Abstract

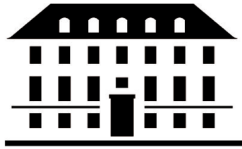
Most of the standard neutrino properties have been determined, and the remaining will be in the coming years. There is a rich sector of new neutrino physics that is as of yet largely unexplored. A relatively unknown solution to the oscillation data including new physics fits the data just as well as the conventional picture and needs to be measure/constrained with both oscillation and scattering data.

The Standard Neutrino Oscillation Parameters and a Surprising Alternative Solution

Peter B. Denton

NBIA N-Talk

September 30, 2016



The Niels Bohr International Academy

VILLUM FONDEN

Takaaki Kajita
Super K

Arthur McDonald
SNO

"for the discovery of neutrino oscillations*,
which shows that neutrinos have mass"

Oscillation Parameters

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$$\delta_{CP} = ??? \quad \Rightarrow \quad \text{sets the amount of } CP \text{ violation}$$

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Long baseline

Matter Effects

Oscillation probabilities are different in matter.

L. Wolfenstein, PRD 17 (1978)

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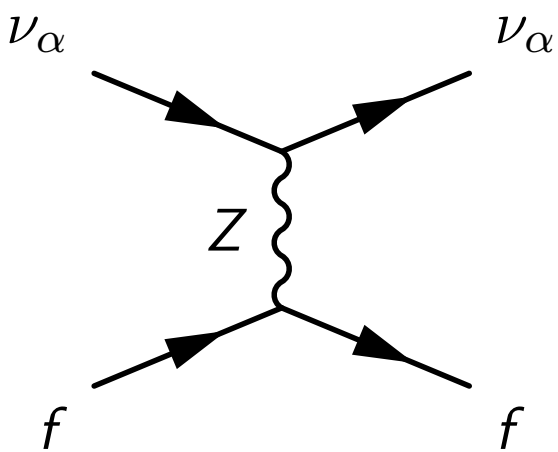

Same for all neutrino flavors

$f = e, u, d$

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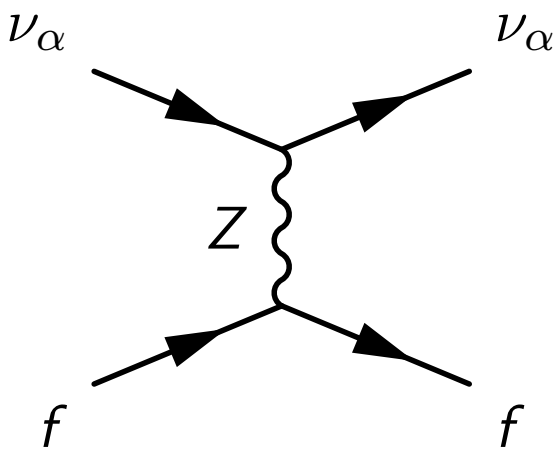

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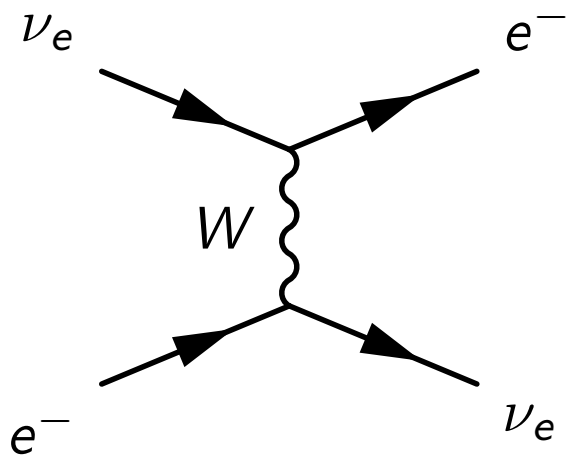

