

$$D \hat{\mathbf{j}} \cdot \frac{\vec{p}_\beta}{E_\beta} \times \frac{\vec{p}_\nu}{E_\beta} \xrightarrow{t \rightarrow -t} -D \hat{\mathbf{j}} \cdot \frac{\vec{p}_\beta}{E_\beta} \times \frac{\vec{p}_\nu}{E_\beta}$$

$$D = \sqrt{\frac{J}{J+1}} y / (1 + y^2) \sin \alpha_V$$

with $y = \frac{|M_F|}{|M_{GT}|}$ Here, $\sin \alpha_V = -i \frac{\langle F | V_{\mathcal{T}} | A \rangle}{\langle F | V_{Coul} | A \rangle}$
 $V_{\mathcal{T}}$ mixing $|F\rangle$ and $|A\rangle$ competes with V_{Coul} not V_{NN} , enhancing α_V by $\sim 10^2$ or 3 ☺

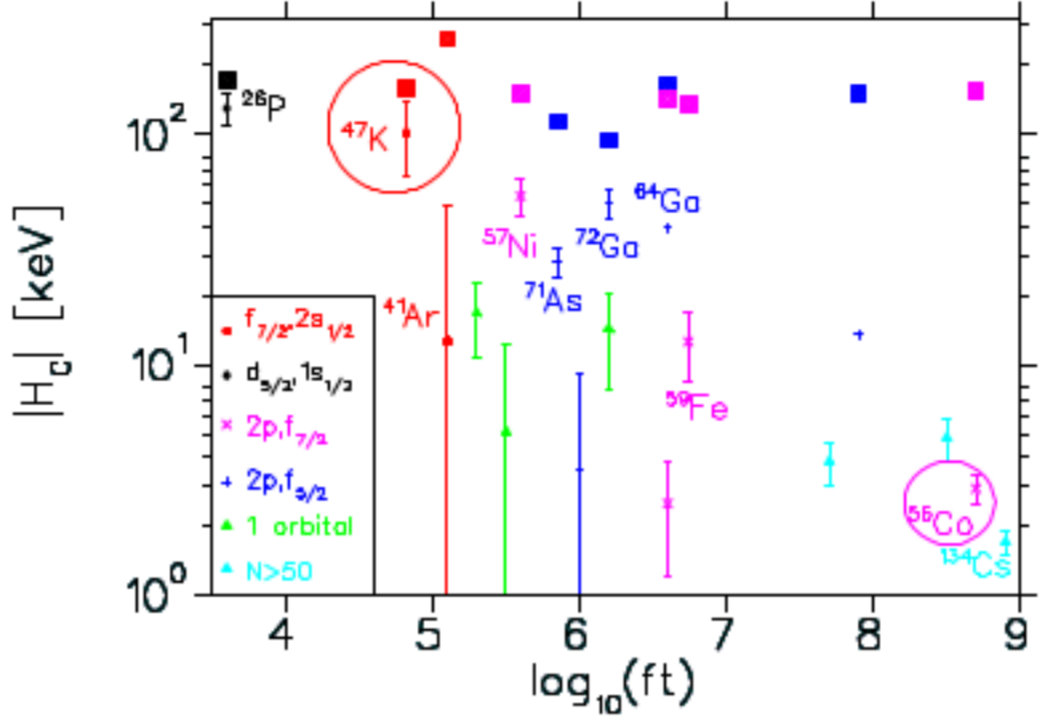
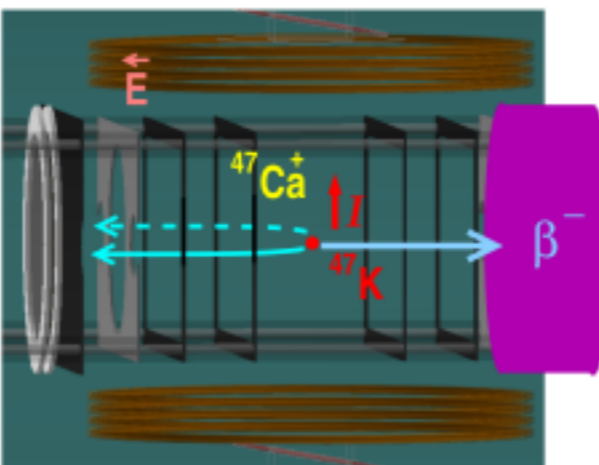
\mathcal{T} decay experiment FAQ's:

