

Neutrino Oscillations and Non-Standard Interactions

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<http://ific.uv.es/~ahep>

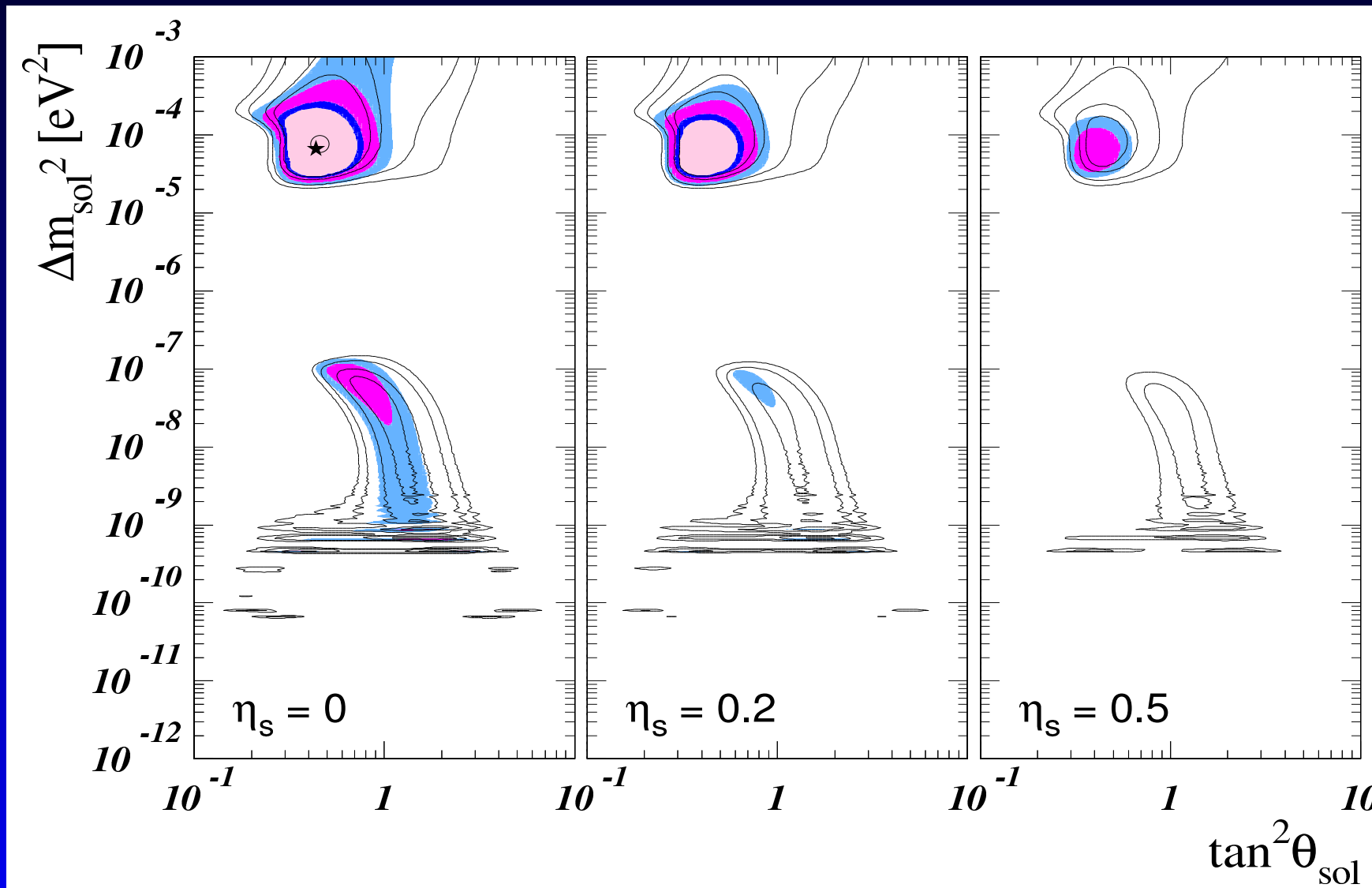
solar parameters

Maltoni etal hep-ph/0207157

	SNO Coll	Super-K Coll	Barger etal	Bandyopadhyay etal	Bahcall etal	Creminelli etal	Aliani etal	De Holanda Smirnov	Fogli etal	Barranco etal	present analysis
d.o.f.	75-3	46	75-3	49-4	80-3	49-2	41-4	81-3	81-3	81-2	81-2
best OSC-fit	active LMA solution										
$\tan^2 \theta_{\text{SOL}}$	0.34	0.38	0.39	0.41	0.45	0.45	0.40	0.41	0.42	0.47	0.44
$\Delta m_{\text{SOL}}^2 [10^{-5} \text{ eV}^2]$	5.0	6.9	5.6	6.1	5.8	7.9	5.4	6.1	5.8	5.6	6.6
χ_{LMA}^2	57.0	43.5	50.7	40.6	75.4	33.0	30.8	65.2	73.4	68.0	66.1
GOF	90%	58%	97%	66%	53%	94%	80%	85%	63%	81%	85%
$\Delta \chi_{\text{LOW}}^2$	10.7	9.0	9.2	10.0	9.6	8.1	–	12.4	10.0	–	9.0
$\Delta \chi_{\text{VAC}}^2$	–	10.0	25.6	15.5	10.1	14.	–	9.7	7.8	–	8.9
$\Delta \chi_{\text{SMA}}^2$	–	15.4	57.3	30.4	25.6	23.	–	34.5	23.5	–	23.2