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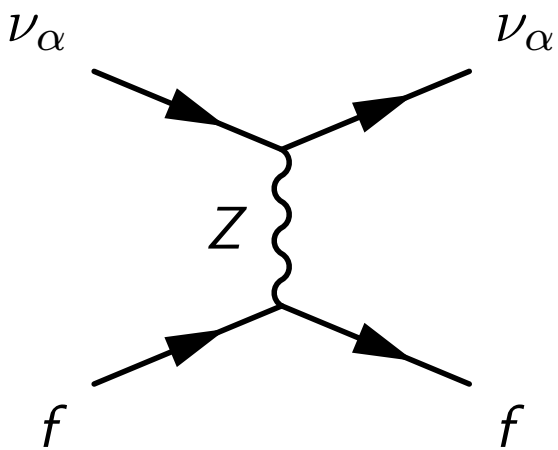

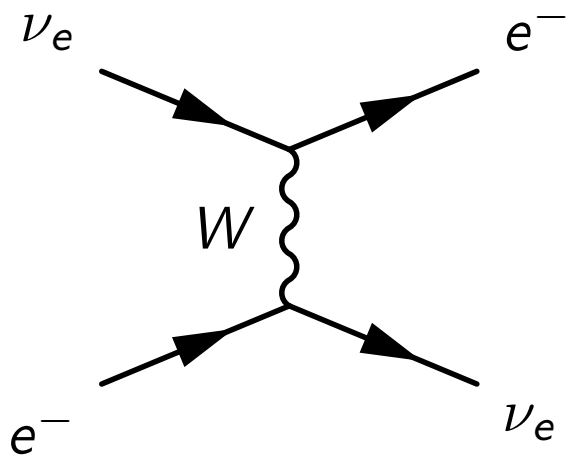

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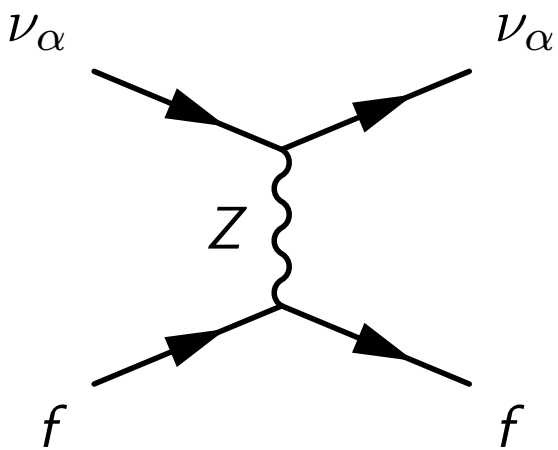