- Does interaction between outgoing particles mimic \mathcal{T} ? We hope we can measure $D_{false} \approx -2 \times 10^{-4} E_\beta / E_0$
- Do null EDM's rule you out? Not if we reach $D < 10^{-2}$
- Has it been done better? Our goal is 3x better than Calaprice+Freedman ^{56}Co ,

complementary to NOPTREX n scattering resonances

• Why not let EDM's find \mathcal{T} ? TOPE N-N naturally breaks isospin; π exchange does not contribute Simonius PRL 1997:

unique sensitivity to isovector short-range N-N \mathcal{T} P even



$I=1/2^+$ ^{47}K β^- decay has large:
 • $H_C = \langle \bar{A} | V_{Coul} | A \rangle = 101 \pm 37 \text{ keV}$
 • fraction of $A - \bar{A}$ mixing prediction Auerbach, Loc NPA 1027 122521 (2022)

\mathcal{T} and analog-antianalog isospin mixing in ^{47}K β^- decay

Measuring *isospin* in $^{47}\text{K}^{28}$ decay determines sensitivity to \mathcal{T} parity-even *isospin* N-N interactions via planned $D\vec{I} \cdot \vec{v}_\beta \times \vec{v}_\nu$

B. Kootte et al. Phys Rev C 109 L052501 2024

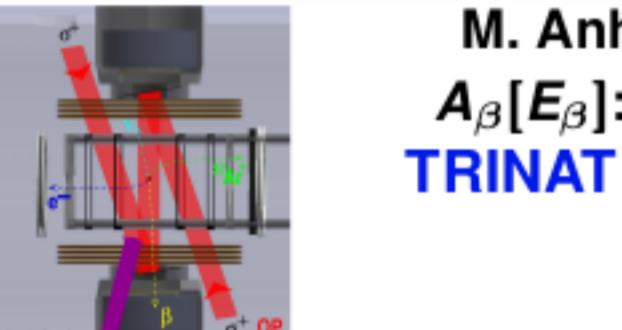
TOPE N-N naturally *isospin*: Complementary to EDM's, NOPTREX

$y = g_V M_F / g_A M_{GT} = 0.098 \pm 0.037$
 $D \propto y \frac{\langle f | TOPE | IAS \rangle}{\langle f | V_{ISB} | IAS \rangle} \rightarrow$ enhanced by ~ 10 to 100 in isospin-suppressed β decay

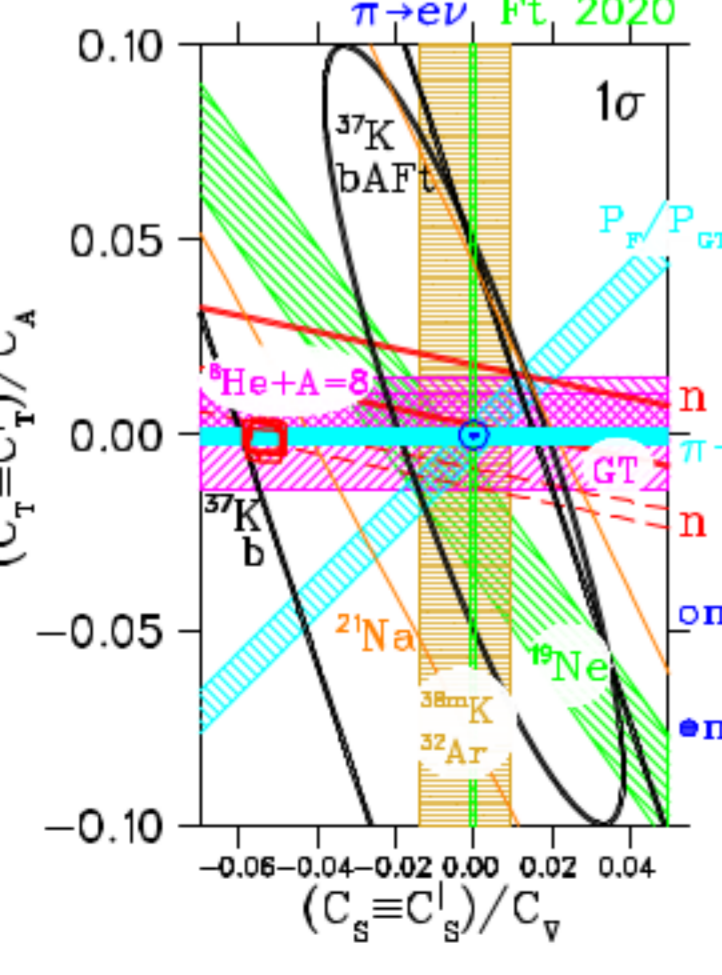
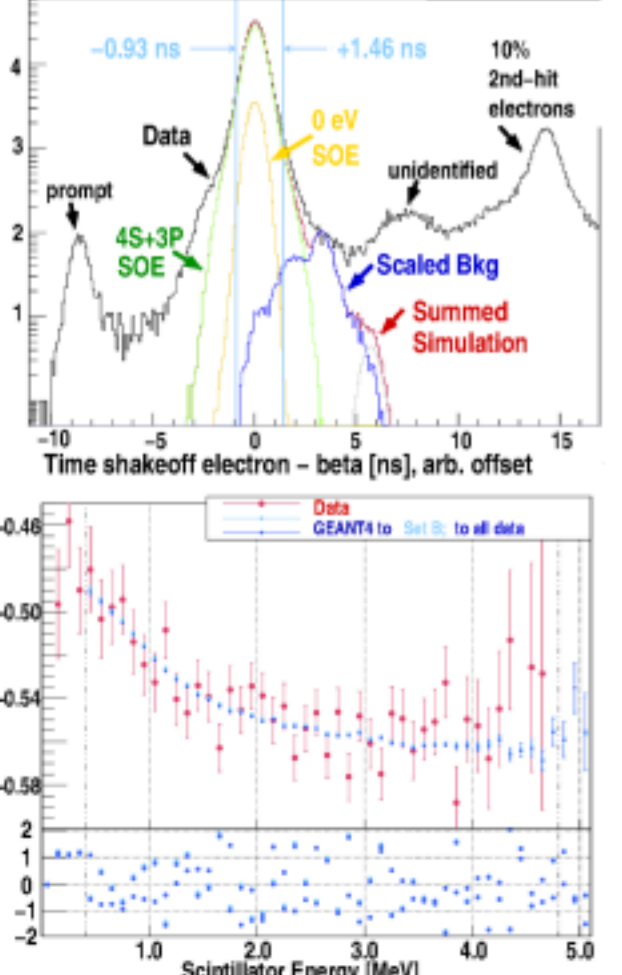
Barroso and Blin-Stoye PL45B 178 (1973)