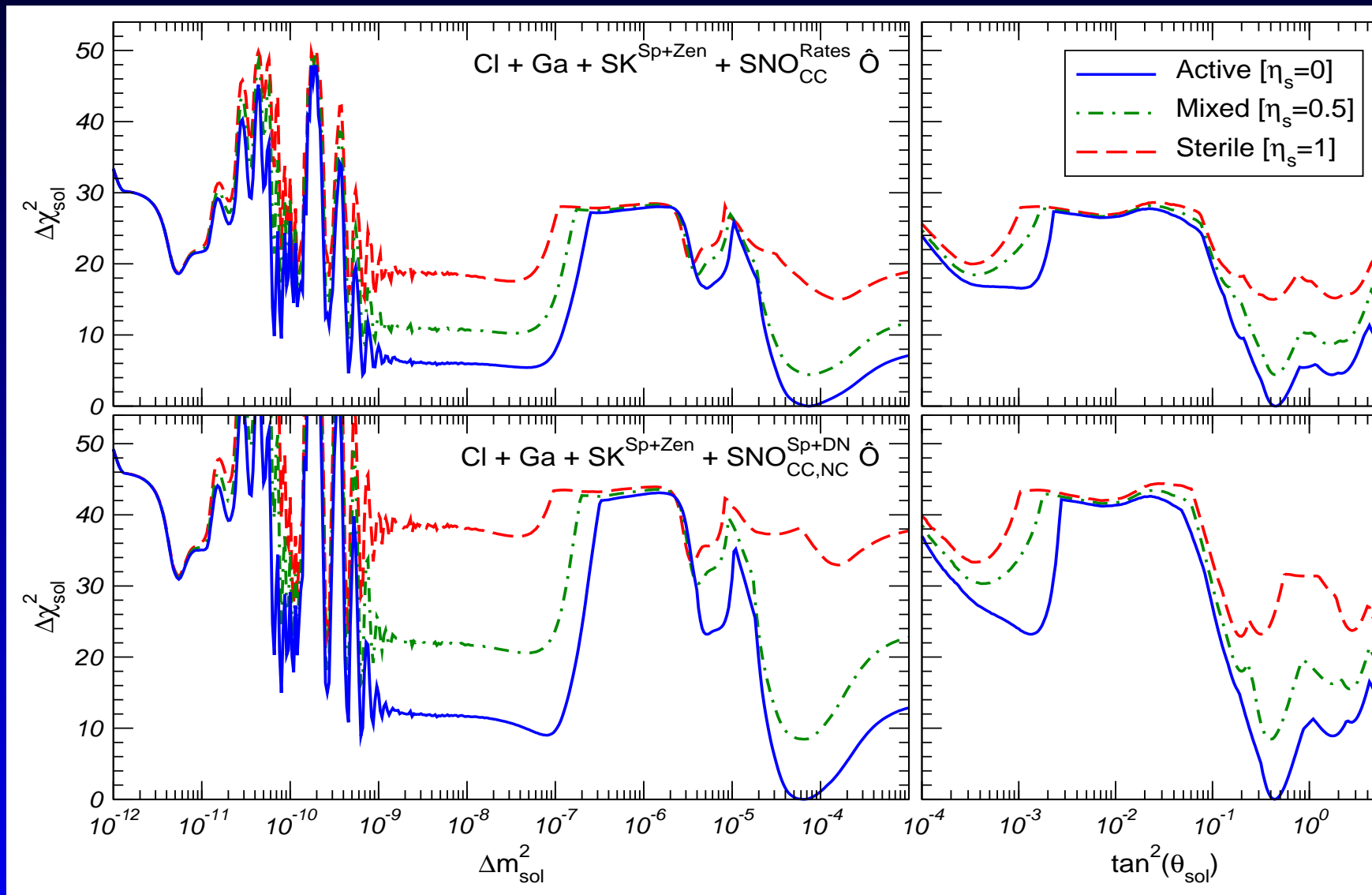
solar-regions back

Maltoni et al hep-ph/0207227



solar-chi2 Maltoni et al hep-ph/0207227

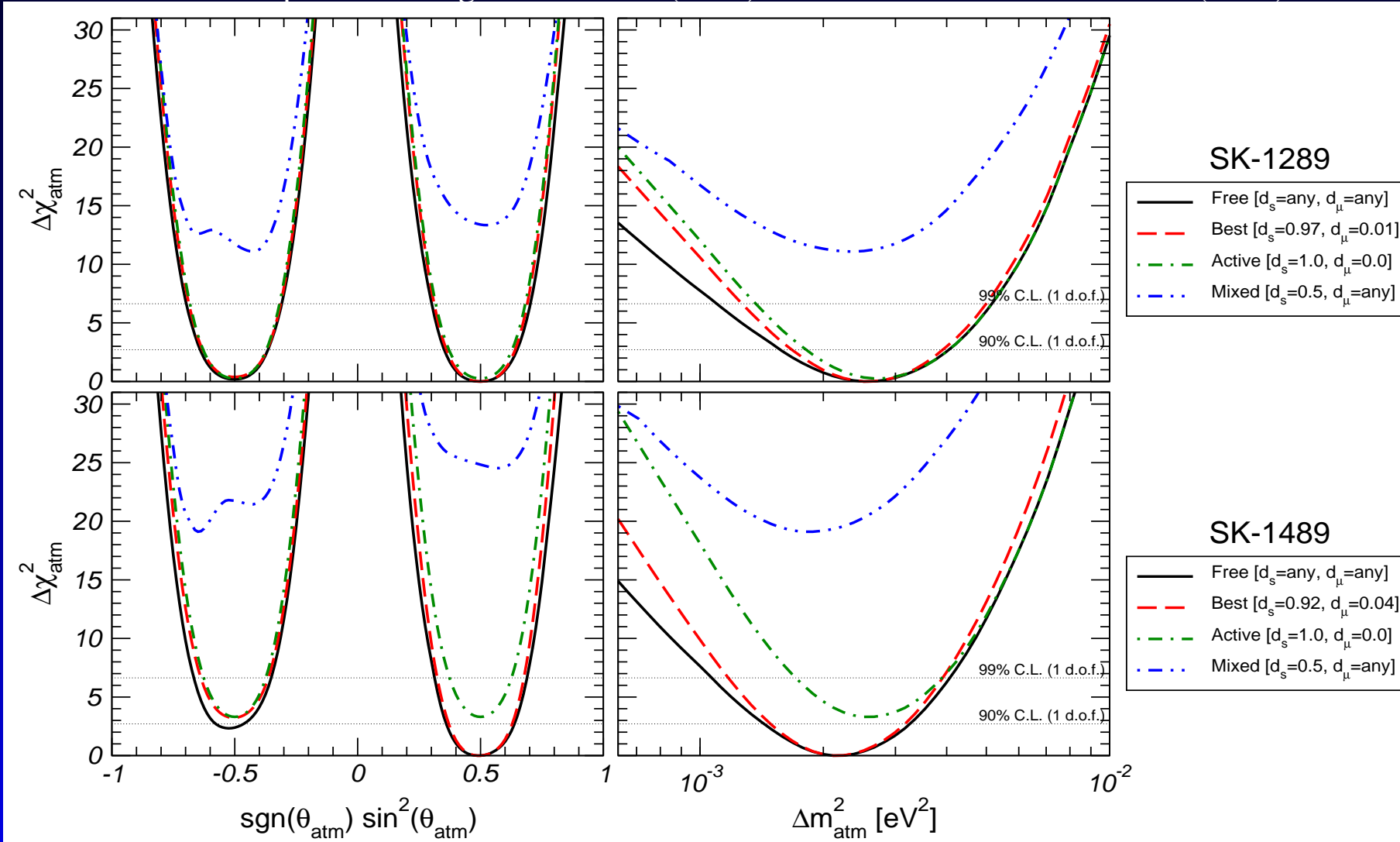
before & after SNO-NC active vs sterile



atmospheric ν_s

Maltoni et al hep-ph/0207227

upd of Fornengo et al PRD65 (2002) 013010 & Maltoni et al PRD65 (2002) 093004



higher sterility rejection

sterile-nu param

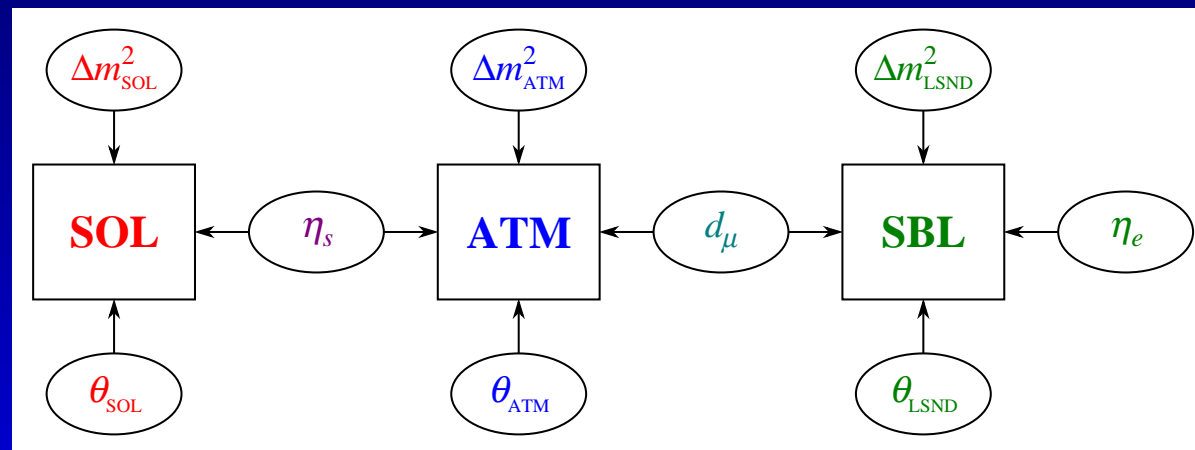
sterile as 4th, not 2nd:

in addition to sol, atm & sbl splittings

- 6 angles in the rectangular CC mixing matrix

Schechter, JV PRD22 (1980) 2227

- factorization

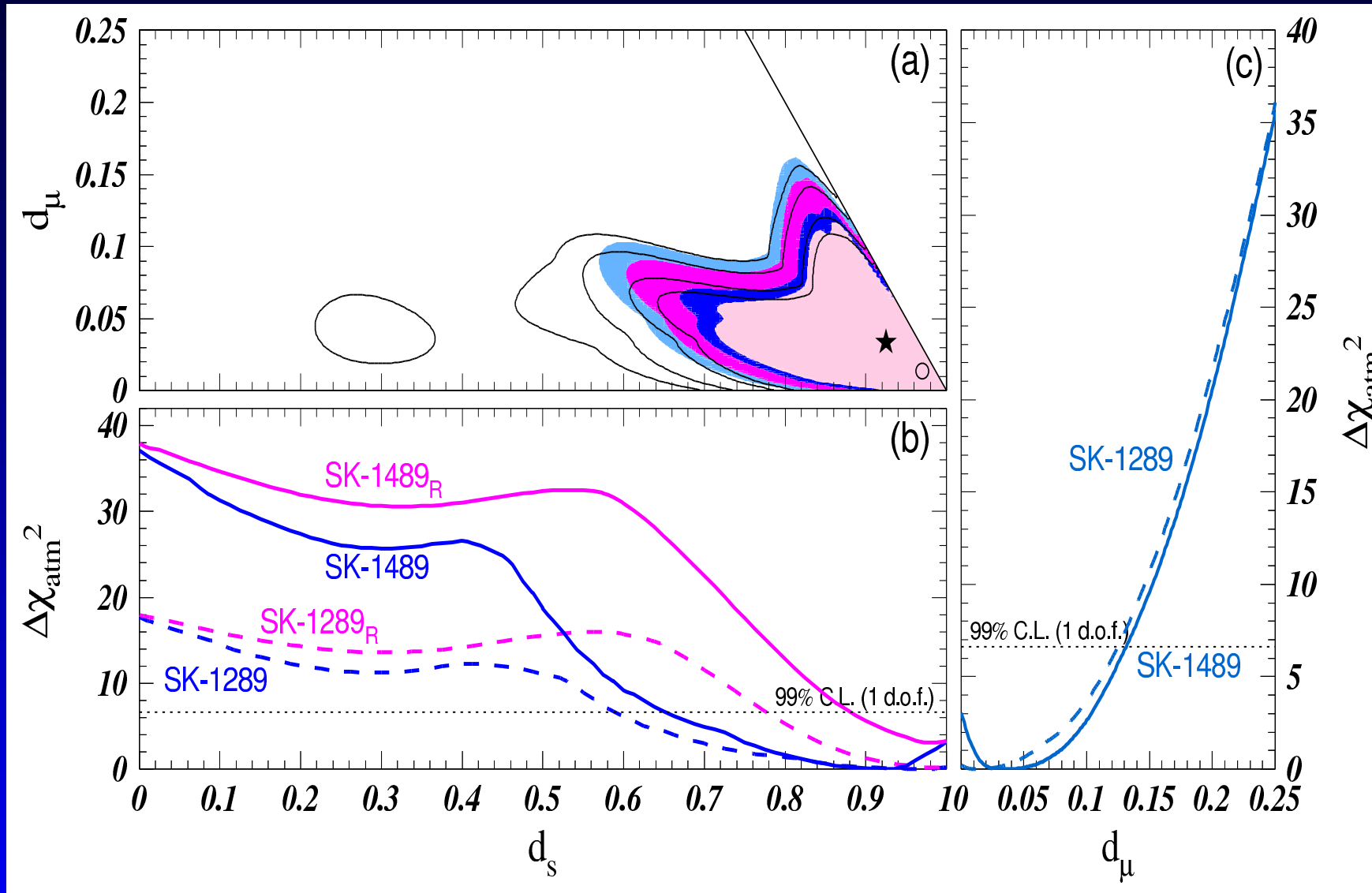


Maltoni et al PRD65 (2002) 093004

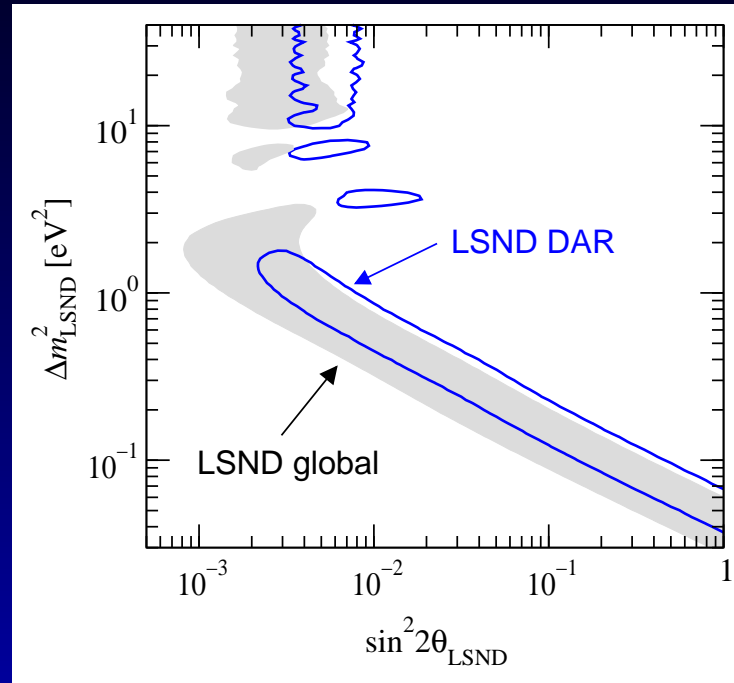
neglect CP phases

role of 4th param in atm

Maltoni et al hep-ph/0207227



adding LSND?