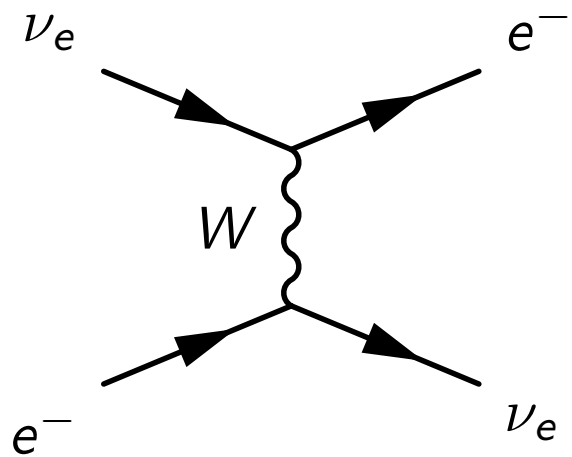

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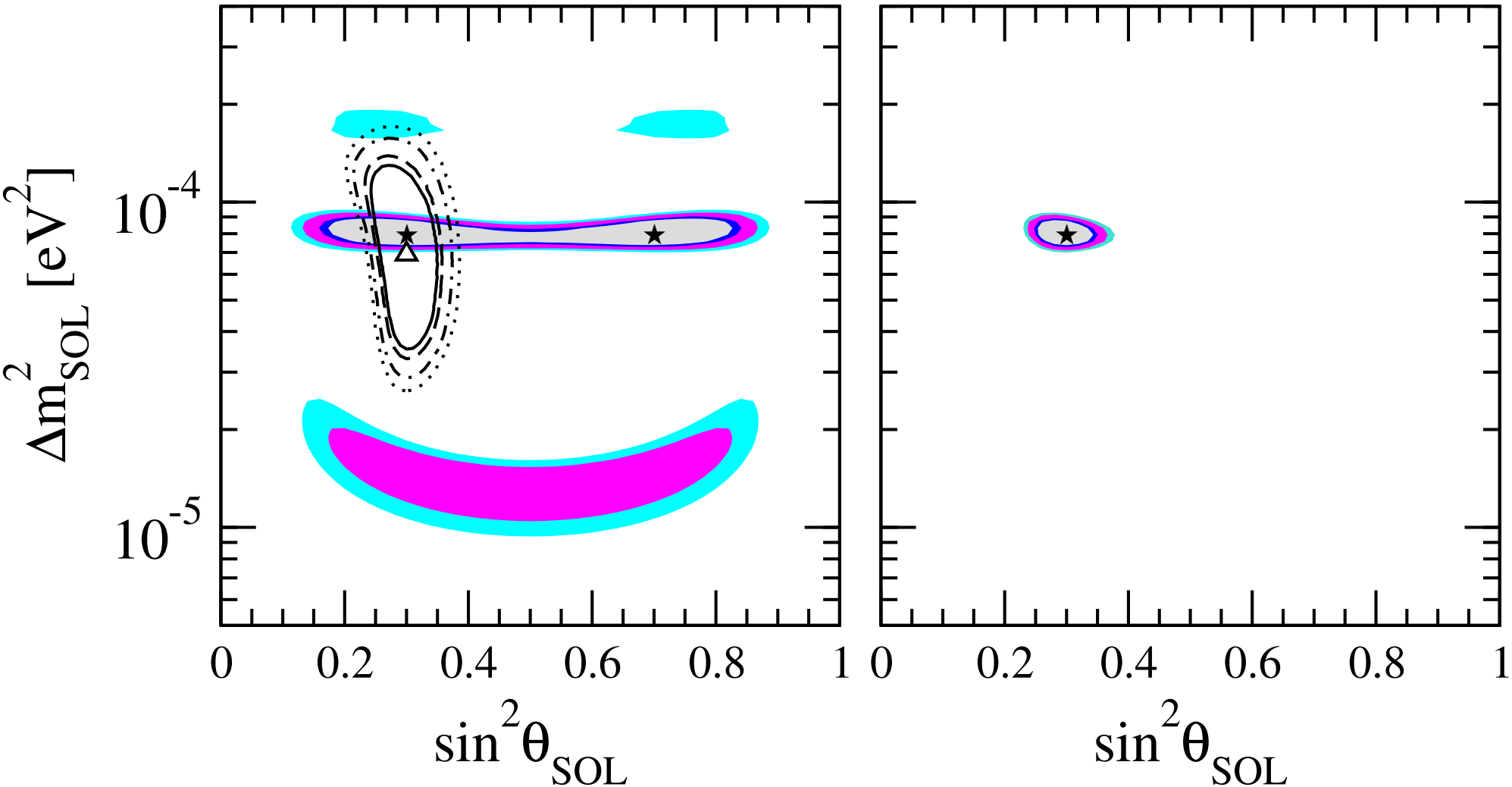
Was used to resolve the solar neutrino problem (MSW effect).

