Mossbauer Neutrinos

Stephen Parke
Fermilab

What are Mossbauer Neutrinos??

What are they good for??

Mossbauer Neutrinos:

Mossbauer effect with Neutrinos in the $^3H -^3 He$ system:

Source: $^3H \rightarrow (^3He + e_B^-) + \bar{\nu}_e$ (recoilless emission)

Detector: $\bar{\nu}_e + (^3He + e_B^-) \rightarrow^3 H$ (resonant re-absorbtion)

$(\cdots)$ means bound in some metallic lattice

count via decay
or
mass spectro.

$Q = 18.6$ keV and $\Gamma_{^3H} = 1.2 \times 10^{-24}$ eV

Various line broadening effects which significantly increase Γ_{eff}

Serious technical difficulties exist but it is not impossible (Raghaven, Potzel)

For $\Gamma_{eff} \sim 10^{-11}$ eV $(\Delta E/E \sim 10^{-15})$

then $\sigma \sim 10^{-33} cm^2$!!!

Do Mossbauer Neutrinos Oscillate? YES

HUGE !!!

(Akhmedov, Kopp, Lindner 0802.2513, 0803.1424)

Phenomenology of Mossbauer Neutrinos ($\equiv \bar{\nu}_e$ Disappearance):

- **First Atm. Osc. Minima occurs at ~ 10 m (desktop!)**

Measure $|U_{e3}|^2 \equiv \sin^2\theta_{13}$ and $|\delta m^2_{31}|$

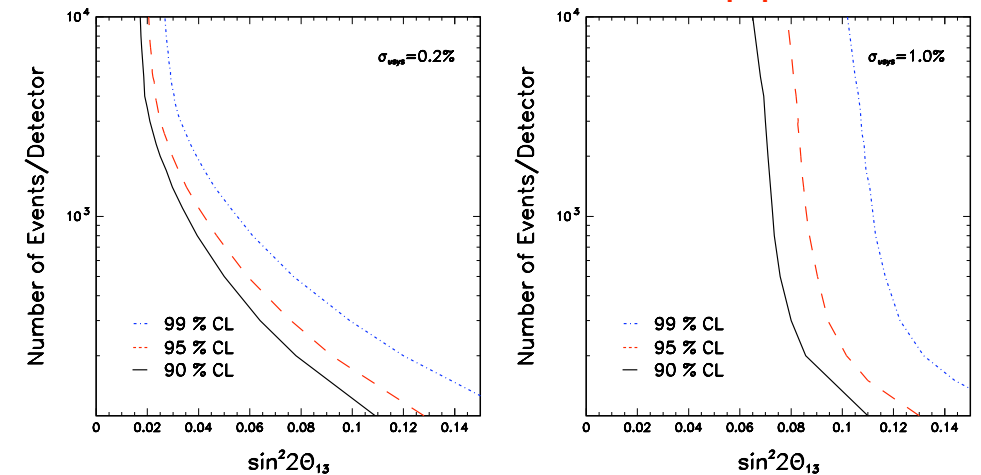Event Rate $= 3 \times 10^5 \left(\frac{S}{1MCi}\right) \left(\frac{M_T}{100g}\right) \left(\frac{L}{10m}\right)^{-2} day^{-1}$
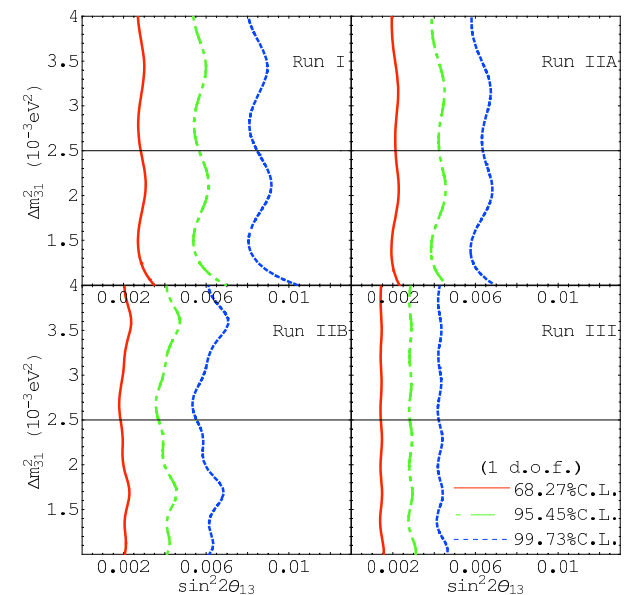
- First Solar Osc. Minima occurs at ~ 300 m (fits on CERN site)

Measure $|U_{e2}|^2 \approx \sin^2\theta_{12}$ and $|\delta m^2_{21}|$

- - Phase Advancement or Retardation of Atm. Osc.
  $\Rightarrow$ Mass Hierarchy ! !

- NO INFORMATION on $|U_{\mu3}|^2 \approx \sin^2\theta_{23}$ OR the Dirac CP phase δ
  (either via CPV or CPC)

- Can observe effects of Sterile Neutrinos, Non-Standard Interactions etc