J}_f\hat{T}_f}\frac{(i|||c^{\dagger}_{k_\beta}|||\pi'')}{\hat{J}_i\hat{T}_i}\right],\end{aligned}$$

where C_π is an isospin coefficient, and π' (π'') denotes states with $T_\pi = T_i - \frac{1}{2}$ ($T_\pi = T_i + \frac{1}{2}$).

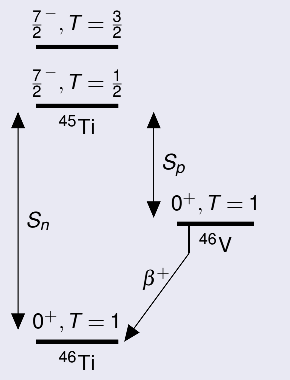
- Isospin structure of δ_{C2} when $T_i \neq T_f$

$$\delta_{C2} = \frac{2}{\mathscr{M}_{GT}} \sum_{k_\alpha k_\beta \tilde{\pi}} C_{\tilde{\pi}}\theta^{\lambda}_{\alpha\beta}\Theta^{\tilde{\pi}\lambda}_{\alpha\beta fi}\Lambda^{\tilde{\pi}}_{\alpha\beta}\xi_{\alpha\beta}\frac{(f|||c^{\dagger}_{k_\alpha}|||\tilde{\pi})}{\hat{J}_f\hat{T}_f}\frac{(i|||c^{\dagger}_{k_\beta}|||\tilde{\pi})}{\hat{J}_i\hat{T}_i},$$

where $\tilde{\pi}$ denotes states with $T_\pi = \min(T_i, T_f) + \frac{1}{2}$.

According to these structures, one expects larger δ_{C2} values for GT transitions with $T_i \neq T_f$, which are typical.

Schematic rep.



Xayavong and Lim, PRC112, 014313 (2025)

Radial mismatch corrections

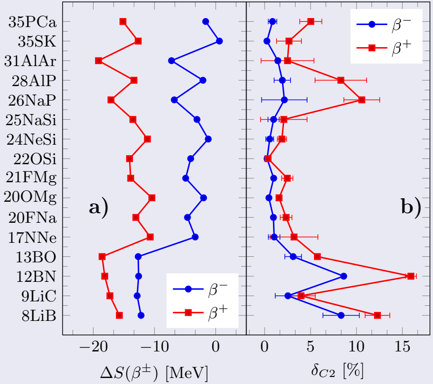
- To maintain correct asymtoptics, WS parameters are adjusted to reproduced S_p and S_n

$$\phi(r) \sim \exp\left(-r\frac{\sqrt{2m|E|}}{\hbar}\right)$$

Subsequently, in addition to the enhancement obtained in weakly bound nuclei ($S_p \approx 0$), δ_{C2} strongly correlates with separation-energy difference. In general, δ_{C2} is stronger in β^+ than in β^- counterpart (because Coulomb effect dominated)

- Charge-radius constraint is also essential, particularly for strongly deformed nuclei. However, charge-radius data are unavailable for most cases.

Another features of δ_{C2}



This property is essential in reproducing experimental data. It completely absent if one uses harmonic oscillator basis!

Xayavong and Lim, PRC112, 014313 (2025)

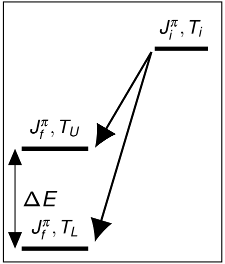
- In the scenario when the isospin mixing occurs on the following way

$$\begin{aligned} |i\rangle &= |J_i^\pi, T_i\rangle\,, \\ |f\rangle &= \sqrt{1-\alpha^2}\,|J_f^\pi, T_L\rangle + \alpha\,|J_f^\pi, T_U\rangle\,, \end{aligned}$$

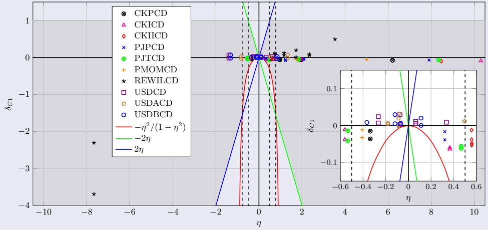
one can easily derive

$$\delta_{C1} = -2\eta\alpha + (1-\eta^2)\alpha^2 + \mathscr{O}(\alpha^3)$$

where $\alpha = \langle J_f^\pi T_L | V_{INC} | J_f^\pi T_U \rangle / \Delta E$ and $\eta^2 = |\mathscr{M}_{GT}^U|^2 / |\mathscr{M}_{GT}^L|^2$.
Note that $\mathscr{M}_{GT}^L$ is generally not isospin forbidden!