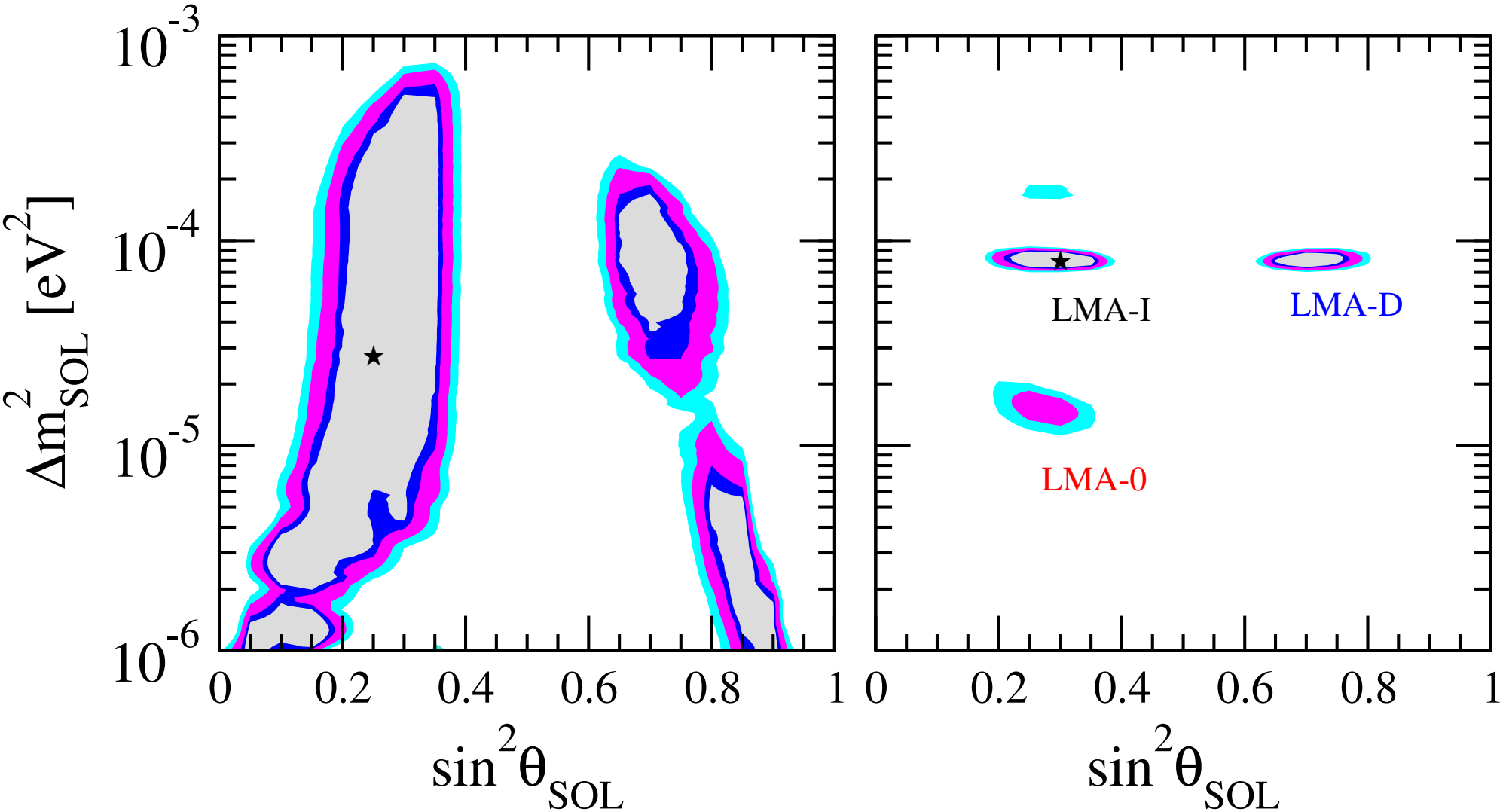
S. Mikheyev, A. Smirnov, Sov. J. Nucl. Phys. 42 (1985)

