Problem 9

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Question:

An experiment with a detector only 15 m away from a reactor reports a 6% deficit of the ν_e flux @ 3 MeV.

Does this result have any implications for an accelerator experiment with a near/far detector?

We ascribe the deficit to the oscillation of the $\overline{\nu}_e$ in sterile neutrinos

The oscillation probability can be written as (2 neutrinos hypothesis):

$$P(\overline{\nu}_e \rightarrow \nu_s) = \sin^2(2\theta)\sin^2(1.267\frac{\Delta m^2 L}{E}\left[\frac{MeV}{eV^2 m}\right])$$

$$= \sin^2(2\theta)\sin^2(1.267\frac{\Delta m^2 15}{3}\left[\frac{MeV}{eV^2 m}\right]) \quad = 0.06$$

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So we can plot a region for the allowed values of Δm^2 and $\sin^2(2\theta)$.

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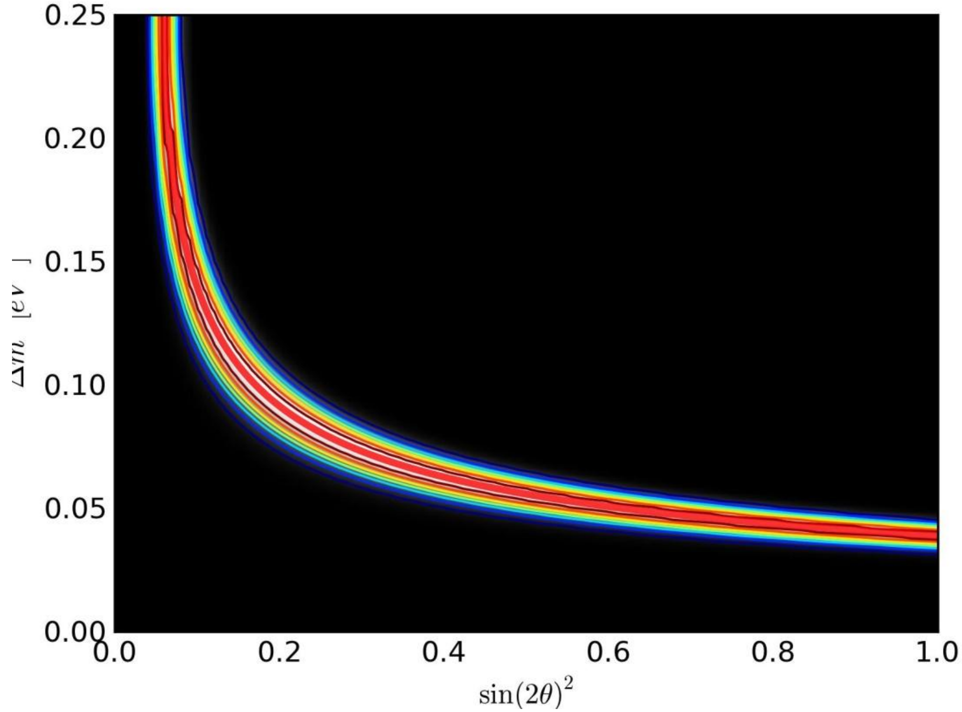
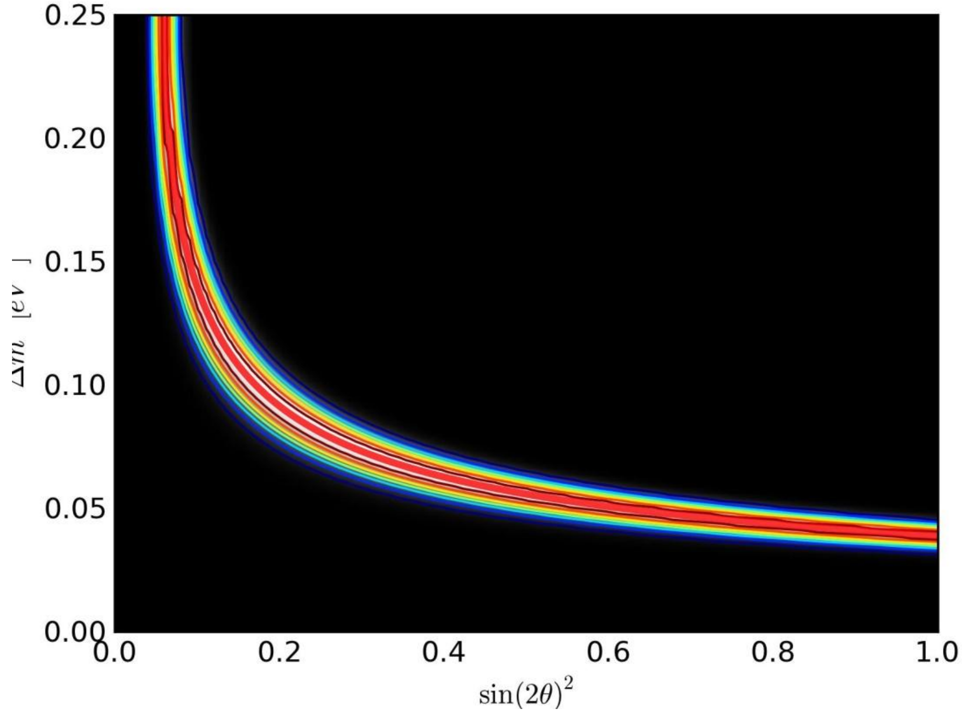


Smearing assuming:
ΔL = 0.6 m
ΔE/E = 10%

$$P(\bar{\nu}_\mu \rightarrow \nu_s) = \sin^2(2\theta)\sin^2(1.267\frac{\Delta m^2 L}{E}\left[\frac{MeV}{eV^2 m}\right]) = 0.06$$



How does this result affect an accelerator experiment?

