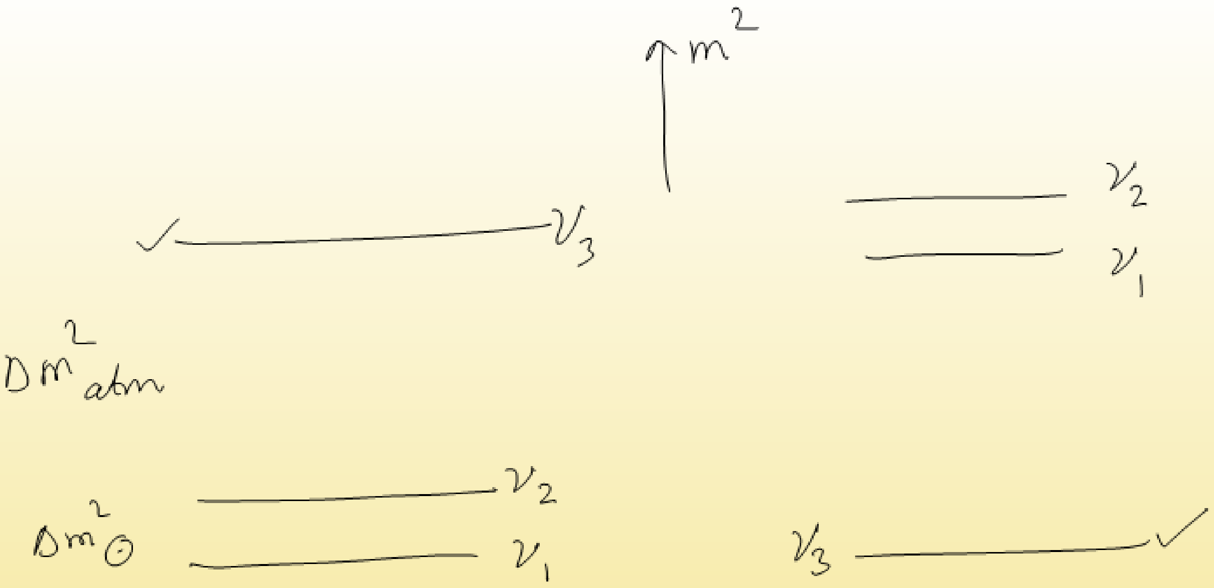

Normal ordering
normal hierarchy

Inverted ordering
Inverted hierarchy

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$$\mathrm{Re}(a\,b)$$

$$= \mathrm{Re}(a)\,\mathrm{Re}(b) - \mathrm{Im}(a)\,\mathrm{Im}(b)$$

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$$P_{\alpha\beta} = |U_{\alpha 1}^{*} U_{\beta 1}|^2 + |U_{\alpha 2}^{*} U_{\beta 2}|^2 + |U_{\alpha 3}^{*} U_{\beta 3}|^2$$

$$+ \sum_{i<j} \left[Re\left(U_{\alpha 1}^{*} U_{\beta 1}^{*} U_{\alpha 2}^{*} U_{\beta 2}\right) \cdot \cos\left(2 i \Delta_{ji}\right) \right.$$

$$+ \sum Im\left(\cdot \right) \cdots$$

$$= |U_{\alpha 1}^{*} U_{\beta 1}|^2 + |U_{\alpha 2}^{*} U_{\beta 2}|^2 + |U_{\alpha 3}^{*} U_{\beta 3}|^2$$

$$+ \sum_{i<j} 2\, Re\left(U_{\alpha i} U_{\beta i}^{*} U_{\alpha j}^{*} U_{\beta j}\right)$$

$$|U_{\alpha 1} U_{\beta 1}^{*} + U_{\alpha 2} U_{\beta 2}^{*} + U_{\alpha 3} U_{\beta 3}^{*}|^2 \to \delta_{\alpha\beta}$$

$$- \sum 2\, Re\left(U_{\alpha i} U_{\beta i}^{*} U_{\alpha j}^{*} U_{\beta j}\right) \left[1 - \cos\left(2 i \Delta_{ji}\right)\right]$$

$$+ \sum Im\left(\cdots \right)$$

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$$U^{\dagger} U = I$$

$$U^{*}_{\alpha i} U_{\beta i} \longrightarrow \delta_{\alpha\beta}$$

$$\begin{pmatrix} U^{*}_{e1} & U^{*}_{\mu 1} & U^{*}_{\tau 1} \\ U^{*}_{e2} & U^{*}_{\mu 2} & U^{*}_{\tau 2} \\ U^{*}_{e3} & U^{*}_{\mu 3} & U^{*}_{\tau 3} \end{pmatrix} \begin{pmatrix} U_{e1} & U_{e2} & U_{e3} \\ U_{\mu 1} & U_{\mu 2} & U_{\mu 3} \\ U_{\tau 1} & U_{\tau 2} & U_{\tau 3} \end{pmatrix} \longrightarrow \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$U_{2\times 2} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$$

$$\square_{\alpha\beta 12} = U_{11} U_{12} U_{21} U_{22} < 0$$

$$\square_{\alpha\alpha 12} = U_{11} U_{12} U_{11} U_{12} > 0$$

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$$P_{\mu\mu}^{(atm)} = 1 - \sin^2 2\theta_{atm} \cdot \sin^2(\Delta_{32})$$

atm