Comments on the Implications of the SNO Results

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Measurement of charged current interactions produced by ^{8}B solar neutrinos at the Sudbury Neutrino Observatory

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(18 June 2001)

Solar neutrinos from the decay of ^{8}B have been detected at the Sudbury Neutrino Observatory (SNO) via the charged current (CC) reaction on deuterium and by the elastic scattering (ES) of electrons. The CC reaction is sensitive exclusively to ν_e's, while the ES reaction also has a small sensitivity to ν_μ's and ν_τ's. The flux of ν_e's from ^{8}B decay measured by the CC reaction rate is $\phi^{\rm CC}(\nu_e) = 1.75 \pm 0.07$ (stat.)$^{+0.12}_{-0.11}$ (sys.) $\pm$ 0.05 (theor.) $\times 10^6$ cm^{-2}s^{-1}. Assuming no flavor tranformation, the flux inferred from the ES reaction rate is $\phi^{\rm ES}(\nu_x) = 2.39 \pm 0.34$ (stat.)$^{+0.16}_{-0.14}$ (sys.) $\times$ 10^6 cm^{-2}s^{-1}. Comparison of $\phi^{\rm CC}(\nu_e)$ to the Super-Kamiokande Collaboration's precision value of $\phi^{\rm ES}(\nu_x)$ yields a 3.3σ difference, providing evidence that there is a non-electron flavor active neutrino component in the solar flux. The total flux of active ^{8}B neutrinos is thus determined to be $5.44 \pm 0.99 \times 10^6$ cm^{-2}s^{-1}, in close agreement with the predictions of solar models.

FOGLI ET AL., '01

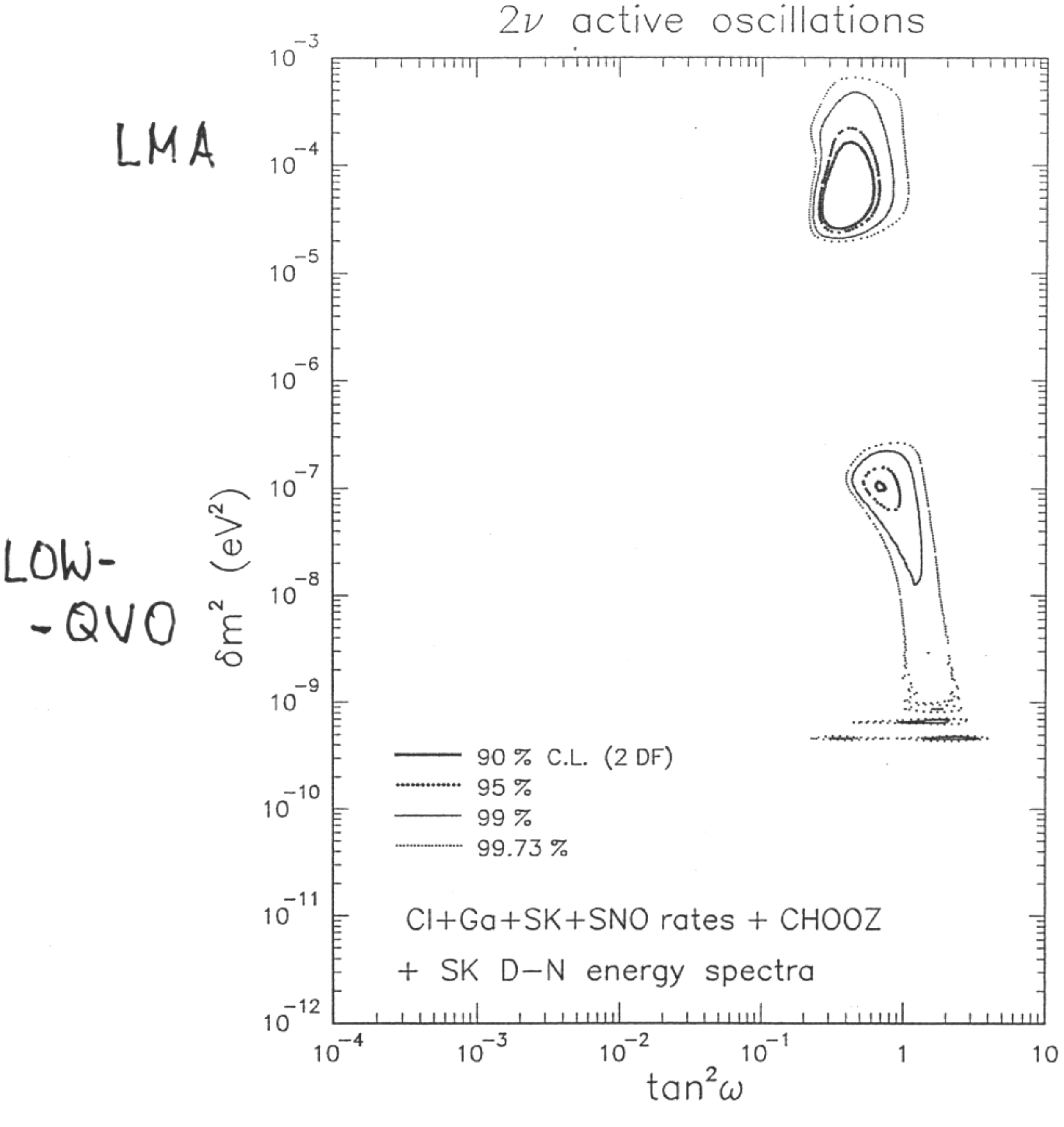


Fig. 7. Post-SNO 2ν oscillation analysis of total neutrino event rates and of SK day-night energy spectra. CHOOZ data included. Solutions at small mixing are highly disfavored. See the text for details.

