



The Neutron
Decay Problems
and New Physics

Zurab Berezhiani

Summary

Introduction

The neutron
lifetime enigma

Cabibbo Angle
anomaly ?

Neutron lifetime
anomaly in details

Parallel Mirror
Sector

Lifetime
anomalies and
 $n - n'$

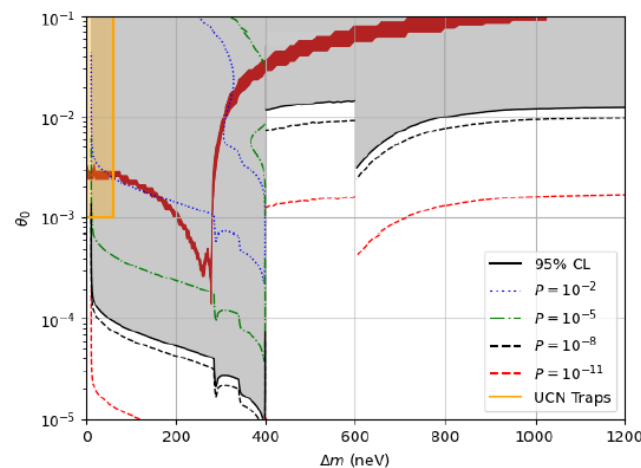
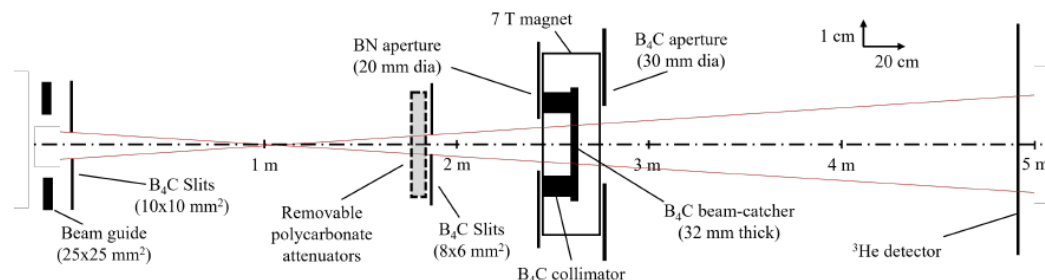
Summary

ORNL experiment

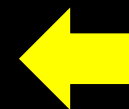
Broussard et al. arXiv:2111.05543

Testing this scenario via $n \rightarrow n' \rightarrow n$ in strong magn. fields

Difference of neutron counts between $B = 0$ and $B = 5$ T



For $\Delta m \gg 1 \mu\text{eV}$ initial state in the beam is not n but the light eigenstate $n_1 = cn - sn'$ (heavier n_2 cannot be bounced by the walls of guide)



From $H = \begin{pmatrix} m_n & \epsilon \\ \epsilon & m_{n'} \end{pmatrix}$ follow two levels of energy: $E_{1,2} = \frac{m_n + m_{n'}}{2} \pm \sqrt{\left(\frac{m_n - m_{n'}}{2}\right)^2 + \epsilon^2}$

For large $\Delta m \gg \epsilon$ $E_{1,2} = \bar{m} \pm \frac{|\Delta m|}{2}$ Berezhiani is talking about $\Delta m \cong 1\mu eV = 1000 neV = 10^{-6} eV$

He compare this with Fermi potential of the neutron guide (say, pure Ni $V_F(Ni) = 252 neV$)

In the guide the transversal velocity of the neutron $T_n = T_{\parallel} + T_{\perp}$ is reflected if it is less than V_F

$$T_{\perp} < V_F \quad \text{or} \quad v_{\perp} < \sqrt{\frac{2V_f}{m_{\pm}}} = 6.95 \frac{\text{m}}{\text{s}} \text{ for Ni}$$

$$\text{In reflection } \theta_{max} < \frac{v_{\perp}}{v_{tot}} = \frac{6.95}{1000} \cong 0.4^{\circ}$$

typical n-velocity
in cold beam



$$\text{For } \Delta m = 10^{-6} eV \quad v_{\perp}(m_{\pm}) = v_{\perp}(m) \cdot \left(1 \pm \frac{\Delta m}{2m}\right) = v_{\perp}(m) \cdot (1 \pm 5 \times 10^{-16})$$

So, both eigenstates n_1 and n_2 will be successfully reflected, unlike stated by Berezhiani