Best Fit Assuming Standard Neutrino Physics



90%, 95%, 99% and 99.73% C.L O. Miranda, M. Tórtola, J. Valle, hep-ph/0406280

Allowing For New Neutrino Interactions



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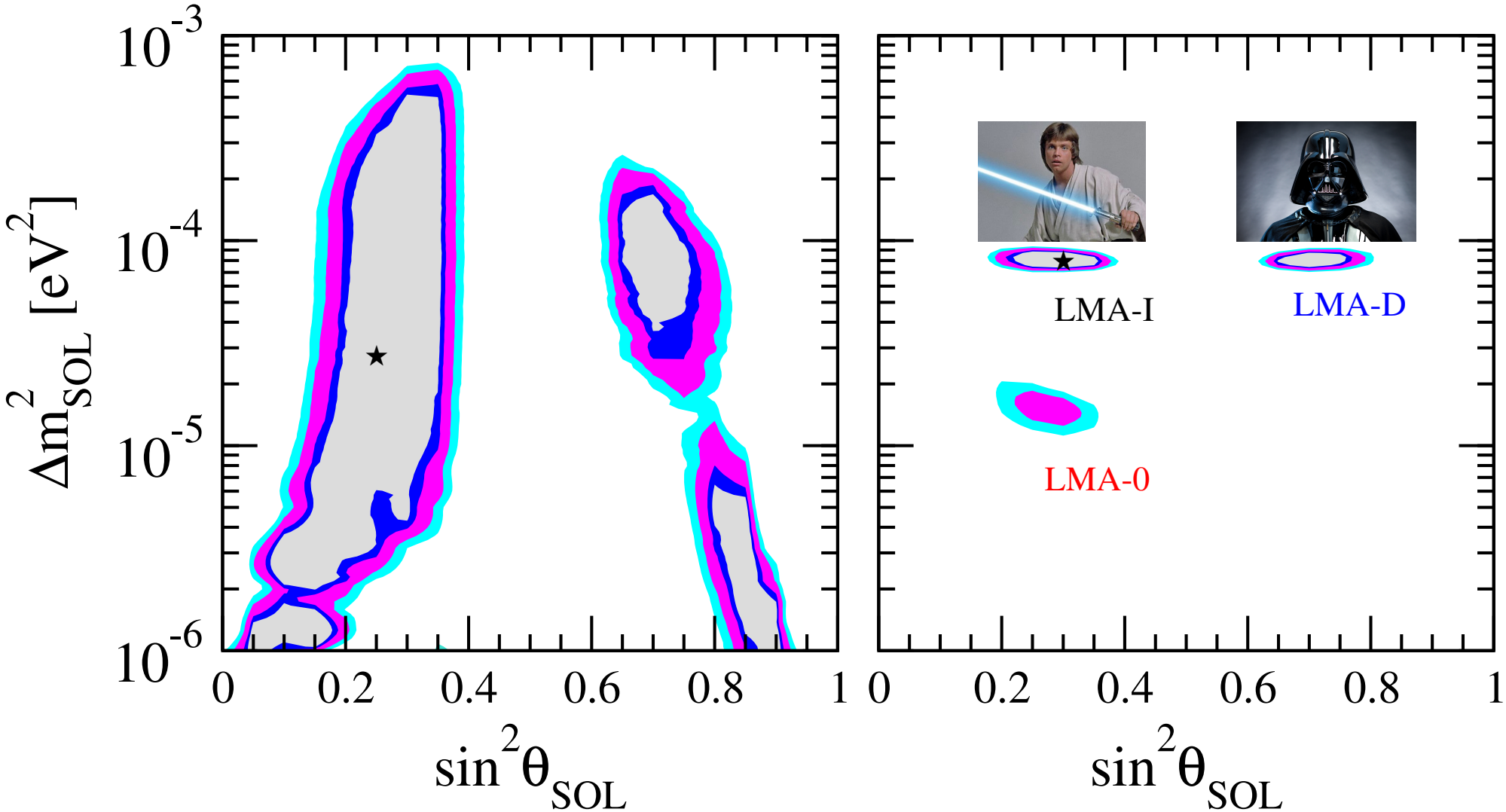

