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Final state interaction in neutrino-nucleus scattering

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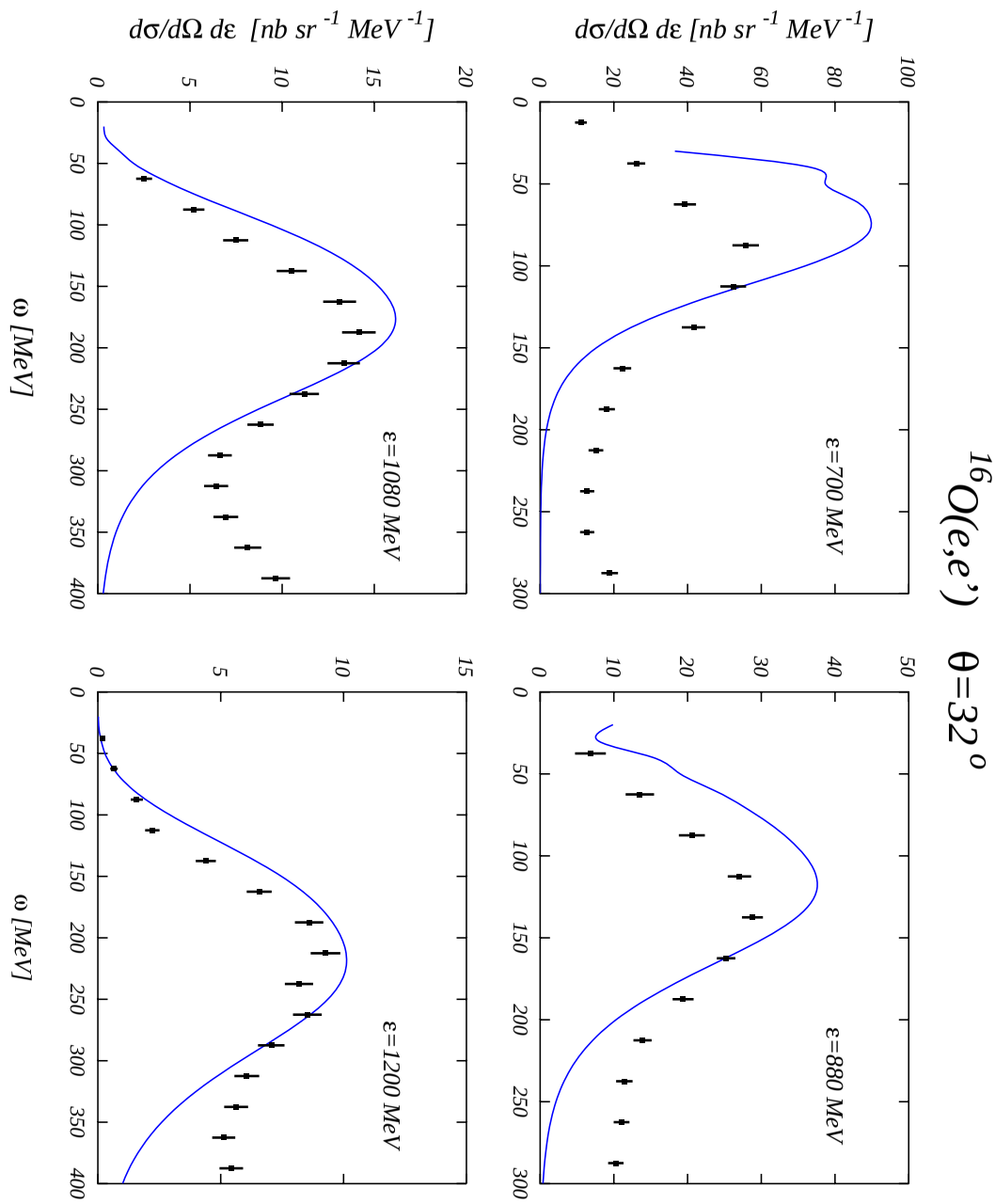