BEST FIT VALUES:

	Δm^2	$\sin^2 2\theta$	
LMA	$4.9 \cdot 10^{-5}$	0.79	(1)
	$4.4 \cdot 10^{-5}$	0.77	(2)
	$4.5 \cdot 10^{-5}$	0.82	(3)
LOW	$1.1 \cdot 10^{-7}$	0.96	(1)
	10^{-7}	0.97	(3)
SMA	7.9×10^{-6}	$1.3 \cdot 10^{-3}$	(1)
	5.7×10^{-6}	$7.2 \cdot 10^{-3}$	(2)
	4.7×10^{-6}	$1.6 \cdot 10^{-3}$	(3)

(1) FOGLI ET AL.
(2) KRASTEV, SMIRNOV
(3) BAHCALL ET AL.

95% C.L. INTERVALS:

LMA

$$2.5 \cdot 10^{-5} \leq \Delta m^2 \leq 2 \cdot 10^{-4}\, eV^2$$

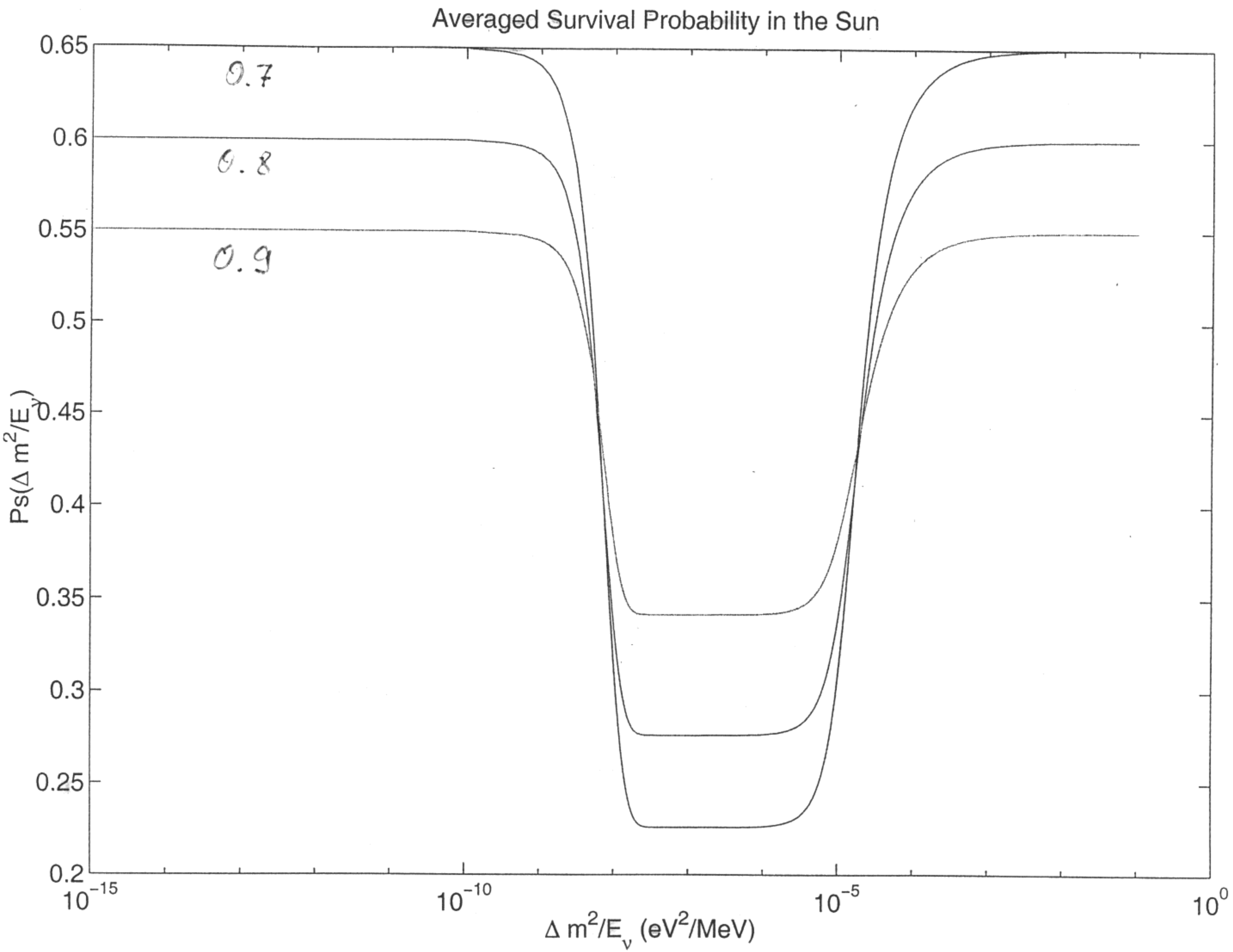
$$0.62 \leq \sin^2 2\theta \leq 0.97 \quad (1)$$

LOW

$$6 \cdot 10^{-8} \leq \Delta m^2 \leq 2 \cdot 10^{-7}\, eV^2$$

$$0.94 \leq \sin^2 2\theta \leq 1.0 \quad (1)$$

(M. MARIS, S.T.P.


Averaged Survival Probability in the Sun
0.7
0.8
0.9
Ps(Δ m^2/E_ν)
Δ m^2/E_ν (eV^2/MeV)
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
10^-15
10^-10
10^-5
10^0

(MARIS, S.T.P.)

