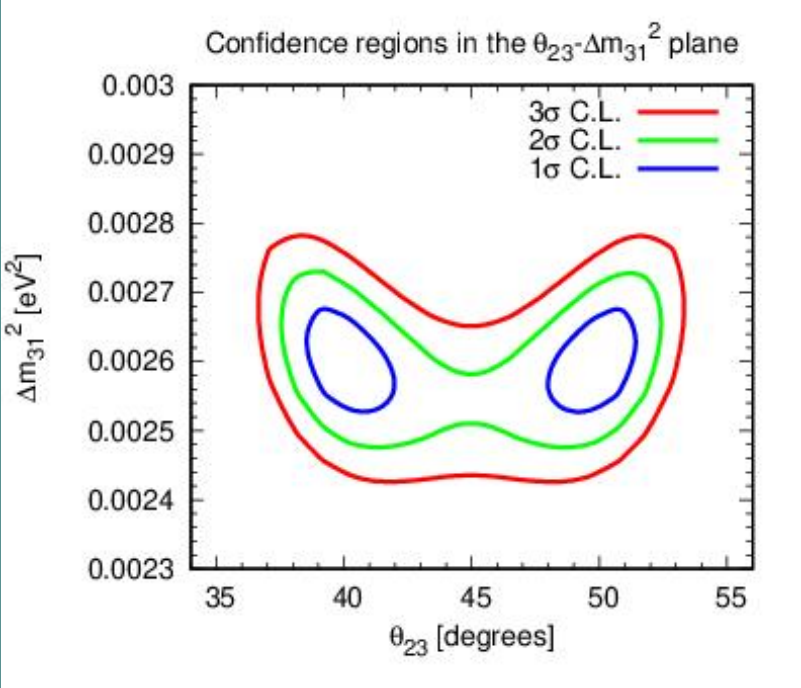
# Sensitivity Studies with GLoBES (T2K)

Khushboo Dixit (IIT Bombay, India)
Dinesh K. Singha (University of Hyderabad, India)

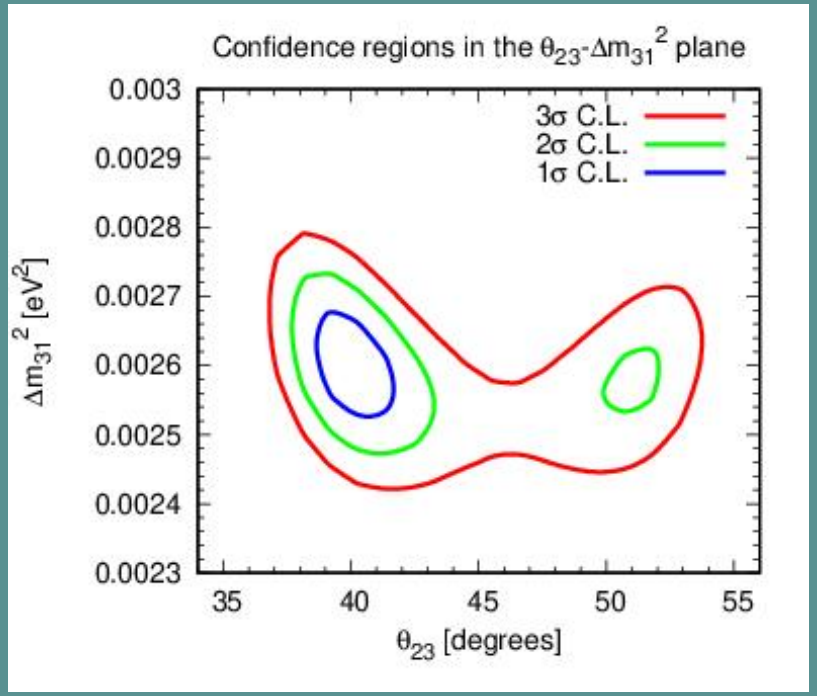
# Problem 3: Sensitivity to the octant degeneracy ($\theta_{23} < 45^\circ$ or $\theta_{23} > 45^\circ$)