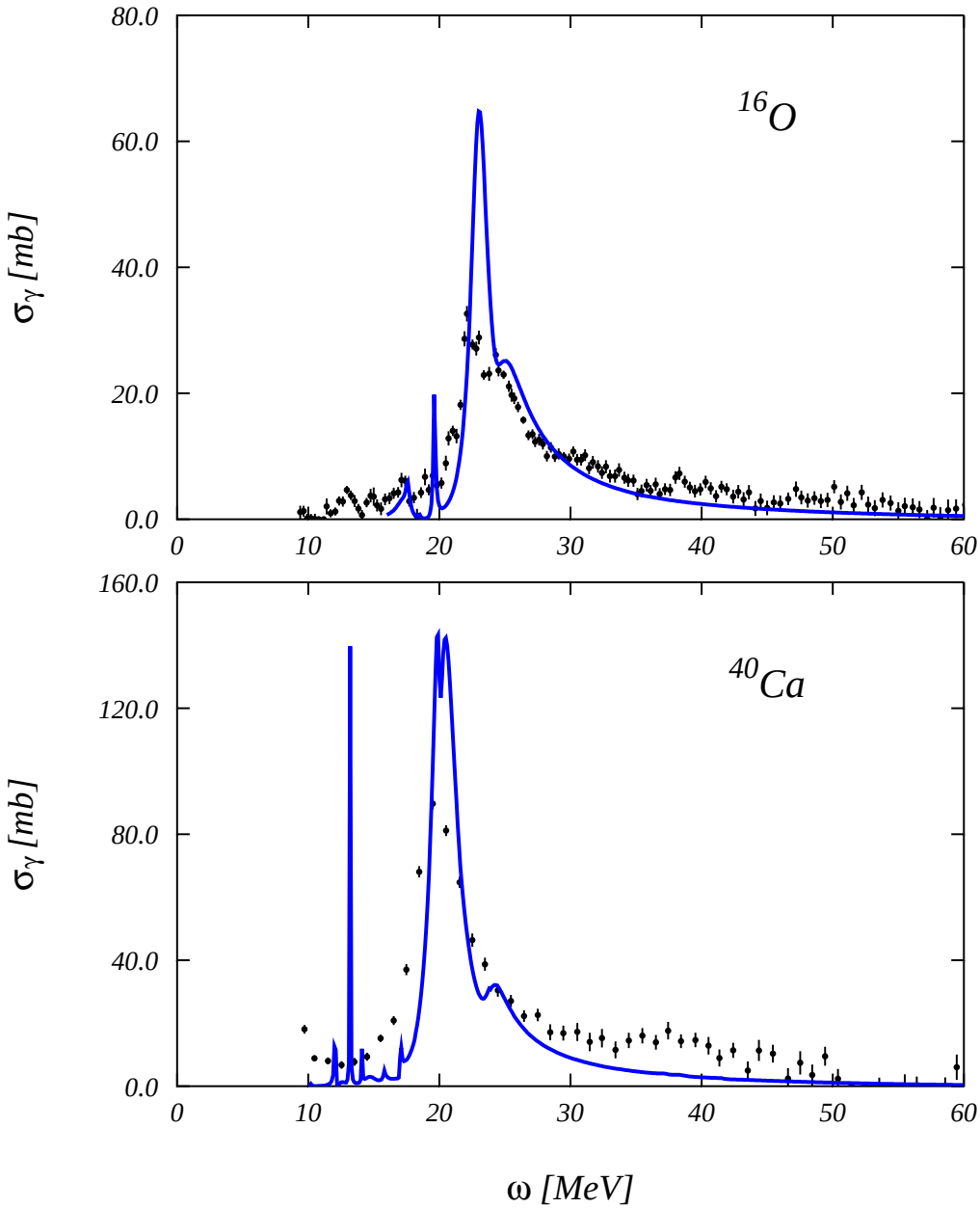
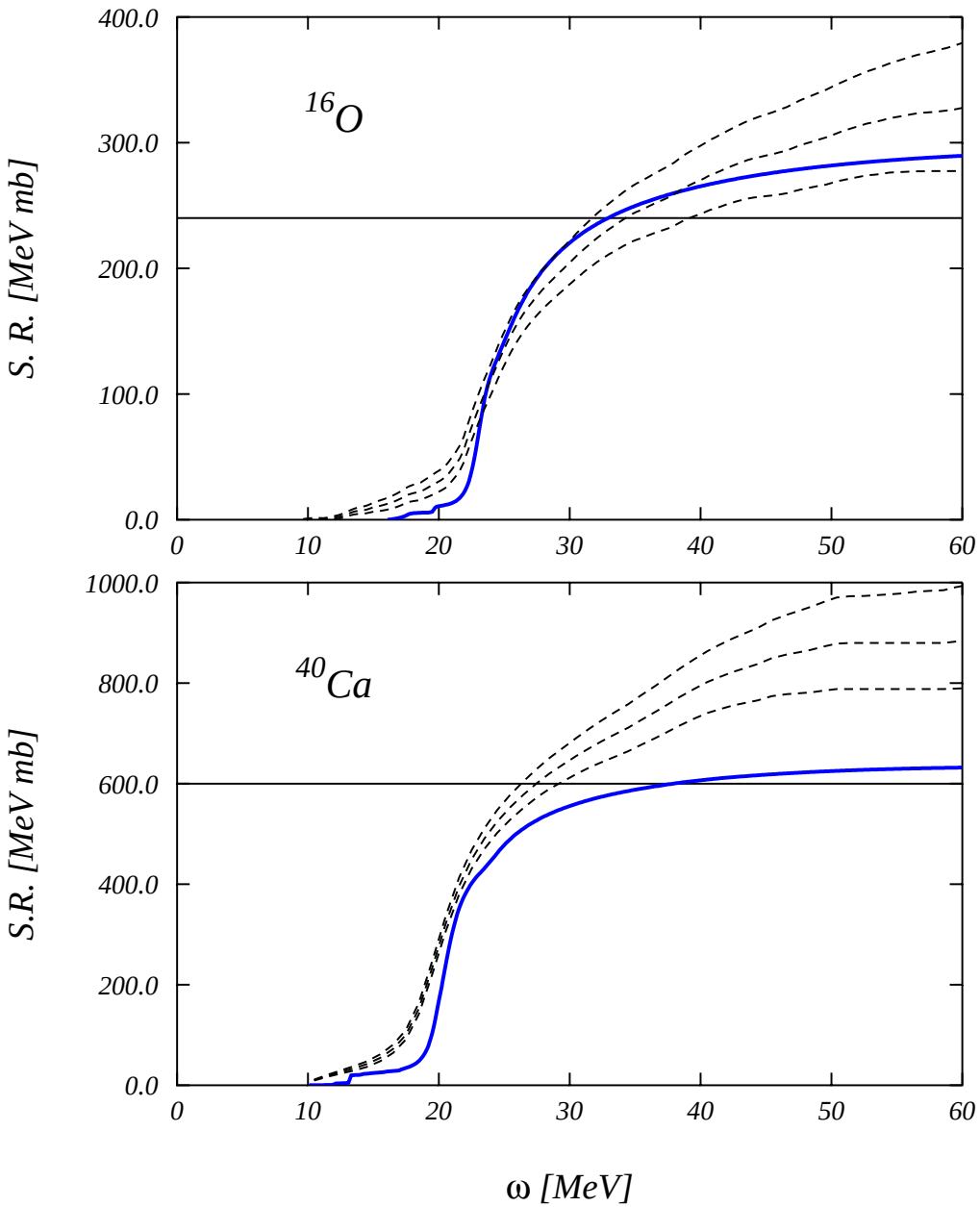
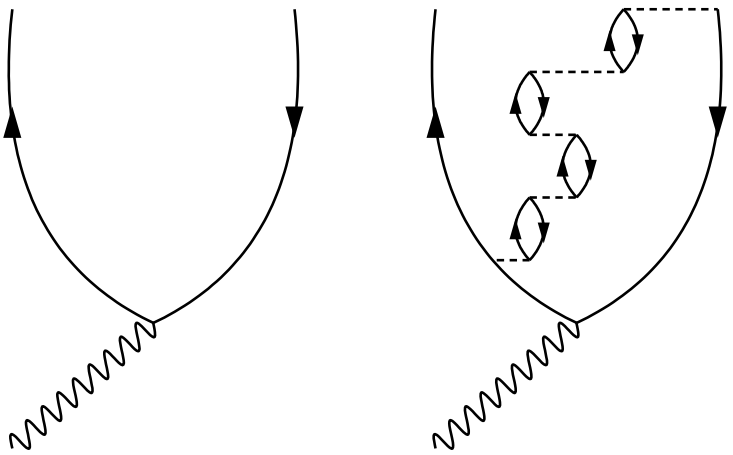
DATA : M. Anghinolfi et al. , Nucl. Phys. A602 (1996) 405.