Peltoniemi, Tommasini & JV PLB298 (1993) 383

Peltoniemi & JV NPB406 (1993) 409

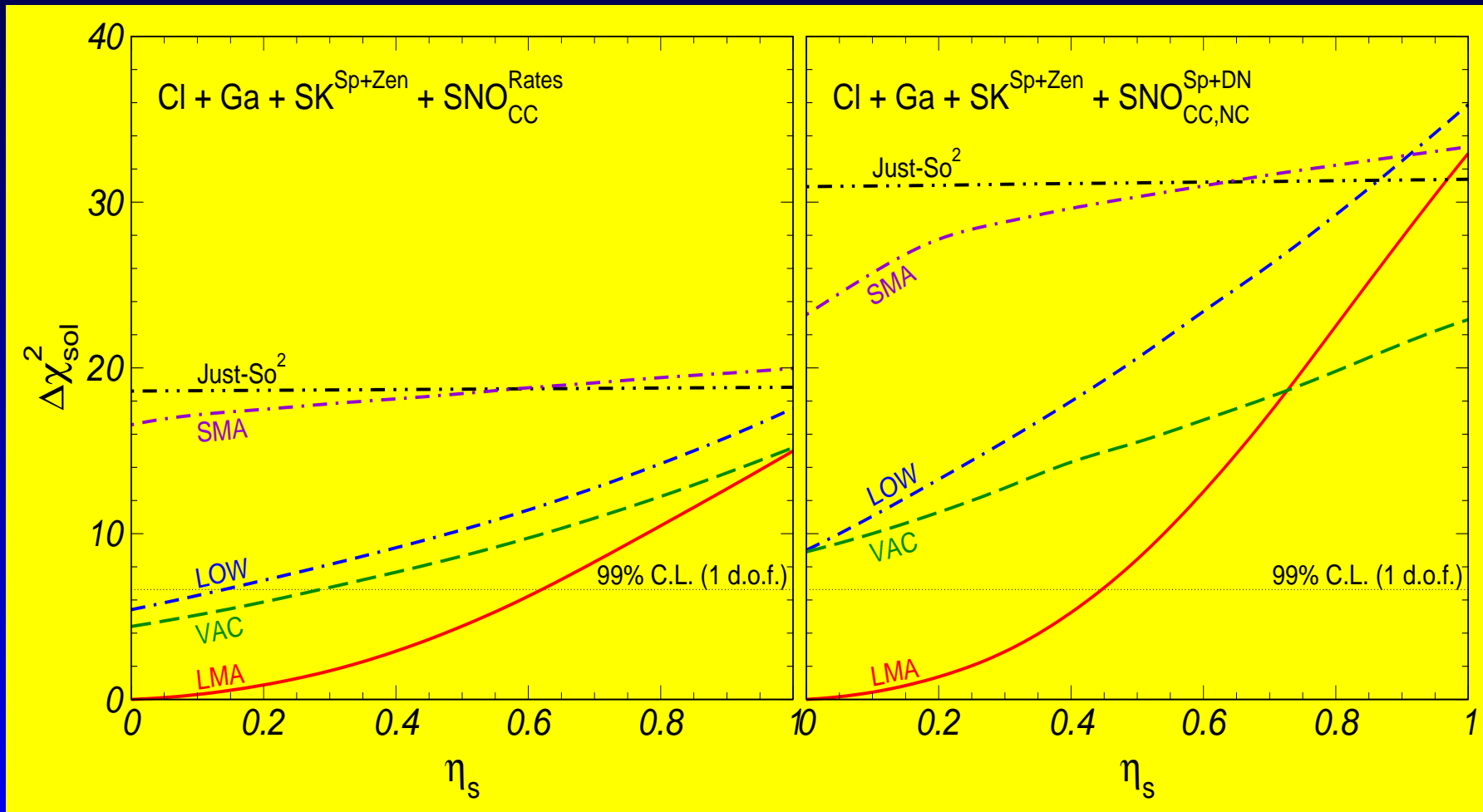
Caldwell-Mohapatra PRD48 (1993) 325

<http://www.to.infn.it/~giunti/neutrino/>

stronger sterility rejection by SOLAR data

after SK-1496d-sol, SNO-NC

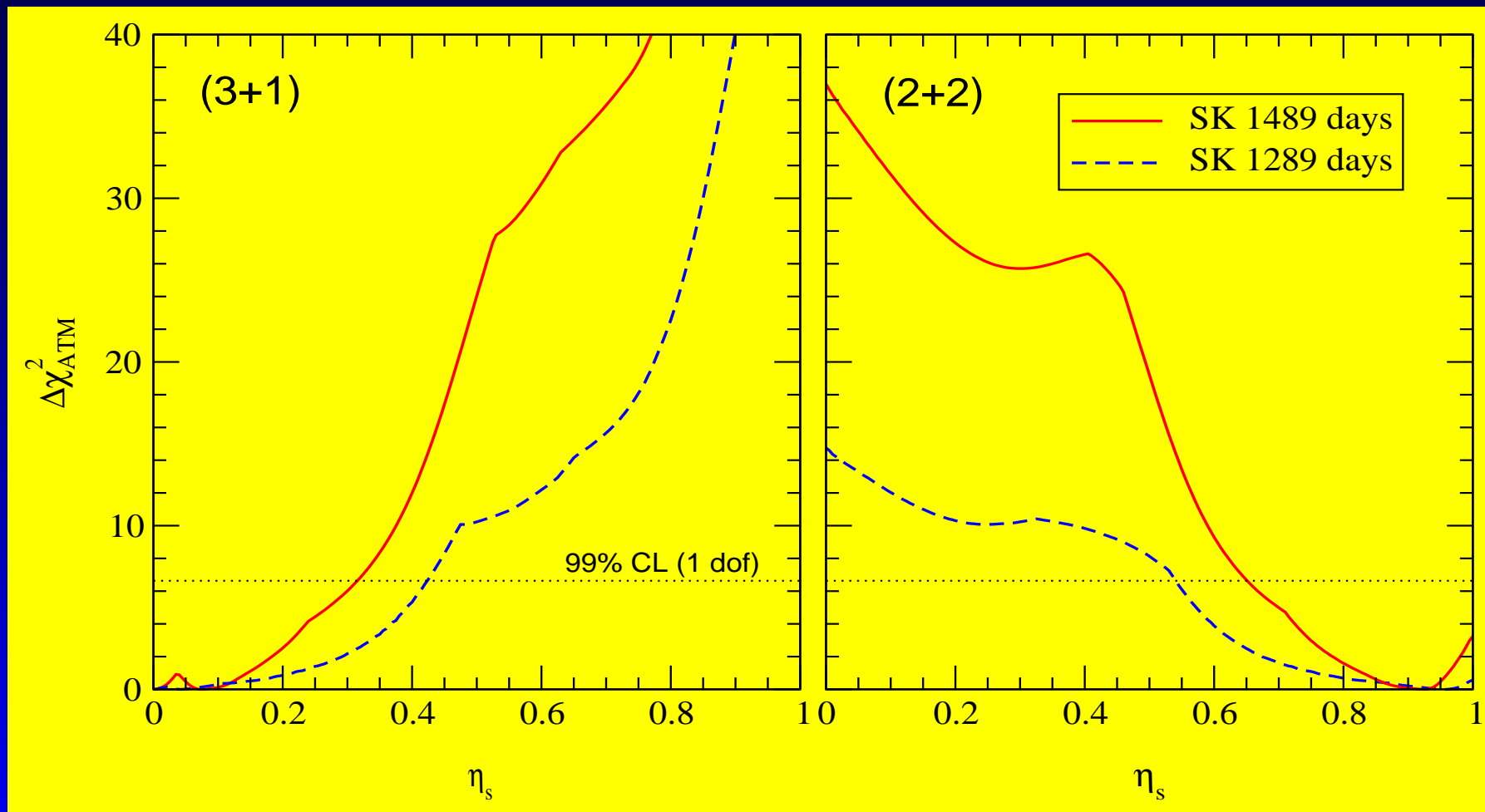
Maltoni et al hep-ph 0207157 & hep-ph/0207227



stronger sterility rejection by ATM data

after SK-1489d-atm

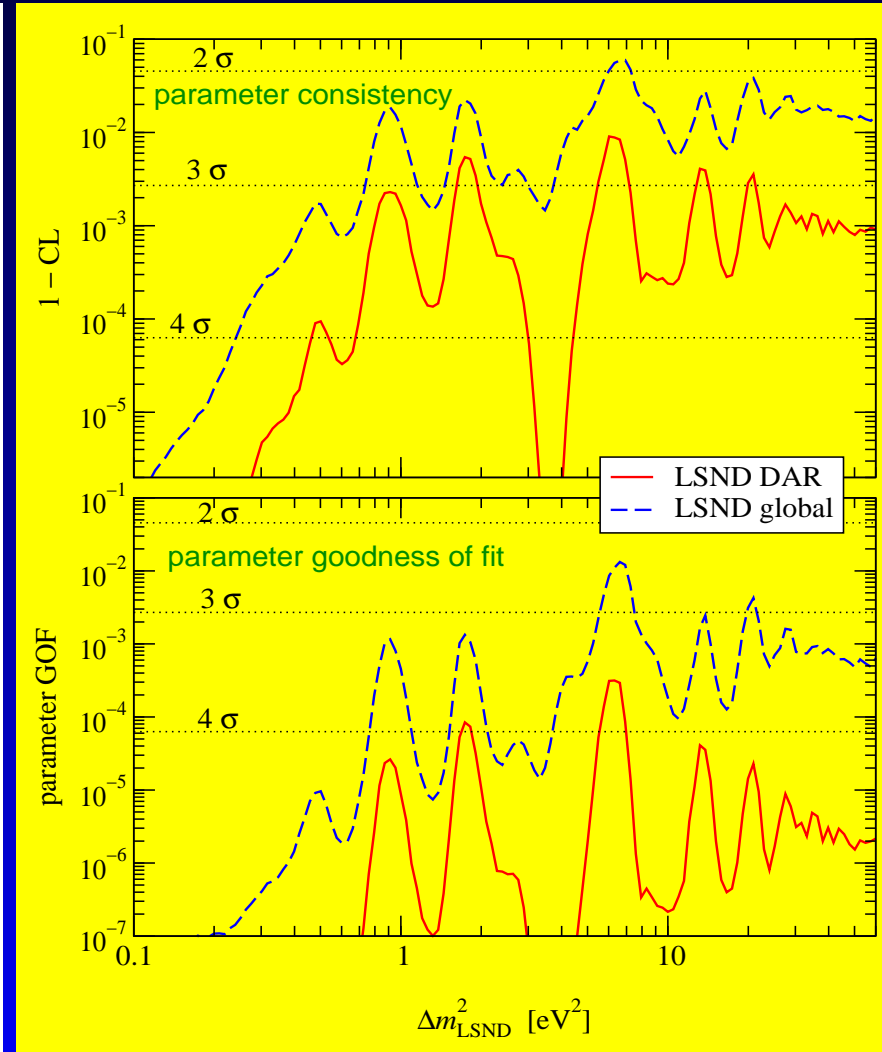
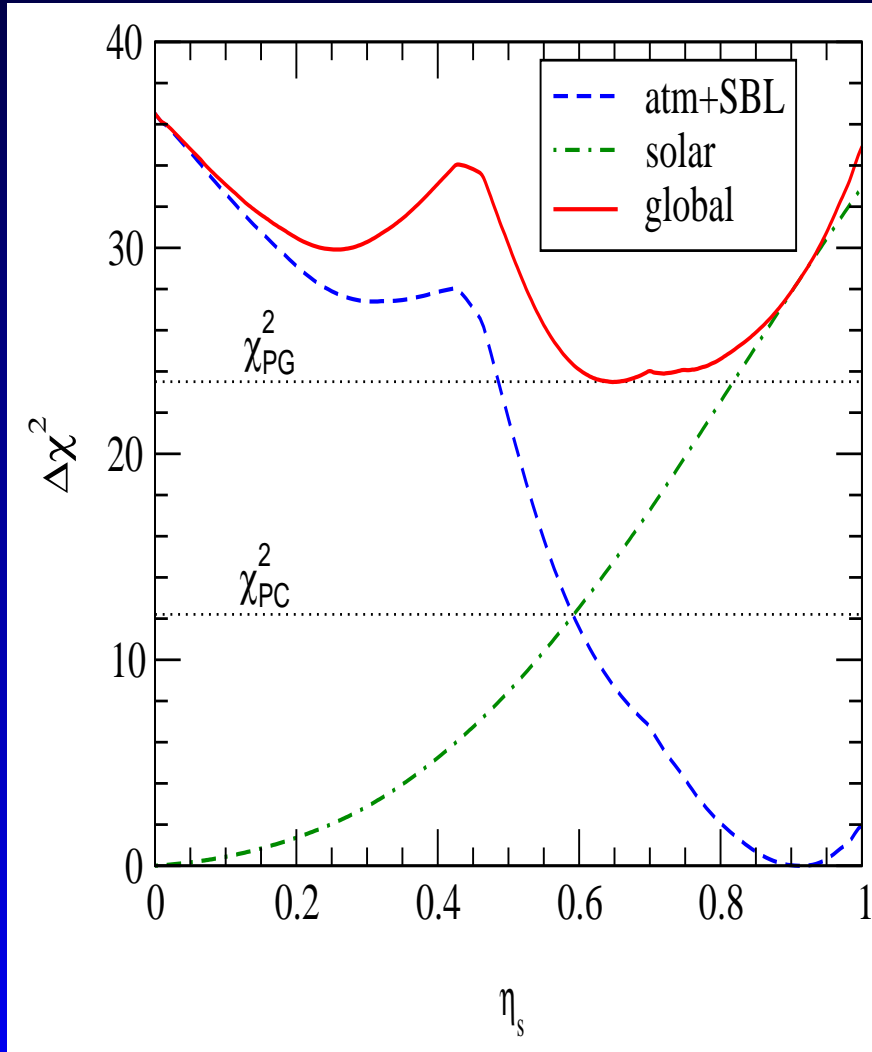
Maltoni et al hep-ph 0207157 & hep-ph/0207227