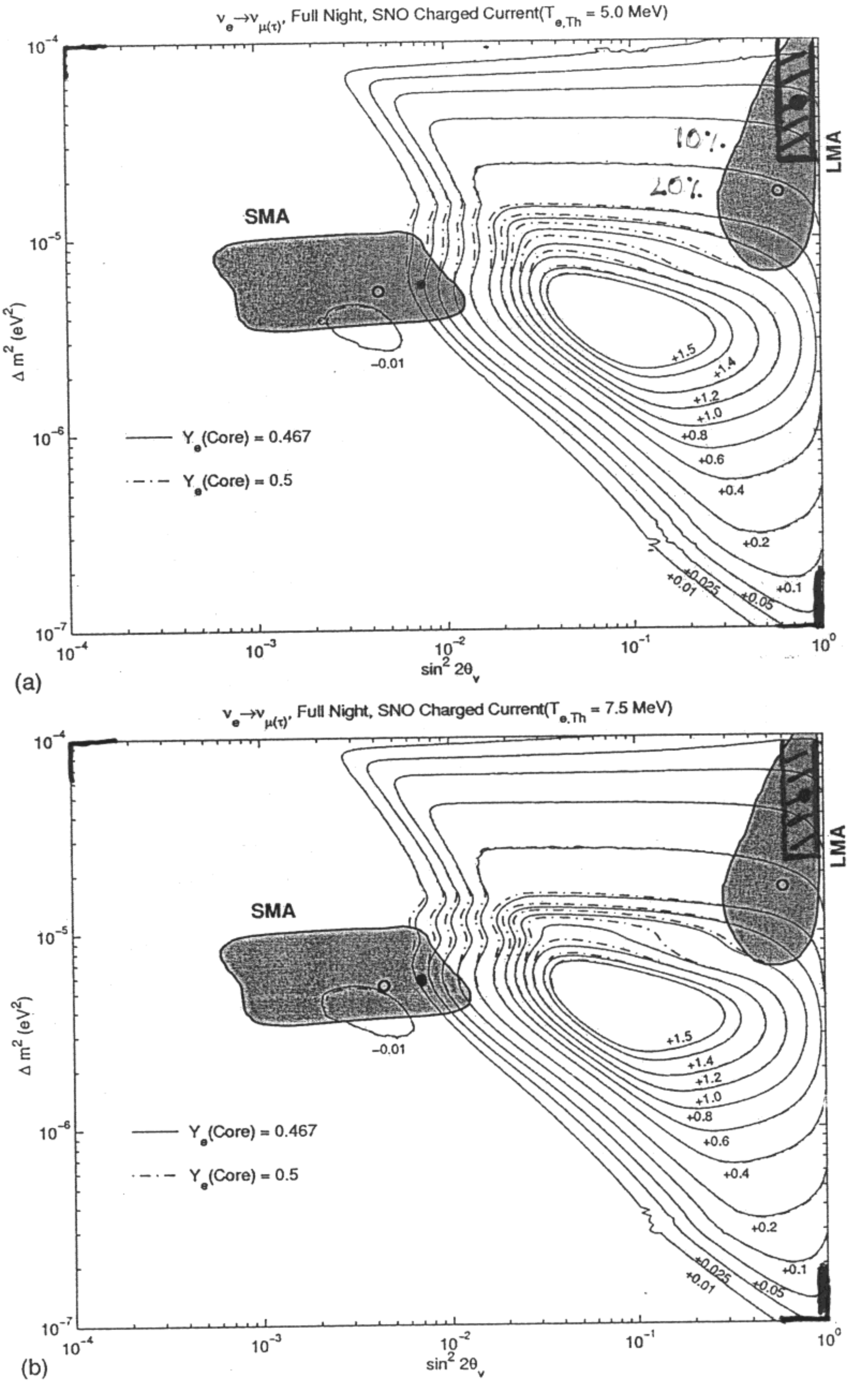
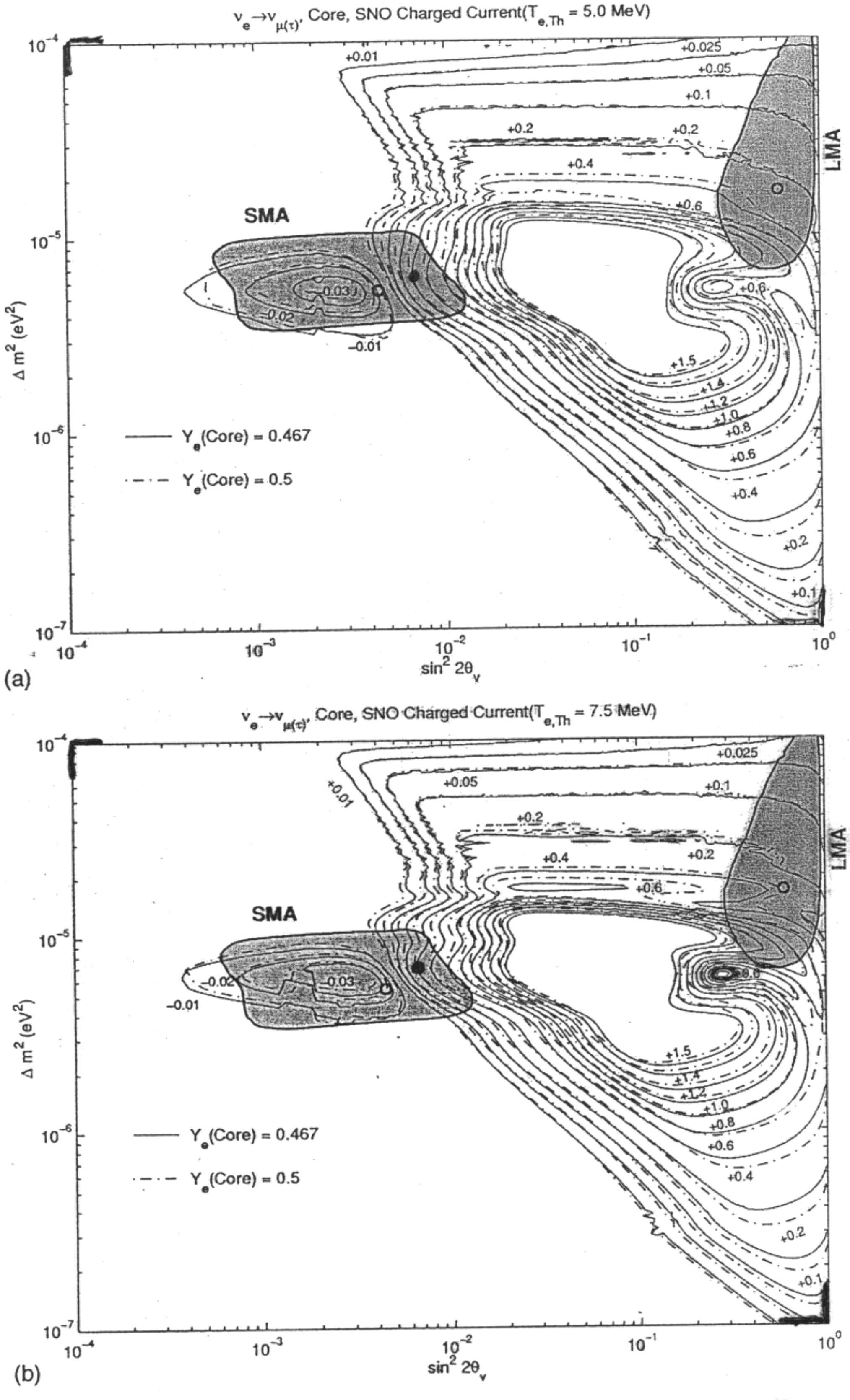


