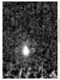
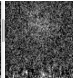
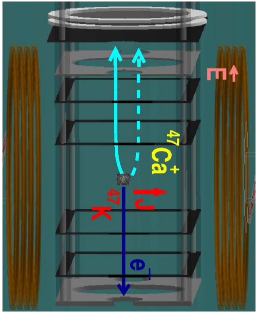
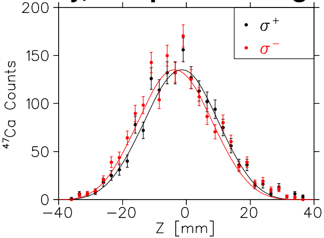
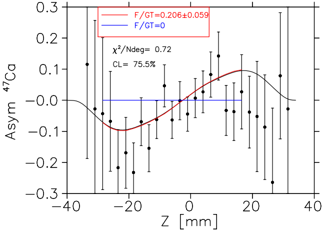
1000 atoms trapped for 1 day, isospin breaking ^{47}K Preliminary without weak mag

DC   MOT then OP







- Nonzero ^{47}Ca asymmetry wrt spin $\Rightarrow$ a nonzero $M_{\rm Fermi}$
  $M_F / M_{GT} =$
  0.21 ± 0.06 stat $\pm$? syst $\Rightarrow$
  $\langle \bar{A} | V_{\rm Coulomb} | A \rangle =$
  160 ± 50 stat $\pm$? syst keV
- $A_{\rm recoil}$ is damped at extreme Z by a $\sim$6% bkg from untrapped ^{47}K, measured by dedicated 'poof' tests
- Apparatus is symmetric:
  X projection flat at 1σ to 0.05;
  Unpolarized data has X, Z projections flat $\sim$ 0.01
- $\beta' s$ fire the eMCP with $\sim$ 20% quantum efficiency– these we measure to be $\sim$ 0.002 correction

weak magnetism $2s_{1/2}$ nucleon

$A_\beta \propto 1 + 0.005 E_\beta / E_0$;

weak magnetism larger and d_I finite for the 20% $1/2^+ \rightarrow 3/2^+$ transition

If $\langle \bar{A}|V_C|A\rangle$ = 160 $\pm$ 50 keV holds in ^{47}Ca, that's a large fraction of $\langle \bar{A}|V_C|A\rangle = 0.35\frac{\sqrt{n_1 n_2}}{2T}\frac{Z}{A^{2/3}}\mathrm{MeV}$ =190 keV Auerbach Loc NPA2022 (unlike ^{56}Co 3 keV Markey, Boehm 1977 and ^{71}At 28 keV Severijns 2005)
$\Rightarrow$ that single 1/2$^+$ final state is the antianalog ☺, so the schematic ψ might be accurate Auerbach Loc NPA2022:

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

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

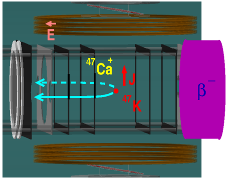
By inspection, the isovector piece of Herzceg 1965 P-even T-odd N-N interaction will flip the 'orthogonalizing' minus sign, enabling large matrix elements Barroso Blin-Stoyle 1973

$$V_{\mathrm{t.v.}} = G_{\mathrm{t.v.}}\tfrac{1}{2}[f(r)\hat{r}\cdot p + \mathrm{h.c.}] \times [1 + a\,\sigma^{(1)}\cdot\sigma^{(2)})(\tau_3^{(1)}+\tau_3^{(2)}) + (b + c\,\sigma^{(1)}\cdot\sigma^{(2)})\tau_3^{(1)}\tau_3^{(2)}]$$

One still needs accurate $\psi(r)$ because $\hat{r}\cdot p$ needs good tails! (Is this why Calaprice, Freedman never extracted microscopic TRV physics *a*,*b*, *c* from ^{56}Co?)

So our ^{47}K goal: measuring isospin-enhanced TRV in a system that can be understood theoretically well enough to extract useful microscopic physics

For future TRV D:



In ^{56}Co, E_1 = -0.01 $\pm$ 0.02,
$\langle \bar{A}|V_C|A\rangle$= 2.9$\pm$ 0.5,
$\langle \bar{A}|V_{TRV}|A\rangle$ = 54 $\pm$ 110 eV,
M_{GT}=0.0034.
$\langle \bar{A}|V_C|A\rangle$ cancels in *D* or *E*: sensitivity scales with 1/M_{GT} (=1/0.3 in ^{47}K).
Measuring *D* to 0.001 in ^{47}K ($\sim$ 3 weeks) leaves us 3x short in sensitivity to $\langle \bar{A}|V_{TRV}|A\rangle$ compared to ^{56}Co, but the simpler TRV N-N matrix elements are likely larger and calculable

^{47}K recoil order estimates still in progress

$^{47}_{19}K^{28}$ μ = 1.9 μ_{nucleon} $\Rightarrow$ thought to be 71% $2s_{1/2}$ Choudhary, Kumar, Srivasta, Suzuki PRC 103 064325 (2021)

Assuming $1/2^+ \rightarrow 1/2^+$ transition is $2s_{1/2} \rightarrow 2s_{1/2}$ (no orbital *l* contributions):

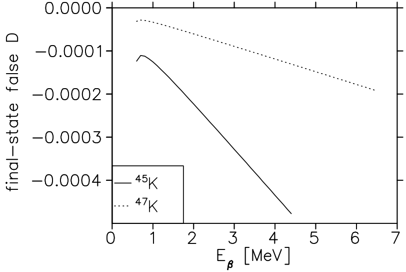
- Weak magnetism $b_W \sim$ the nucleon value
- 1st-class induced tensor $d_I \sim 0$

For our M_F/M_{GT} measurement,

A_β changed by ≤ 0.01

Recoil-order effects small at present level of accuracy $\rightarrow$ statistics-limited measurement

Future *D* final-state effects Holstein PRC 5 1529 (1972) small at this accuracy:



Note: ^{56}Co final-state E_1=0.0002 Calaprice 1977