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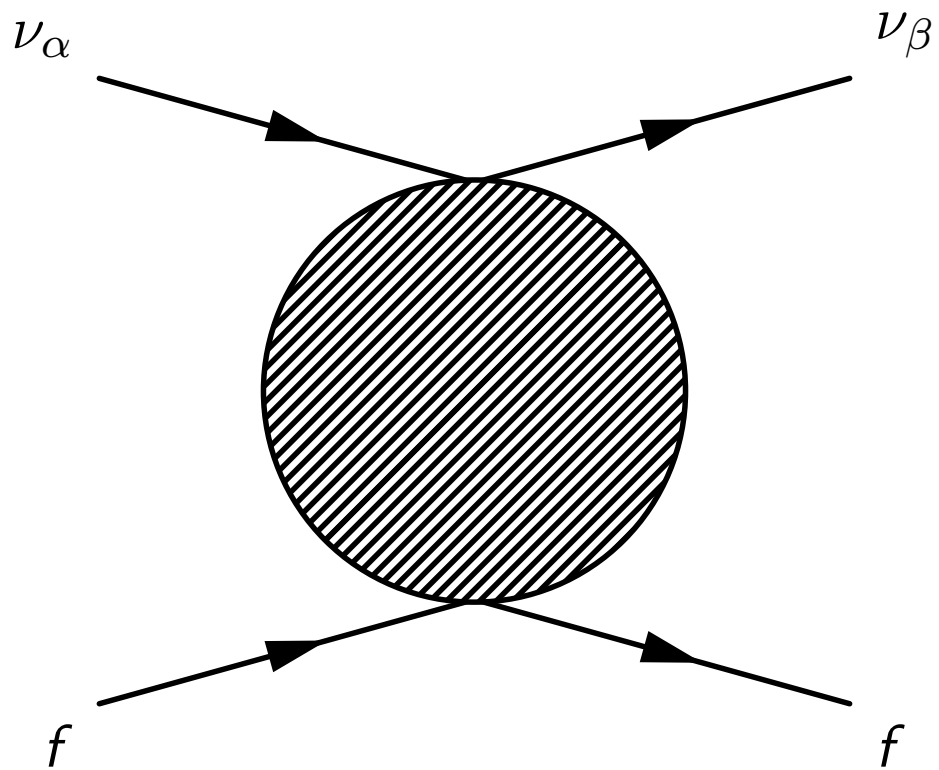
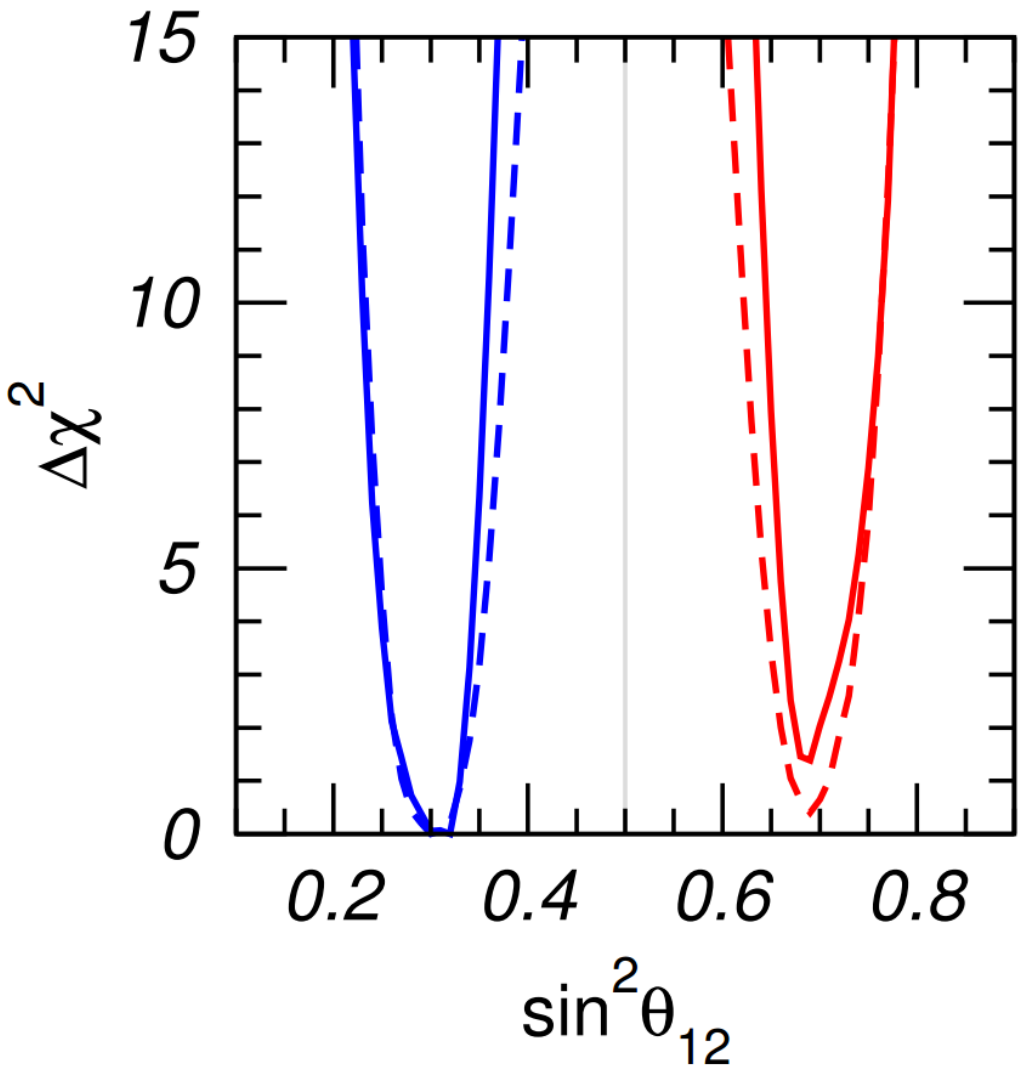
New Neutrino Physics: Non-Standard Interactions