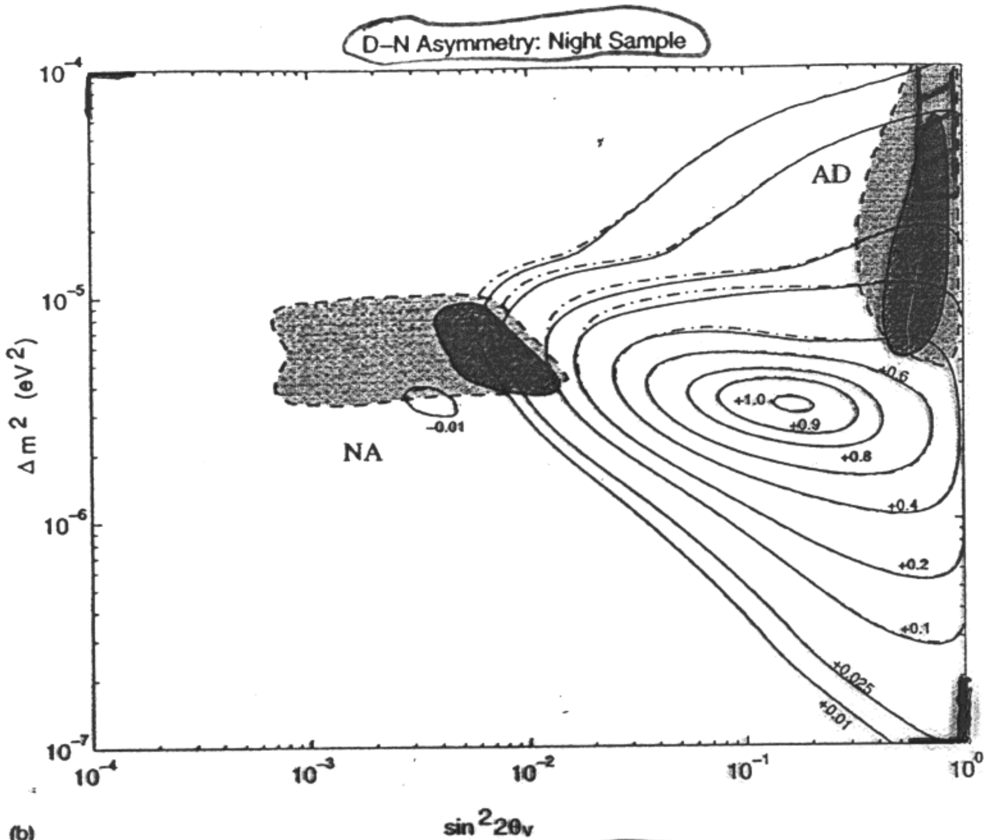
FIG. 4. Iso-(D-N) asymmetry contour plots for the one year average CC *Night* asymmetries for the SNO detector in the case of the $\nu_e \to \nu_{\mu(\tau)}$ transitions and $T_{e,th} = 5.0$ (a); 7.5 (b) MeV. The solid (dash-dotted) lines correspond to $Y_e^c = 0.467$ (0.500). The MSW SMA and LMA "conservative" solution regions from Ref. [11] are also shown.