In the problem we have an accelerator with:

$E(\nu_\mu)$ = 0.6 GeV.
L (near detector) = 3 km
L (far detector) = 1000 km

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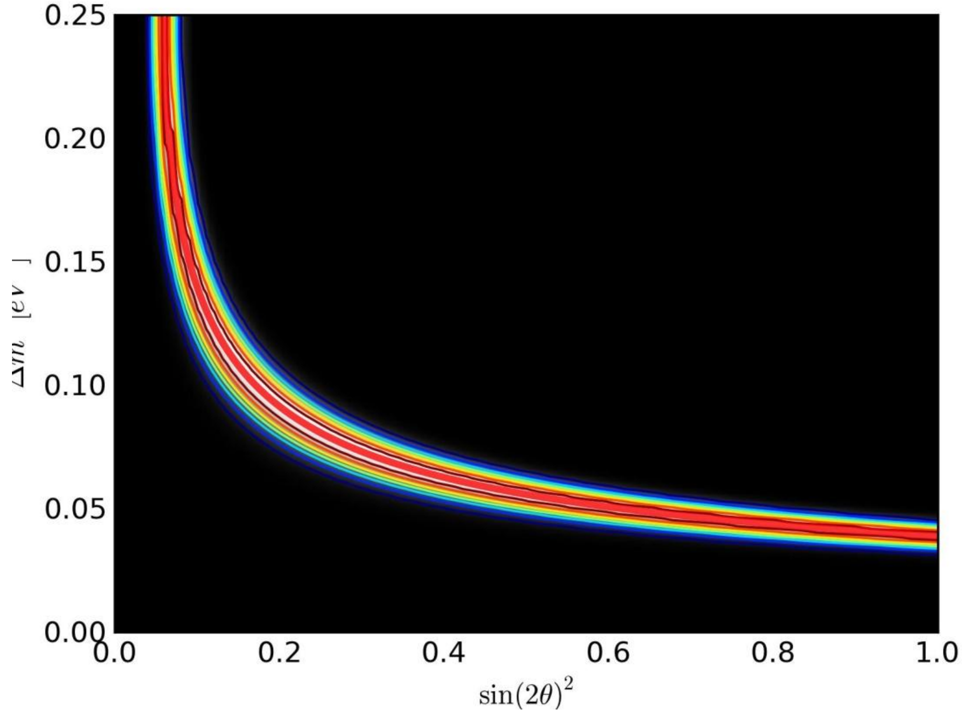

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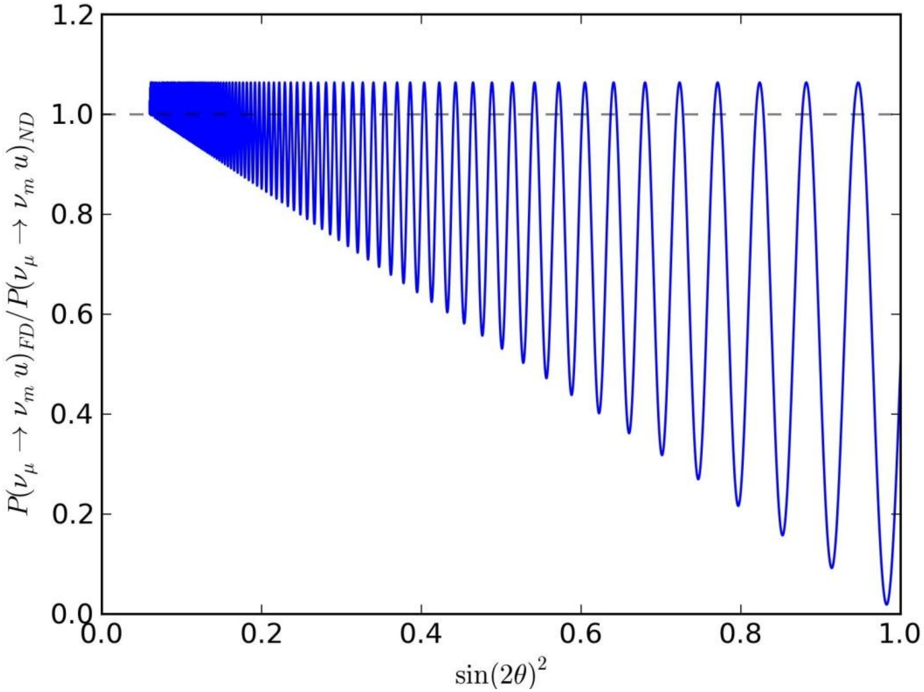
We have to understand what happens when the ν oscillates before/after the near detector.
For each point in the previous graph we calculate the number of ν_μ in the far detector, in the near detector and we plot the ratio.

$$P(\overline{\nu}_{\mu} \rightarrow \nu_{s}) = \sin^{2}(2\theta)\sin^{2}(1.267\frac{\Delta m^{2} L}{E}\left[\frac{MeV}{eV^{2}m}\right]) = 0.06$$



How does this result affect an accelerator experiment?

$$R = \frac{P(\nu_{\mu} \rightarrow \nu_{s})_{FAR}}{P(\nu_{\mu} \rightarrow \nu_{s})_{NEAR}} = \frac{\sin^{2}(2\theta)\sin^{2}(\frac{\Delta m^{2}\ 1000\ km}{0.6\ Gev})}{\sin^{2}(2\theta)\sin^{2}(\frac{\Delta m^{2}\ 3\ km}{0.6\ Gev})}$$