^{47}Ca 's $1/2^+$ simple structure \rightarrow calculating \mathcal{T} nuclear matrix elements of $\hat{r} \cdot \vec{p}$ practical?

Figure of merit: $\langle f | TOPE | IAS \rangle \propto M_{GT} \Delta E_{IAS-f} D_{exp}$. Although larger M_{GT} than ^{56}Co naively \rightarrow poorer limit on TOPE for given σ_D , simplicity of f might increase $\langle f | TOPE | IAS \rangle$



M. Anholm et al. PRC 113, L012201 (2026)
 $A_\beta[E_\beta]$: New Physics with Opposite Helicity
 TRINAT ^{37}K results consistent with 'smell'



• neutron $a_{\beta\nu}$ aSPECT 2025 3σ disagreement with SM at few ppt.

- 2nd-class CVC-breaking $e/A=-30$ explains, evades: nuclear β decay (8 exps.) PSI $\pi \rightarrow e\nu\gamma$ LHC $p + p \rightarrow e + M_T$
- e/A lepton-nucleon charged interaction induced by QCD has same signature as quark-lepton Lorentz scalar. One model: a 2nd set of quarks with a new quantum number Holstein Treiman 1976 Feynman called this "smell"

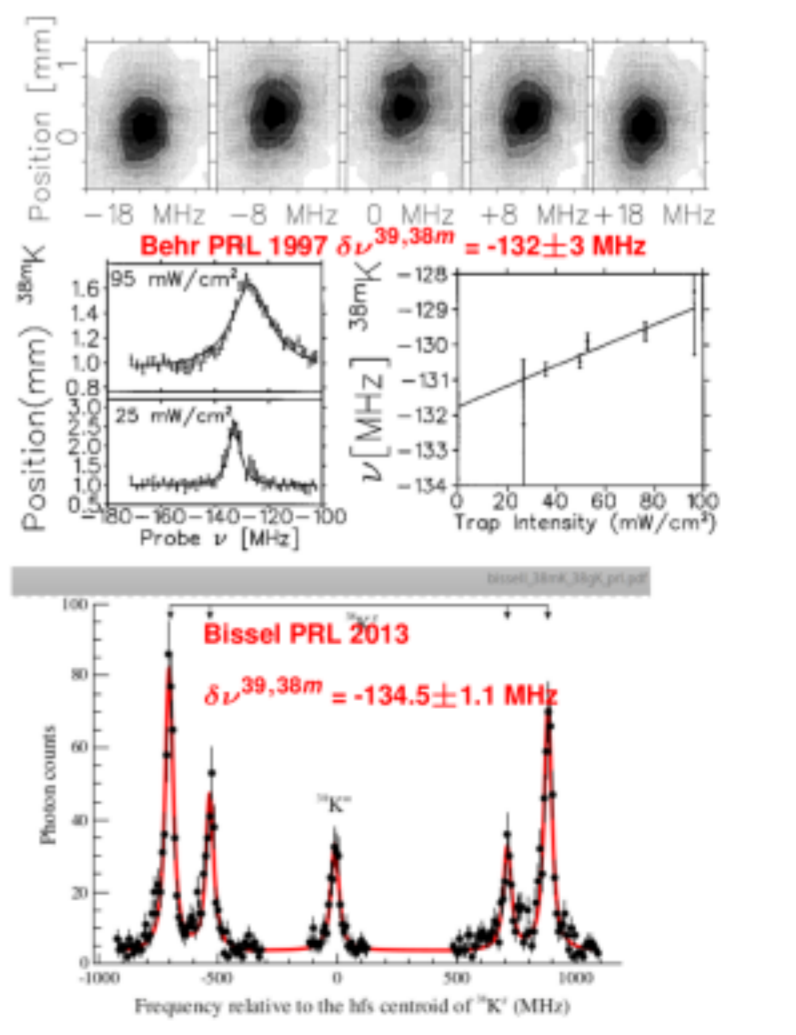


Improved measurement of ^{38m}K $\langle r_{ch}^2 \rangle$ for V_{ud} corrections

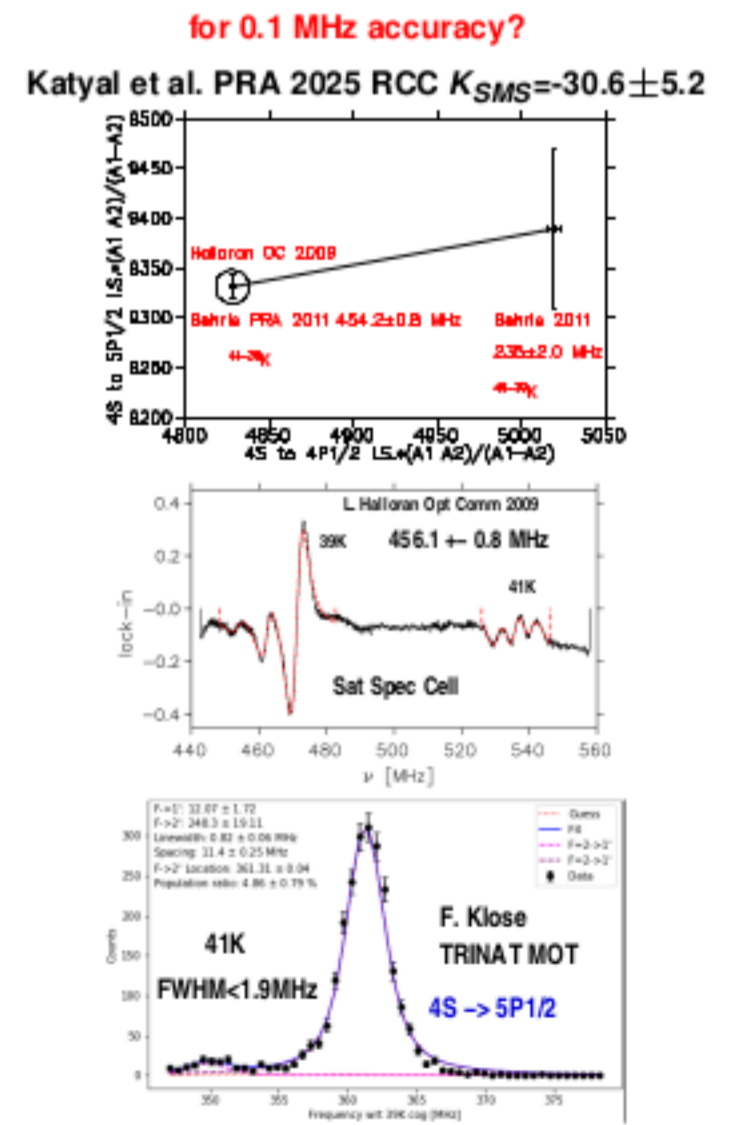
Isospin breaking of β decay ψ_i and ψ_f can be related to triplets of isobaric charge radii Seng, Gorchtein Phys Lett B 2023

Only triplet with $\langle r_{charge}^2 \rangle^{1/2}$ known is $A=38$:
 ^{38}Ca 3.467(1) fm,
 ^{38m}K 3.437(4) fm,
 ^{38}Ar 3.4028(19) fm
 $\Rightarrow \Delta M_B^{(1)} = -0.03(54) \text{ fm}^2$;
 models span 0.42 to 0.04 fm^2
 Needs order of magnitude better $\langle r_{charge}^2 \rangle^{1/2}$!

J.A. Behr, P. Hembling, F. Klose, B. Ohayon, B.K. Sahoo
 $4S \rightarrow 4P_{1/2} \Gamma=6 \text{ MHz}$



$4S_{1/2} \rightarrow 5P_{1/2} \Gamma = 1.1 \text{ MHz}$



ISOLDE did much better