4-nus do not fit LSND with sol+atm

Maltoni et al hep-ph 0207157; upd of PRD65 (2002) 093004

stronger rejection by solar & atm in 2+2 than 3+1



neutrinos as SN-probe

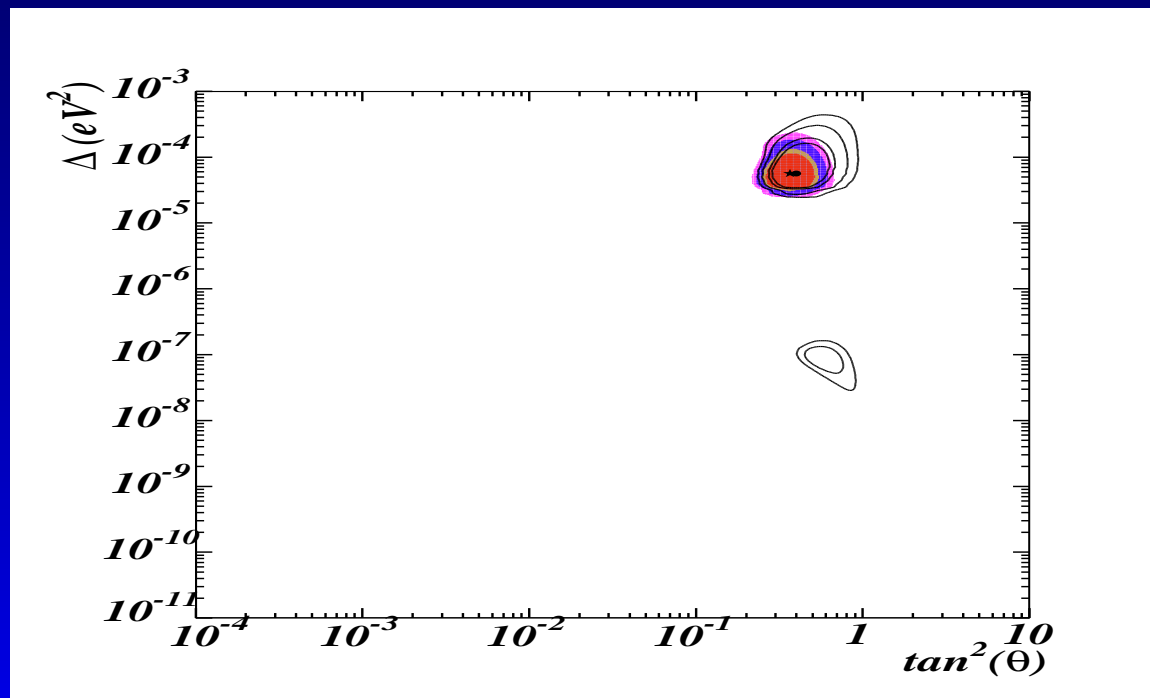
- large angle oscillations affect $\bar{\nu}_e$ SN-signal

Smirnov, Spergel, Bahcall 94; Raffelt et al 96, Kachelriess et al JHEP 0101 (2001) 030

- solar+SN1987A analysis

Kachelriess et al PRD65 (2002) 073016

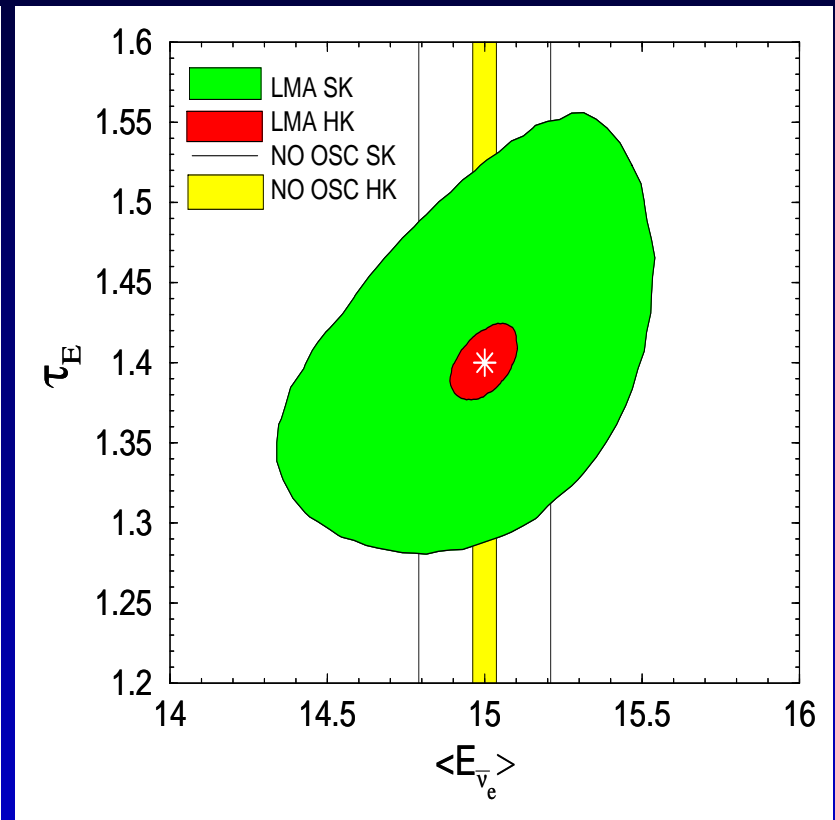
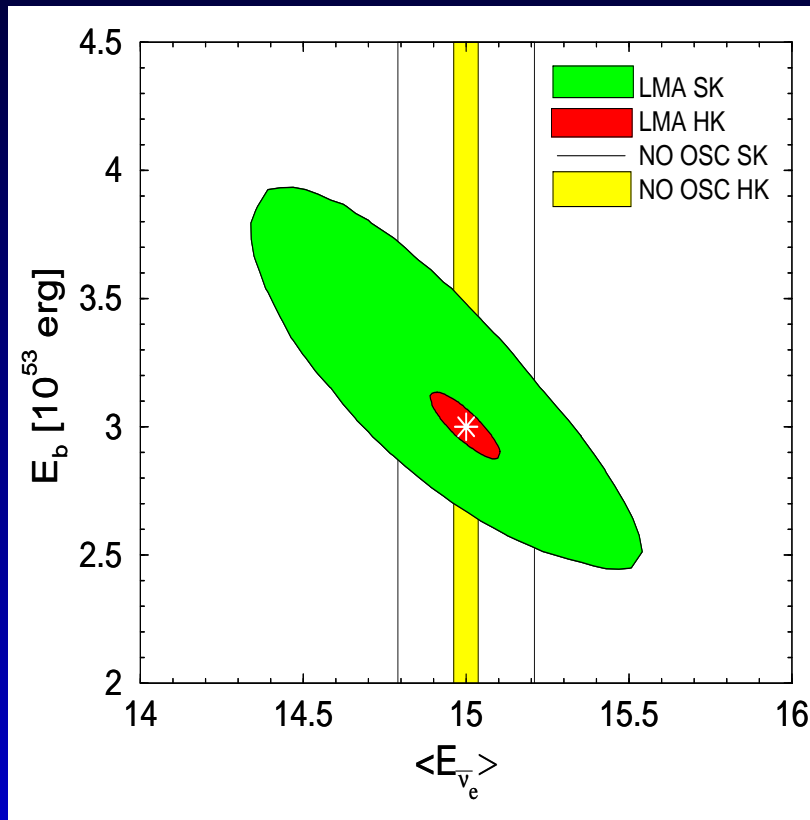
let $E_{\bar{\nu}_e} = 14$ MeV, $E_{\text{bind}} = 3 \times 10^3$ erg, $\tau \equiv T_{\nu_h}/T_{\bar{\nu}_e} = 1.4$



LMA may remain best

neutrinos as future SN probe

Minakata et al, PLB542 (2002) 239



see also Barger et al

more assume 10 kpc gal SN, simulate data with given astro param

alternatives to oscillations?

Spin Flavor Precession

the effect:

