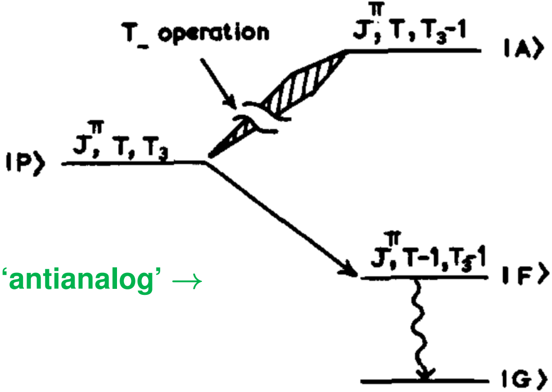
TRV in isospin-hindered β^- decay
Barroso and Blin-Stoyle, PL 45B 178 (1973) observables:



'antianalog' →

$D\ \hat{\mathbf{J}} \cdot \frac{\vec{p_\beta}}{E_\beta} \times \frac{\vec{p_\nu}}{E_\beta}$

$E_1\ (\hat{\mathbf{J}} \cdot \hat{k_\gamma})(\hat{\mathbf{J}} \cdot \hat{p_\beta} \times \hat{k_\gamma})$

D, E_1 are both proportional to

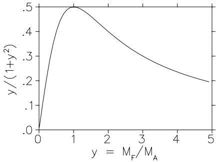
$$K = \frac{Im(G_V G_A^* M_V M_A^*)}{|G_V|^2|M_V|^2 + |G_A|^2|M_A|^2}$$

$$= y/(1+y^2)\sin(\alpha_V - \alpha_A)$$

with $y = \frac{g_V|M_V|}{g_A|M_A|}$

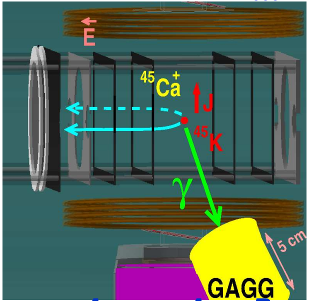
In this system, $\tan\alpha_{\mathrm{V}} = -\mathrm{i}\,\frac{\langle F|V_{TRV}|A\rangle}{\langle F|V_{\mathrm{Coul}}|A\rangle}$

So for *TRV* physics mixing $|F\rangle$ with $|A\rangle$, then V_{TRV} is only competing with V_{Coul}, not V_{strong}, enhancing α_V by $\sim 10^3$ ☺



TRIUMF

$A_{\rm recoil}$ to measure $\langle F|V_{\rm Coul}|A\rangle$ in ^{45,47}K



- $A_{\rm recoil} \propto A_\beta + B_\nu$

$$A_{\rm recoil} \overset{p_{\rm recoil} \gg m_\beta}{\longrightarrow} 5/8(A_\beta + B_\nu)$$

- So $A_{\rm recoil}$ = 0 for pure Gamow-Teller

$$A_{\rm recoil} = 2\sqrt{\frac{J}{J+1}} G_V M_V / G_A M_A$$

linear in M_V/M_A

- Recoil-γ coincidences to select the antianalog

	^{47}K	^{45}K
$t_{1/2}$	18 s	18 m
ISAC Yield UC$_x$	4-7e6/s	2-4e7/s
N atoms (trap 10 s)	40,000	100,000
Decay rate	1000/s	50/s
with ϵ_β=2%	20/s	1/s
$\epsilon_{\rm ion}$=0.5 Ca$^+$	500/s	25/s
e$^-$-Ca$^{+2\cdots}$	40/s	0.2/s
γ-Ca$^+$, ϵ_γ=0.5% photopeak	5/s	0.25/s

$A_{\rm recoil}$ with e$^-$-Ca$^{+2\cdots}$, σ = 0.01	6-12 hr	30-60 shifts
with γ-Ca$^{+1\cdots}$ UCx	6-12 shifts	120-240 shifts
with γ-Ca$^{+1\cdots}$ TiC 1.6e9/s		12 shifts

$A_{\rm recoil}$ Uncertainties*100

Melconian PLB 649 270 (2007)	B_ν	Improvements	Projected
Polarization	0.8	$B_\perp$, $\sigma^\pm$	0.05
Cloud position	1.3	500 μm $\rightarrow$ 20μm	0.05
Cloud size/Temp	0.3	" "	0.03
MCP Position cal	1.0	DLA+ mask	$\leq$ 0.1
E field	0.2	Data at 2 fields	$\leq$ 0.1

Motivation for Analog-antianalog mixing

N. Auerbach, B.M. Loc arXiv:2101.06199v3

Coulomb corrections Fermi β decay

- **A-$\bar{A}$ mixing** (T $>$ 1: only T=2 0^+ for V_{ud} are affected)

$\delta_C[A\bar{A}]$ can be a few %.

They consider nuclei with the excess neutrons occupying orbits in different major shells, with relatively small isospin.

$A\bar{A}$ mixing explains isospin-forbidden particle decays, Γ_A:

A a well-defined single resonance.

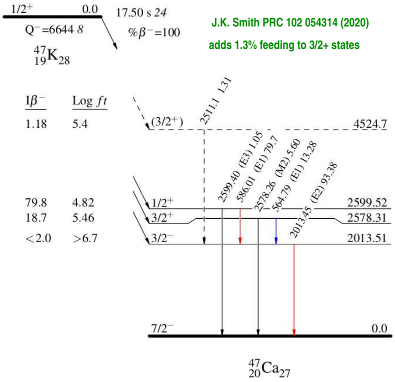
Fragmentation of $\bar{A}$ is usually greater, but...

HO estimate: $\langle \bar{A}|V_C|A\rangle = 0.35\frac{\sqrt{n_1 n_2}}{2T}\frac{Z}{A^{2/3}}$ **MeV**

^{88}Sr	250 keV	Skyrme interactions $\Rightarrow$ 250 to 310
^{71}As	300	28$\pm$ 4 Severijns PRC 71 064310 2005 Fragmented $\bar{A}$
^{56}Co	160	2.9$\pm$0.5 Markey PRC 26 287R 1982 Fragmented $\bar{A}$
^{45}K	200	? $\bar{A}$ fragmented like 71As?
^{47}K	190	$\bar{A}$ might be one state!
A=32	δ_C=0.25%	T=2 A δ_C= 1-2% Melconian PRL 107 182301 2011

J.K. Smith PRC 102 054314 (2020)

adds 1.3% feeding to 3/2+ states



The analog is:

$$|A\rangle = \frac{1}{\sqrt{2T}}\left[\sqrt{n_1}\,\left|j_1^{n_1-1}(n)j_1(p)j_2^{n_2}(n)\right\rangle + \sqrt{n_2}\,\left|j_1^{n_1}(n)j_2^{n_2-1}(n)j_2(p)\right\rangle\right]$$

The anti-analog $|\bar{A}\rangle$ is then:

$$|\bar{A}\rangle = \frac{1}{\sqrt{2T}}\left[\sqrt{n_2}\,\left|j_1^{n_1-1}(n)j_1(p)j_2^{n_2}(n)\right\rangle - \sqrt{n_1}\,\left|j_1^{n_1}(n)j_2^{n_2-1}(n)j_2(p)\right\rangle\right].$$