$$\propto \epsilon_{\alpha\beta} G_F$$

Best Fit to Neutrino Oscillation Data



M.C. Gonzalez-Garcia, M. Maltoni, 1307.3092

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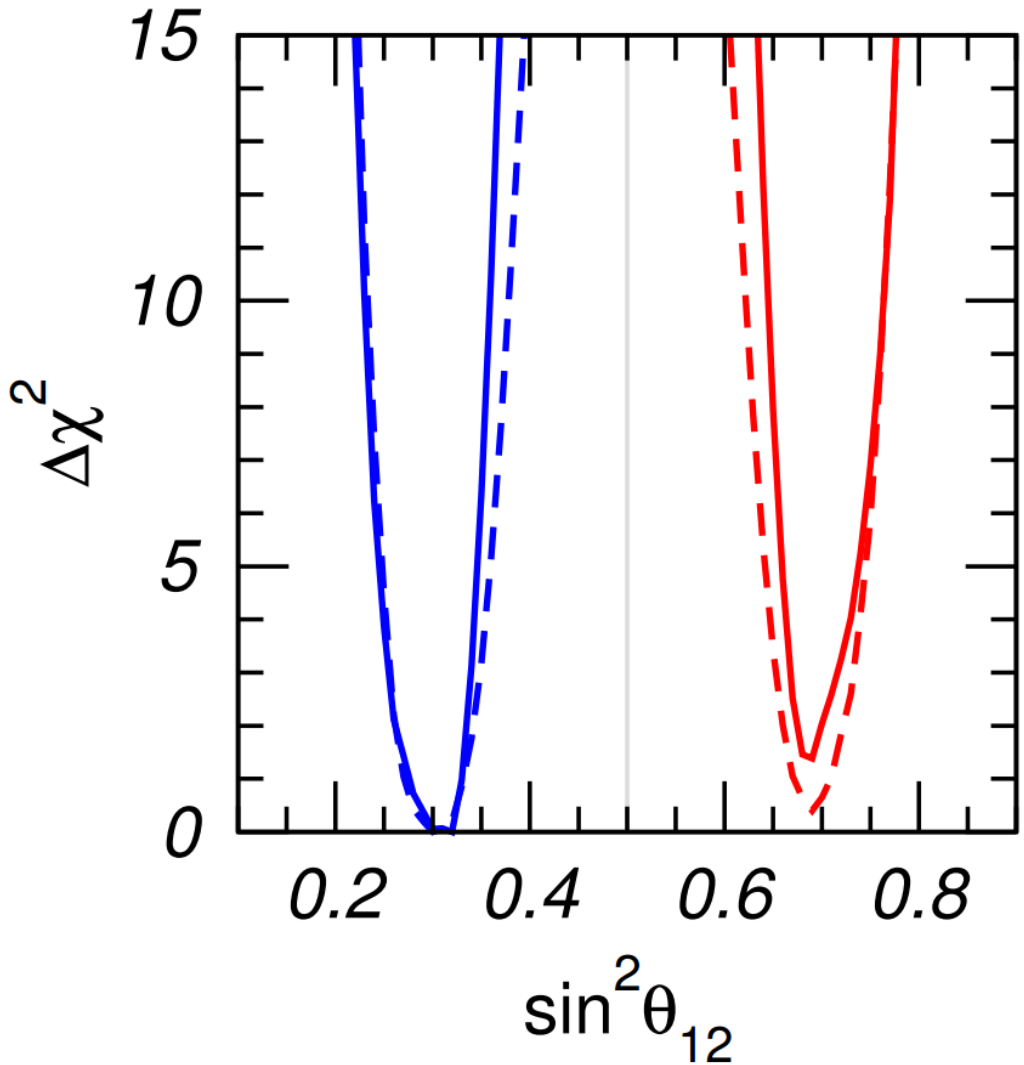