Schechter, Valle

PRD24 (1981) 1883 & D25, 283

Akhmedov; Lim-Marciano

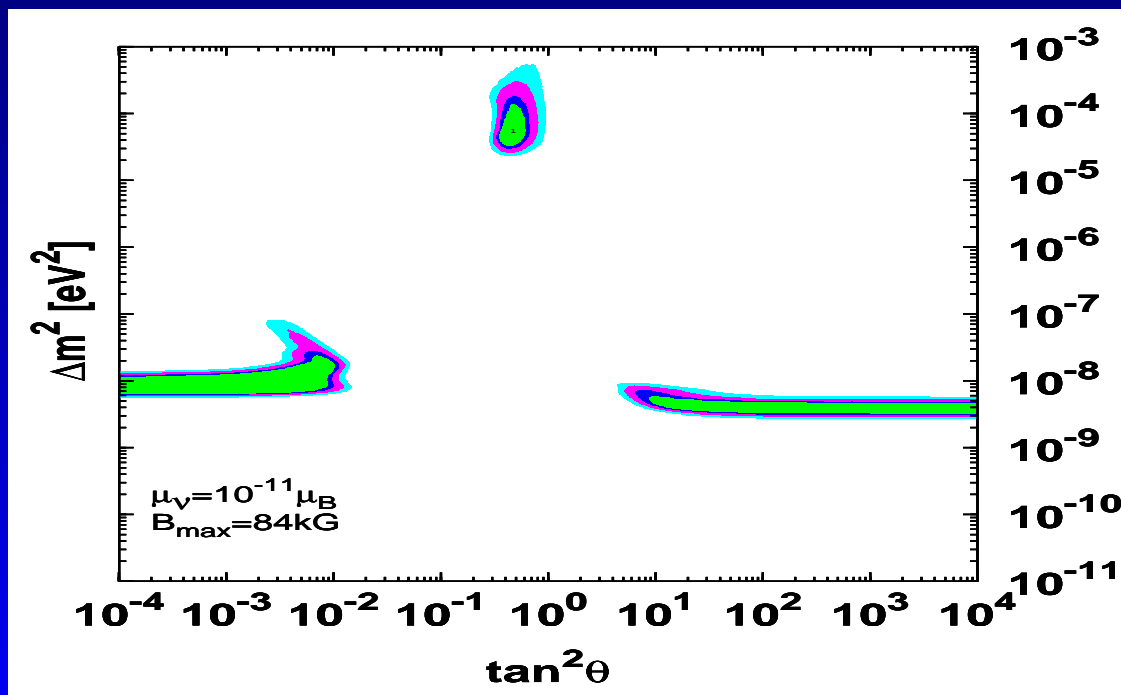
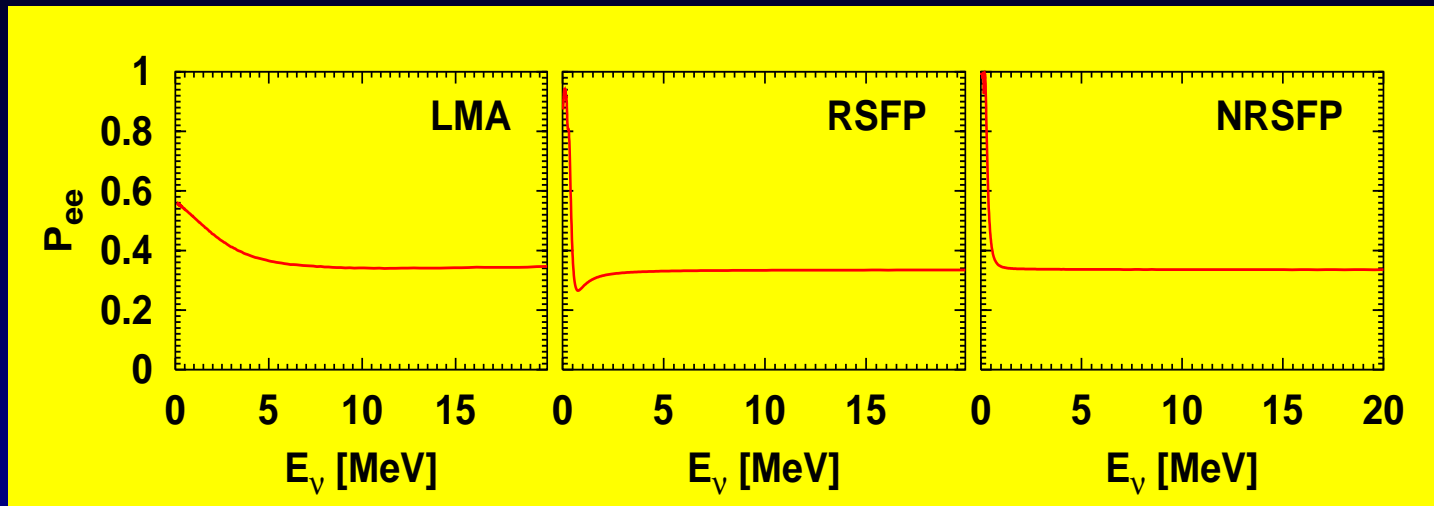
PRD37 (1988) 1368; PLB213 (1988) 64

although important, matter effect need not be resonant

MHD fixes B-profile

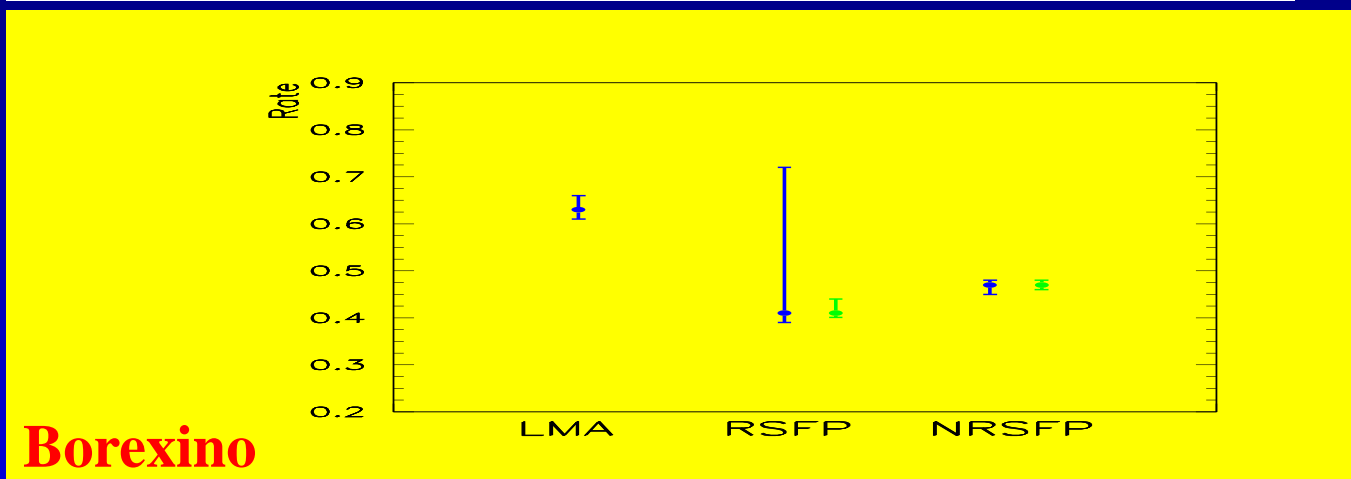
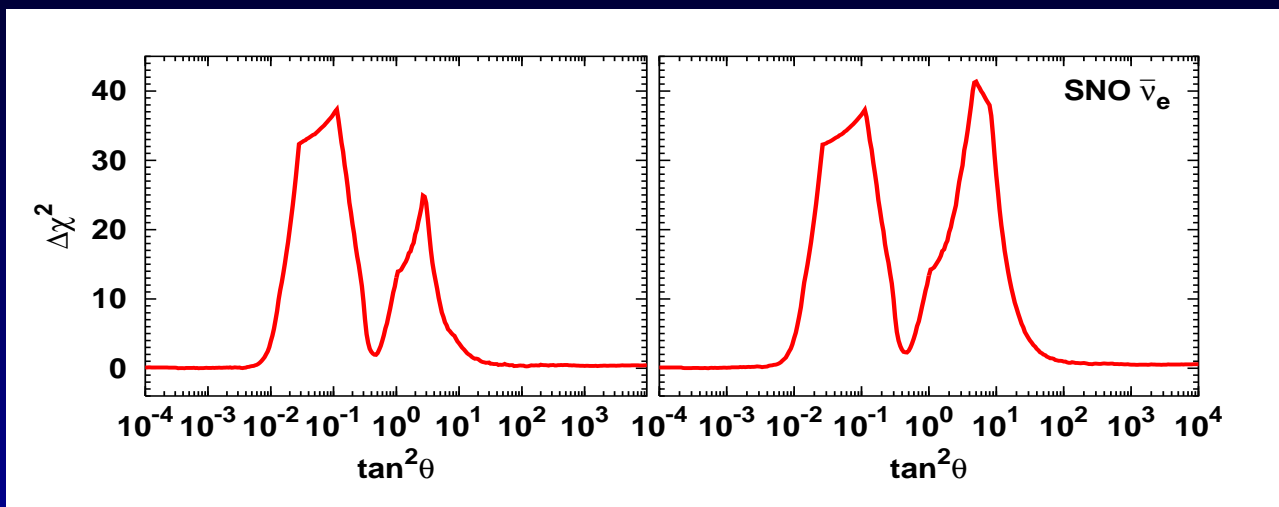
Miranda etal PLB521 (2001) 299, NPB595 (2001) 360