Sin $\theta_{13} << 1$

- Correlation between $\theta_{23}$ and dm31 is maintained
- Octant degeneracy is visible
- Other oscillation parameters were kept fixed: hep-ph/0405172

# Problem 3: Sensitivity to the octant degeneracy ($\theta_{23} < 45^\circ$ or $\theta_{23} > 45^\circ$)




$s_{13} = 0$, $s_{13} \neq 0$ $\quad \Delta m_{21}^2 << \Delta m_{31}^2$

- $P_{\mu\mu} = 1 - \sin^2 2\theta_{23} \sin^2\Delta + \alpha\, c_{12}^2 \sin^2 2\theta_{23}\, \Delta \sin 2\Delta - \alpha^2 \Delta^2 [\sin^2 2\theta_{12}\, c_{23}^2 + c_{12}^2 \sin^2 2\theta_{23} (\cos 2\Delta - s_{12}^2)] + 4\, s_{13}^2\, s_{23}^2 \cos 2\theta_{23} \sin 2\Delta - 2\,\alpha\, s_{13} \sin 2\theta_{12}\, s_{23}^2 \sin 2\theta_{23} \cos\delta_{CP}\, \Delta \sin 2\Delta$

- $P_{\mu e} = \alpha^2 \sin^2 2\theta_{12}\, c_{23}^2\, \Delta^2 + 4\, s_{13}^2\, s_{23}^2 \sin 2\Delta + 2\,\alpha\, s_{13} \sin 2\theta_{12} \sin 2\theta_{23} \cos(\Delta + \delta_{CP})\, \Delta \sin\Delta$

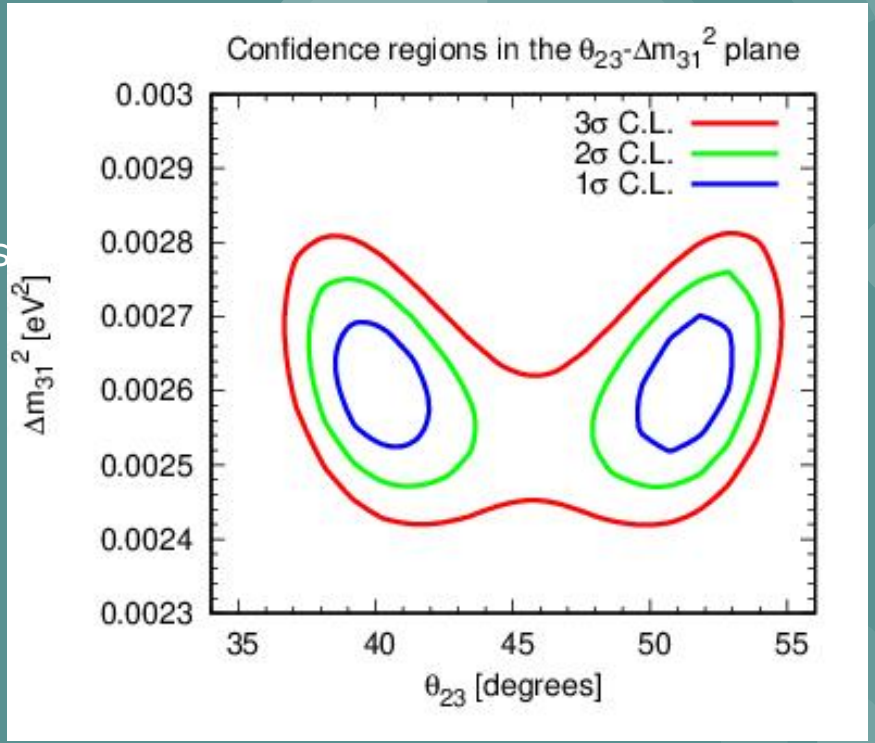
$\alpha = \Delta m_{21}^2 / \Delta m_{31}^2$ , $\Delta = \Delta m_{31}^2 L/4E$