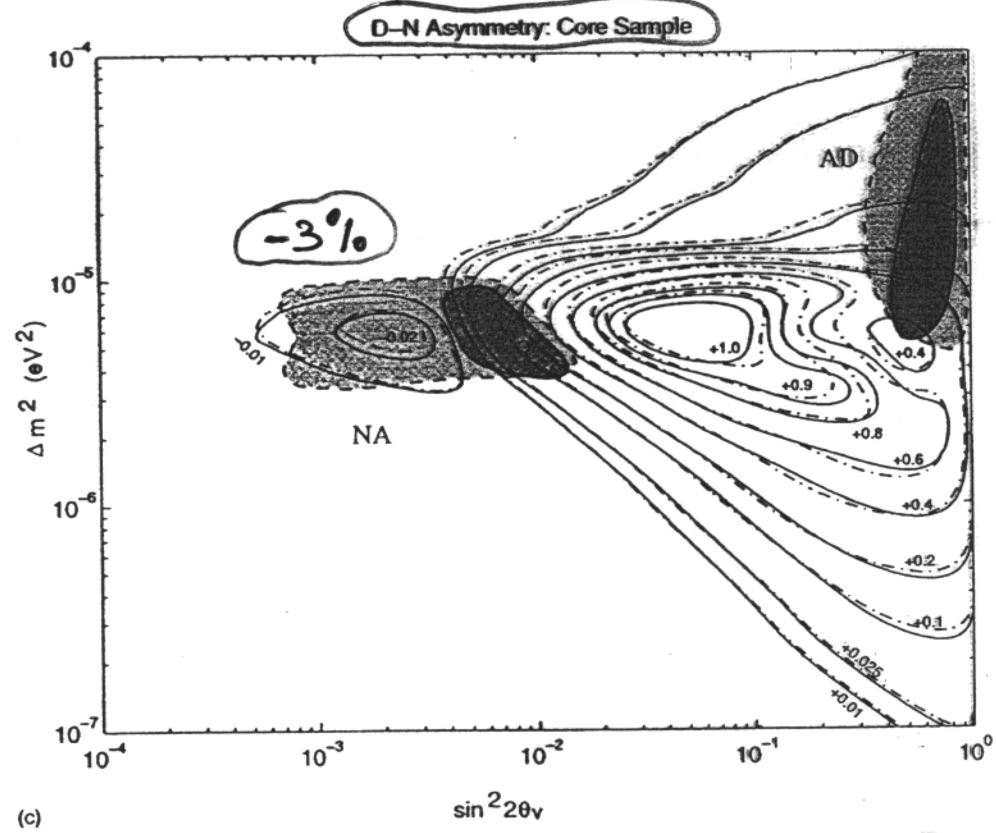
• SMA B.F.P.

FIG. 5. Same as Fig. 4 but for the *Core* asymmetries. The dash-dotted lines correspond to $Y_e^c = 0.500$.

(M. MARIS, S.T.P. '97)



(b)



(c)

FIG. 3 (*Continued*).

mantle and the core samples cross each other nearly perpendicularly. Therefore, if $\sin^2 2\theta_V \gtrsim 8\times 10^{-3}$ and $3.5\times 10^{-6}\ \mathrm{eV}^2 \lesssim \Delta m^2 \lesssim 6\times 10^{-6}\ \mathrm{eV}^2$, it should be possible to reduce considerably the allowed NA region by just combining the experimental results for $A^C_{\text{D-N}}$ and $A^M_{\text{D-N}}$. Outside this region the D-N effect can be detectable only in the core sample for $\sin^2 2\theta_V \gtrsim 5\times 10^{-3}$. If, for instance, a + 10% D-N asymmetry will be detected in the core sample and no D-N asymmetry will be observed in the mantle sample, the NA solution region would be restricted to a narrow band along

SNO:

$$\Phi(\nu_e) = 1.75 \pm 0.15 \times 10^6\ cm^{-2}s^{-1}$$

$$\Phi(\nu_{\mu,\tau}) = 3.69 \pm 1.17 \times 10^6\ cm^{-2}s^{-1}$$

$$\frac{\Phi(\nu_e)}{\Phi(\nu_e) + \Phi(\nu_{\mu,\tau})} = 0.32 \pm 0.07$$

$$= \frac{R^{CC}_{SNO} / R^{NC}_{SNO}}{(R^{CC}_{SNO} / R^{NC}_{SNO})_{SSM}}$$

$$R^{CC/NC} = 0.25 - 0.39$$

$$0.18 - 0.46$$

(P.I. KRASTEV, S.T.P. '96,

R_{CC}/R_{NC} at SNO

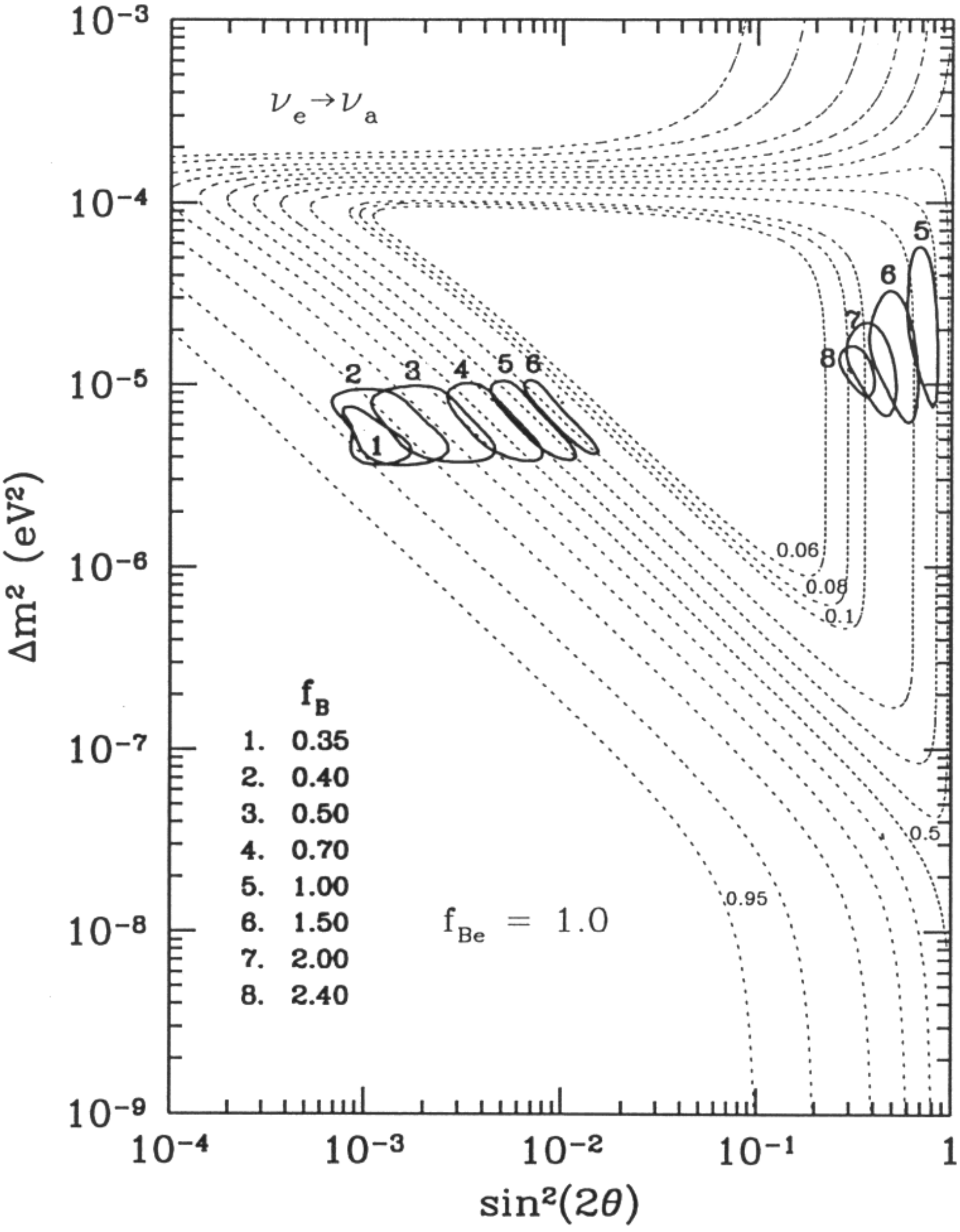
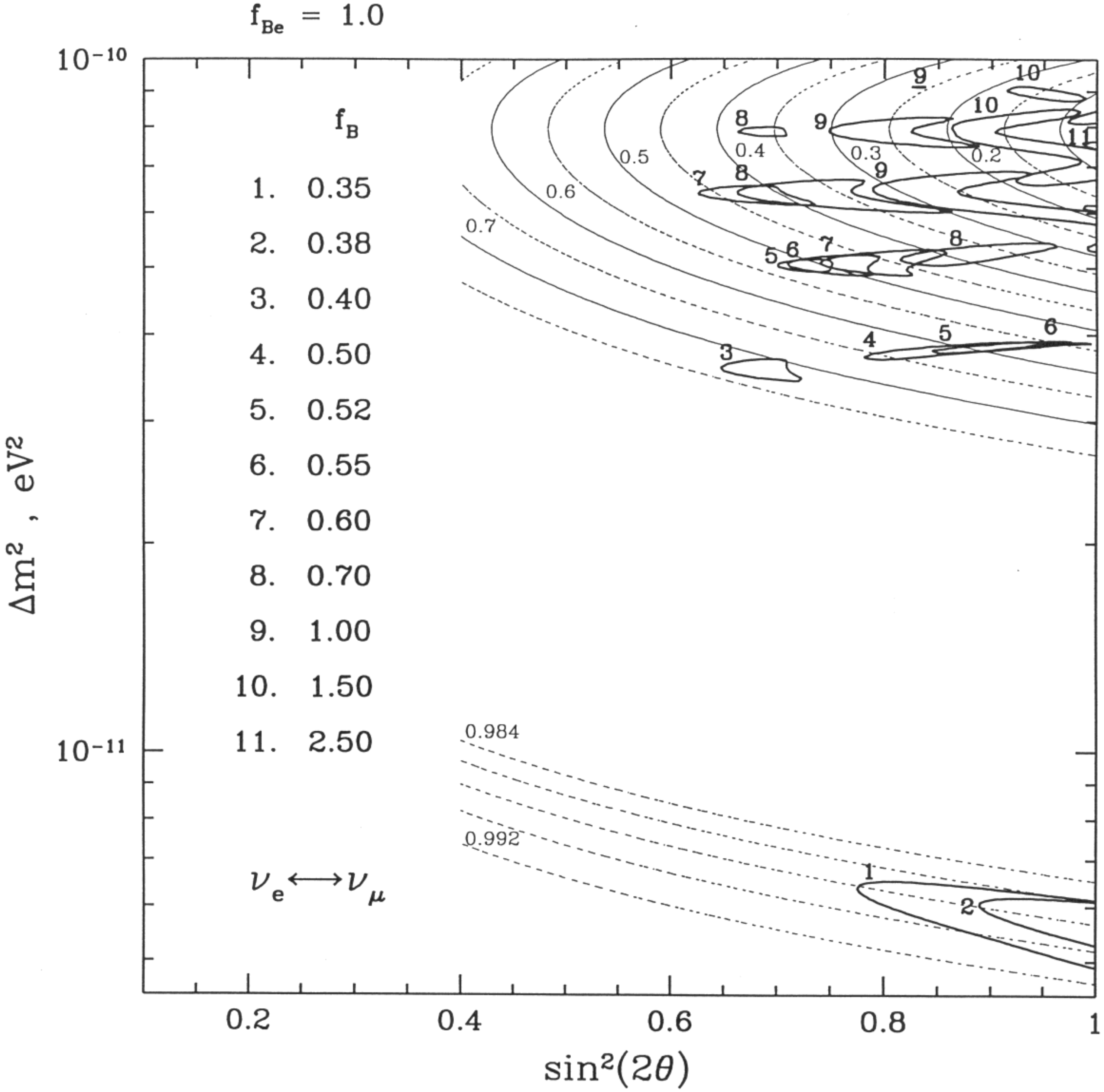
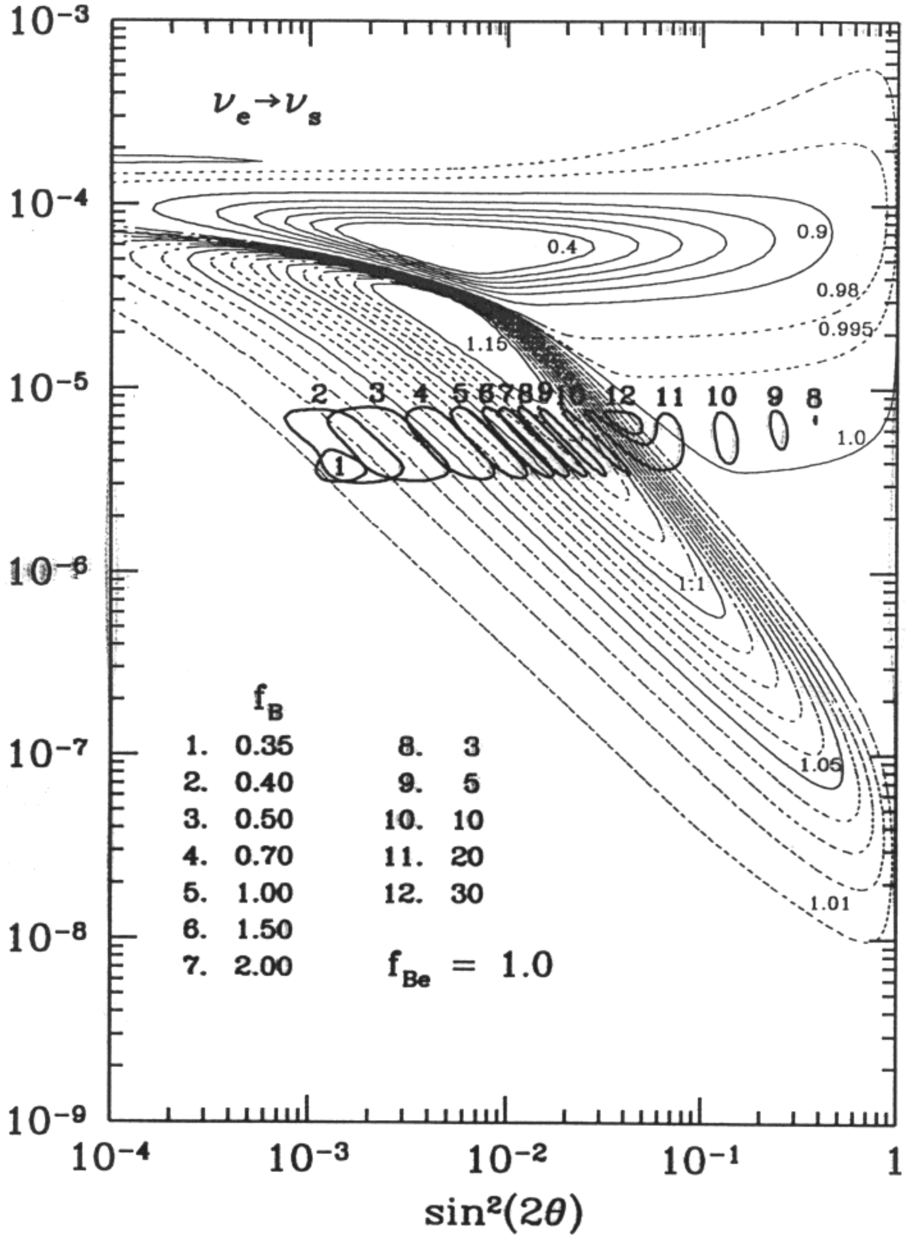