Some regions are not allowed



- δ_{C1} contains a LO term in α (hence $\Im\{\alpha\} = 0$!)
- δ_{C1} can be enhanced by η (isospin symmetric qty!)
- These behaviors are in good agreement with shell-model calculations

Xayavong and Lim, PRC111, 015501 (2025)

Isospin-mixing corrections

- Strong dependence on η is clearly observed. The sensitivity to α is relatively weaker. This behavior is consistent with the results of the two-state model
- δ_{C1} is sometime constructive (carrying negative sign)
- Its magnitude spans over a wide range (from 0 to 164 % because of η enhancement)

Xayavong and Lim, PRC111, 015501 (2025)

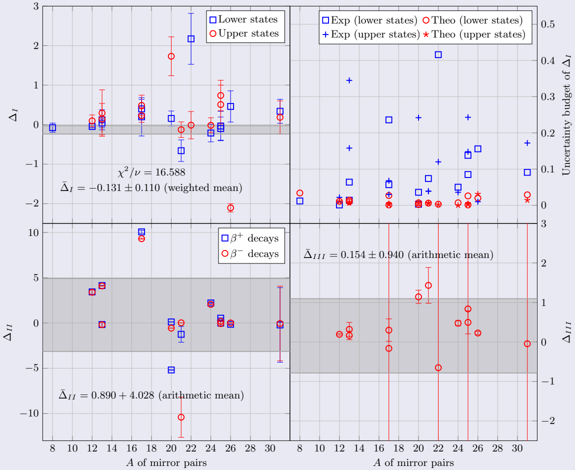
Selected shell-model results for δ_{C1}

Mirror Pair	Interaction	$\mathscr{M}^{L}_{GT}$	$\mathscr{M}^{U}_{GT}$	η	ΔE [MeV]	δ_{C1} [%]	
						β^{+}	β^{-}
8LiB	CKPOT/CD	0.58	3.599	6.205	9.051	-7.597	-10.775
9LiC	CKPOT/CD	0.604	0.586	0.970	4.665	-6.082	-4.785
12BN	CKPOT/CD	0.96	1.893	1.972	13.467	-4.926	-5.602
13BO	CKPOT/CD	1.376	0.462	0.336	8.782	-1.489	-3.589
17NNe	REWIL/CD	0.553	1.952	3.530	1.189	49.436	13.602
20FNa	REWIL/CD	0.882	1.029	1.167	6.242	12.516	6.156
20OMg	REWIL/CD	1.37	1.017	0.742	2.1	11.32	9.079
21FMg	REWIL/CD	0.452	1.058	2.341	4.657	8.775	5.967
22OSi	REWIL/CD	0.245	1.878	7.665	0.673	127.78	164.147
24NeSi	REWIL/CD	0.877	1.513	1.725	1.804	19.496	0.694
25NaSi	USD/CD	0.423	0.142	0.336	1.995	0.937	1.973
26NaP	USD/CD	0.923	0.068	0.074	1.224	2.934	0.332
28AlP	USD/CD	0.81	0.053	0.065	5.592	1.188	0.566
31AlAr	USD/CD	0.894	1.246	1.394	2.252	6.657	-1.66
35SK	USD/CD	0.471	0.125	0.265	2.625	2.414	0.71
35PCa	USD/CD	1.059	0.661	0.624	2.89	2.441	-2.902

- We obtain a remarkable agreement for Δ_I and Δ_{III}. Significant discrepancies persist only in a few cases
- The test based on Δ_{II} is less precise due to the presence of η^2 (isoscalar quantity!).
- In cases where the corrections are small, Δ_{II} may instead serve as an experimental means to extract η^2 (test of isoscalar interaction)
- Experimental uncertainties dominate

Xayavong and Lim, PRC111, 015501 (2025)

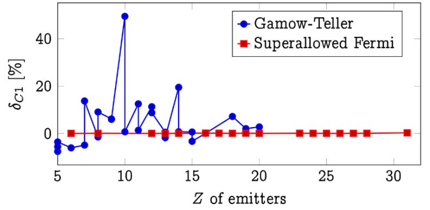
Experimental tests of shell-model calculations



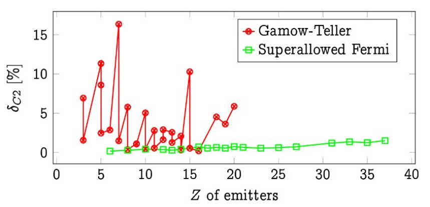
Conclusion

- Comprehensive study of GT mirror asymmetry within the shell-model approach.
- GT matrix elements are very sensitive to isospin-symmetry breaking (ISB) effects.
- This present study supports the reliability of the shell-model predictions employed in superallowd $0^+ \to 0^+$ nuclear β decay, where ISB effects are comparatively less pronounced.
- GT data can serve as constraints for the future development of isospin nonconserving (INC) interactions
- Further investigation using charge-exchange reactions may be possible

GT vs Fermi



GT vs Fermi



Thank You