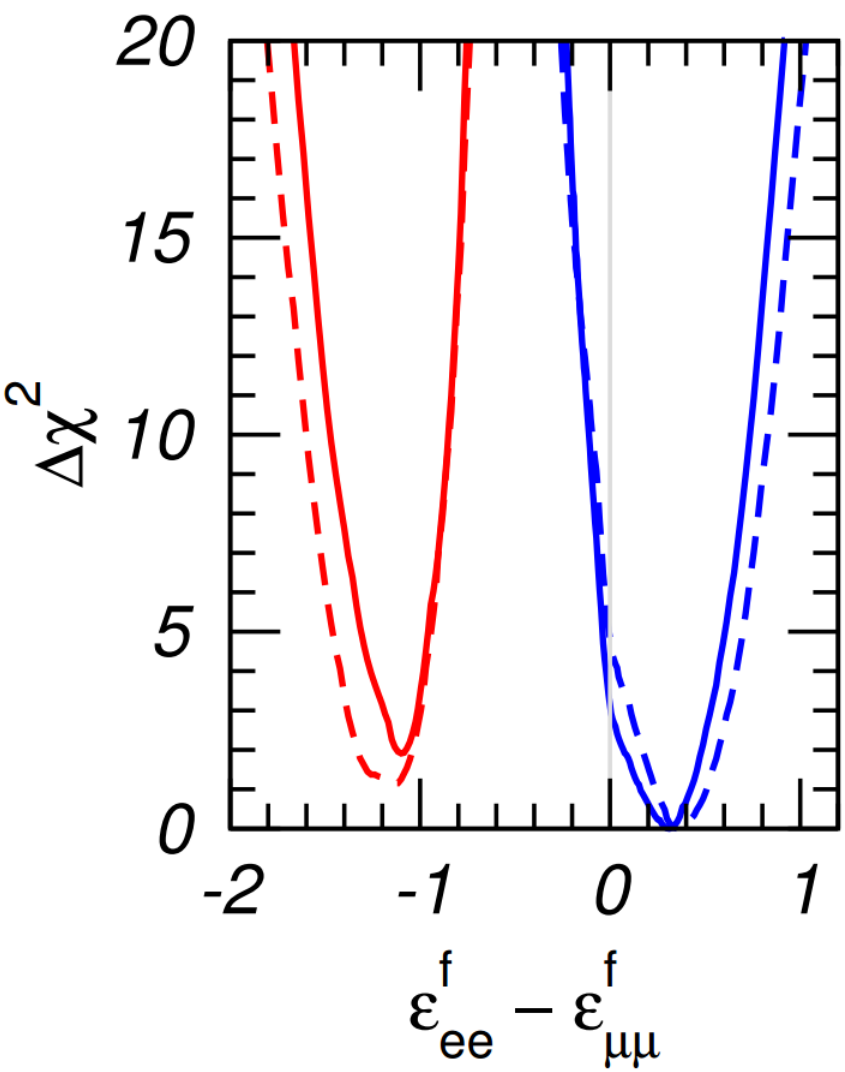

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$$\theta_{12} = \begin{cases} 34^\circ\,, \text{ or} \\ 56^\circ + \text{large NSI} \end{cases}$$
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Review and Prospects

- The standard neutrino oscillation parameters are all (or soon will be) measured.
- Matter effects affect oscillations.
- Non-standard interactions allow for a variety of phenomenologies related to neutrino oscillations and interactions.
- Large non-standard interactions are still a good fit to the data.
- Current data sets on neutrino scattering experiments constrain but do not destroy the dark side.
- Future neutrino scattering experiments should be able to rule it out.