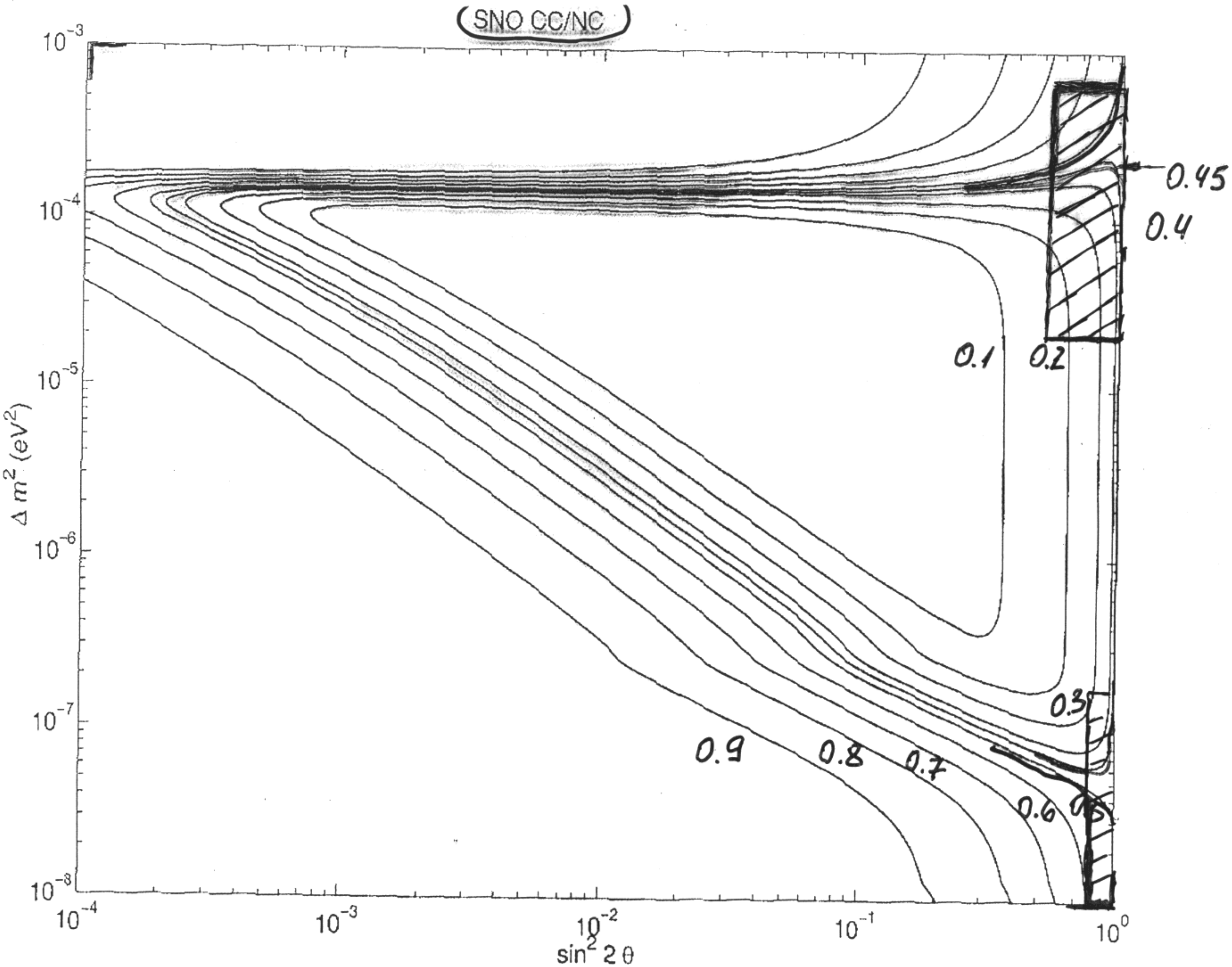
Fig.1b

(P. I. KRASTEV, S.T.P. '96)

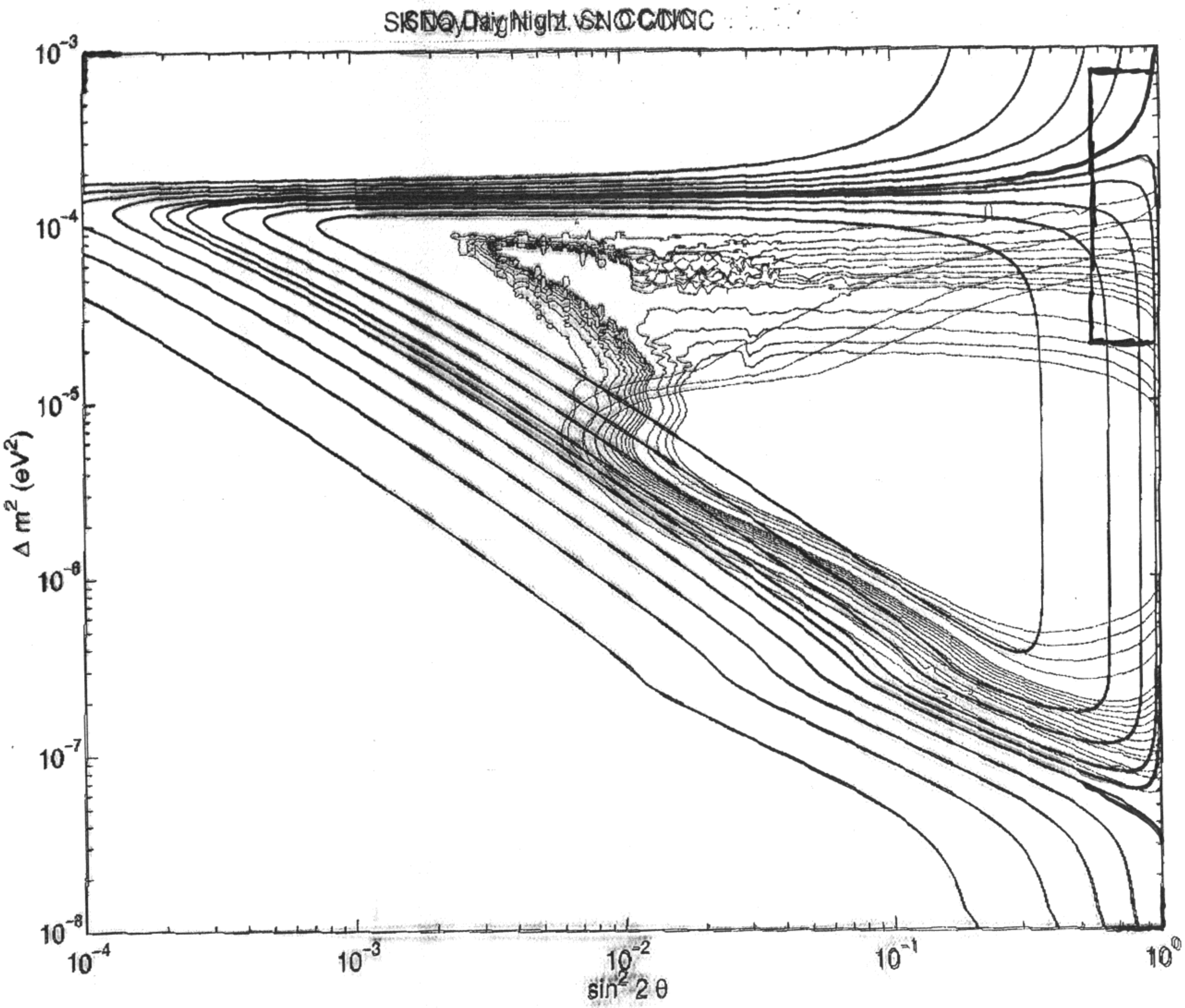


(P.I. KRASTEV, S.T.P. '96)





SNO CC/NC
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
Δm^2 (eV^2)
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
$\sin^2 2\theta$
0.45
0.4
0.1
0.2
0.3
0.9
0.8
0.7
0.6



Δ m² (eV²)
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁴
10⁻³
10⁻²
10⁻¹
10⁰
sin² 2 θ