Oscillation vs SFP Barranco et al, hep-ph/0207326



Distinguishing LMA from SFP

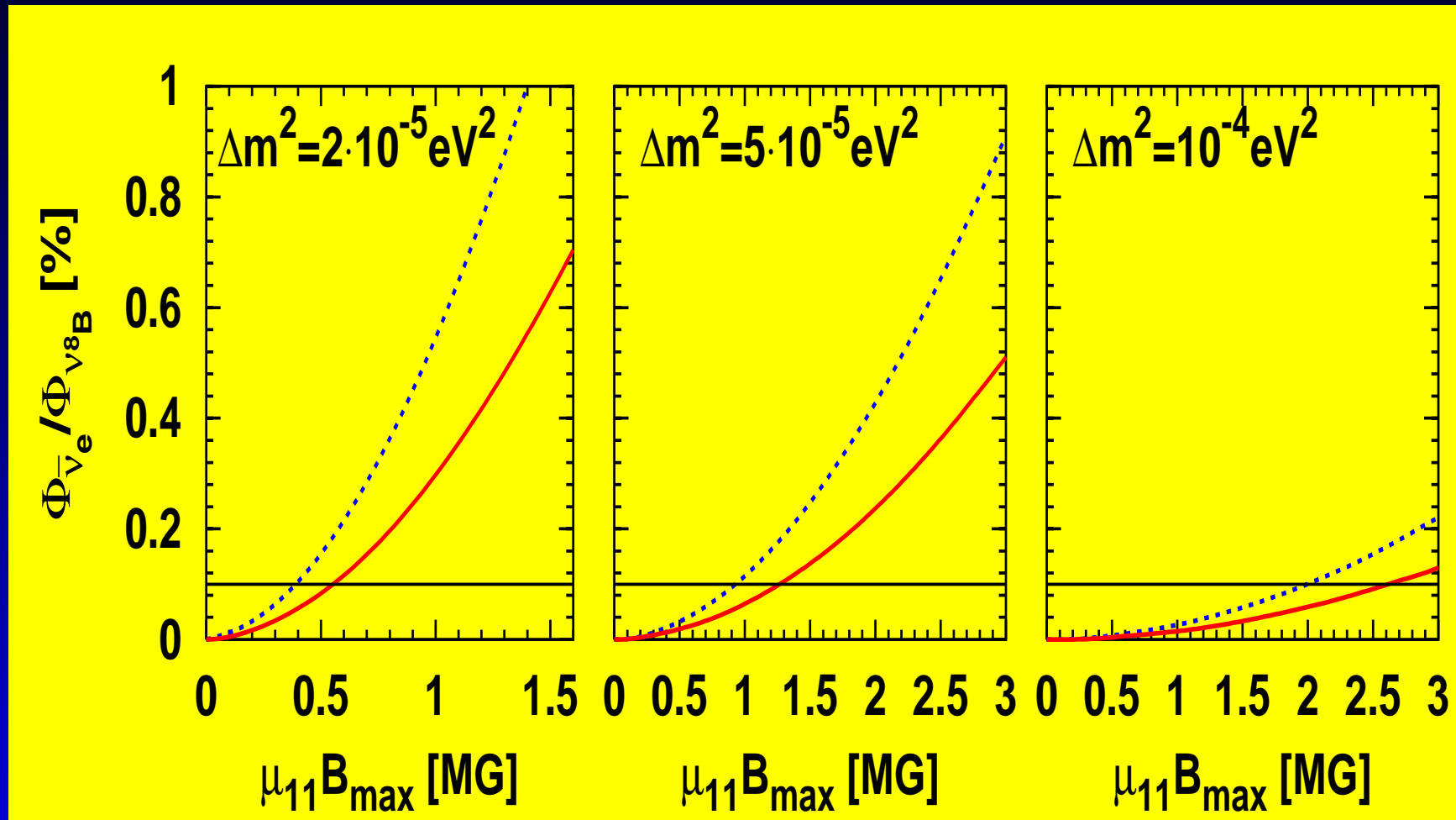
from hep-ph/0207326



see also Akhmedov & Pulido

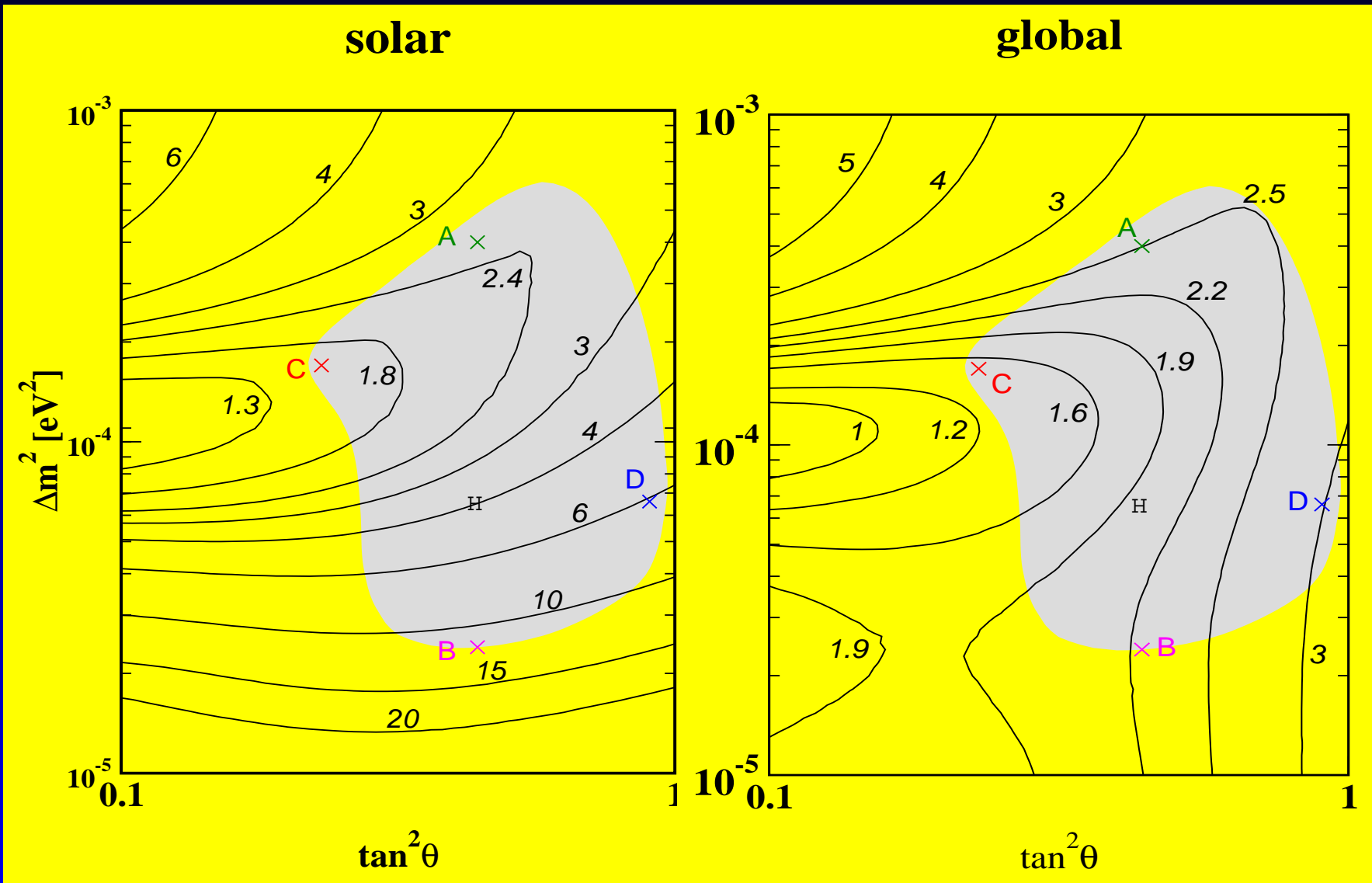
testing SFP as sub-leading

KamLAND



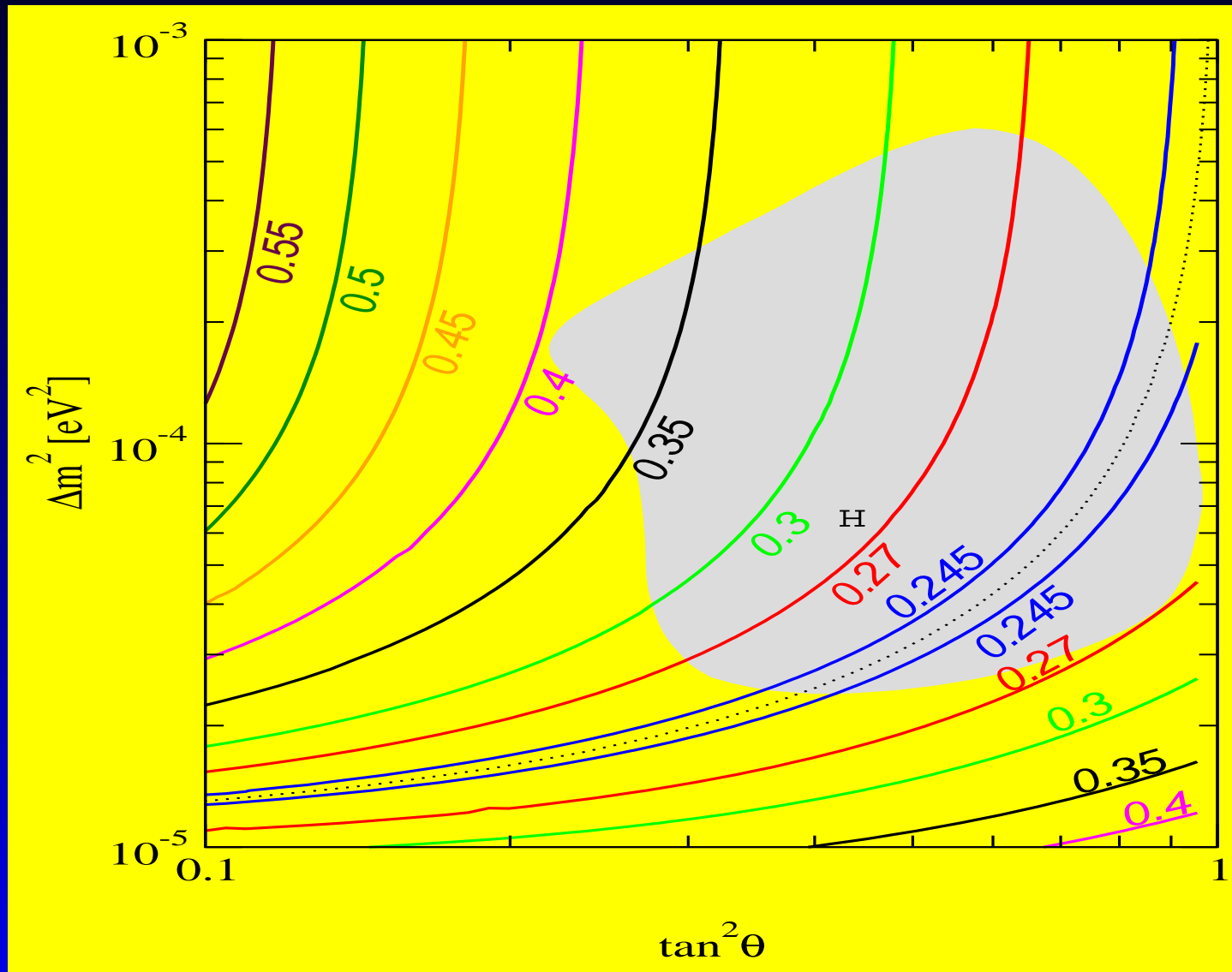
Barranco et al hep-ph/0207326

solar sensitivity to nu-TMM



role of reactor data [Grimus et al hep-ph/0208132](#)

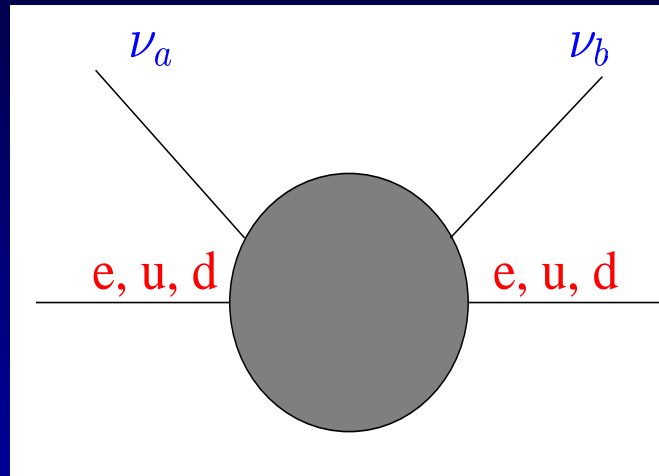
Borexino sensitivity to nu-TMM



Grimus et al hep-ph/0208132

Non-standard interactions

- consider FC/NU sub-weak strength terms εG_F

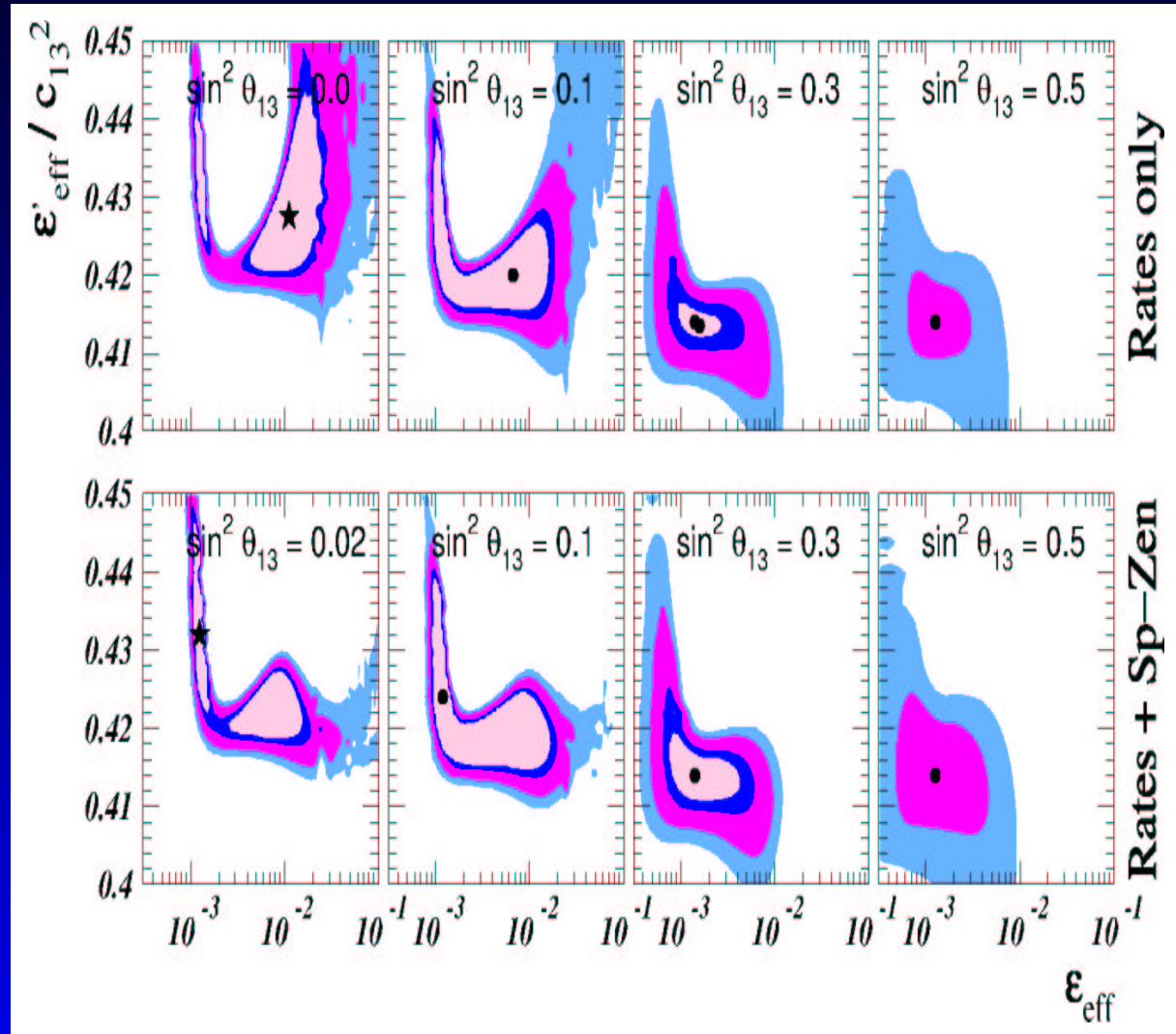
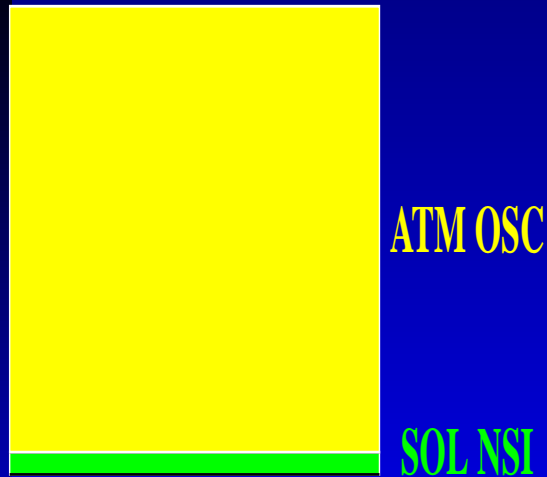


- may induce resonant oscill w/o nu-mass:
E-independent, nu & anti-nu convert (SNovae)
JV **PLB199 (1987) 432**; Guzzo etal 91; Roulet 91; Barger etal 91

hybrid NSI soln to nu-anomalies

post-SNO-NC global fit

upd of Guzzo et al NPB629 (2002) 479



no solar splitting nor mixing needed

In short

- **oscillations fit sol+atm but fail in reconciling LSND**
(but see Pas, Song, Weiler...)
- LMA as astro-probe: SN and Sun
probing the Sun beyond helioseismology
- **beyond oscillations**
SFP & NSI solar solns sub-leading if LMA is confirmed
cf atm robustness
- **NSI test @ NuFact** e-tau NSI-OSC confusion...
- **no hard theory predictions** but suggests Majorana