- Inclusion of $\sin^2\theta_{13} = 0.1$, shows sensitivity to octant degeneracy
- Favors $\theta_{23} < 45^\circ$ solution
- Exhibit strong dependencies between $\theta_{23}$ and $\theta_{13}$

- It is not expected from T2K to have the capability to resolve the octant degeneracy.
- Possible reason of sceptical result: assumption of full knowledge about all oscillation parameters
- GLoBES provides a powerful feature of marginalization over multi-dimensional subspaces of the oscillation parameter space.
- So far we used glbChiSys to obtain $\chi^2$ with systematics only, to marginalize over oscillation parameters used glbChiNP.

# Problem 4: Incorporation of parameter correlations with $\theta_{13}$ and $\delta_{CP}$

- In the absence of any theoretical argument, the oscillation parameters should be kept varying within their presently allowed ranges
- $\theta_{12}$ ,$\theta_{13}$, $\Delta m_{21}^2$ and $\delta_{CP}$ marginalized over their allowed ranges
- degeneracy appears again

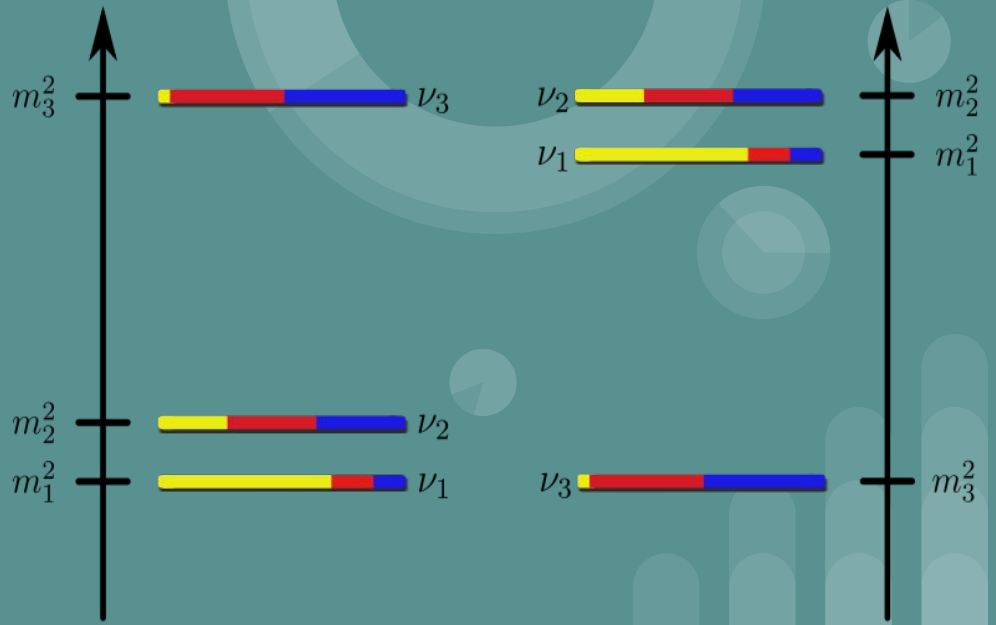


# Problem 5: Sensitivity to the sgn($\Delta m_{31}^2$) degeneracy

For true value of $\Delta m_{31}^2 = 0.002514$, we get

- Position of degeneracy: $\Delta m_{31}^2 = -0.00242058$;
- Position of degeneracy: $\Delta m_{31}^2 = -0.00238943$;

**glbChiAll**: (Local) Minimization over all parameters




- Why is $|\Delta m_{31}^2|$ slightly smaller at the degenerate solutions than at the true one?

$\Rightarrow |\Delta m_{31}^2| = |\Delta m_{32}^2| + |\Delta m_{21}^2|$ for NH

$|\Delta m_{31}^2| = |\Delta m_{32}^2| - |\Delta m_{21}^2|$ for IH

# Thank you !