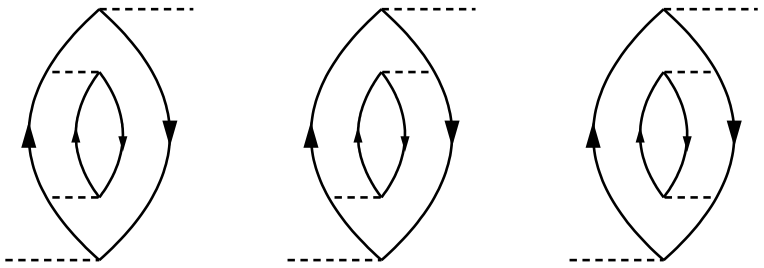
DATA : J. Ahrens et al. , Nucl. Phys. A251 (1975) 479.




400.0
300.0
200.0
100.0
0.0
^{16}O
S. R. [MeV mb]
0
10
20
30
40
50
60
1000.0
800.0
600.0
400.0
200.0
0.0
^{40}Ca
S.R. [MeV mb]
ω [MeV]



MF *RPA*



A *B* *C*

$$H = H_0 + H_1 \qquad H_0|\Phi_n >= E_n|\Phi_n >$$

$$S^0(|\mathbf{q}|,\omega) = \frac{1}{\pi} Im \sum_{n,n'} < \Phi_0|\mathcal{O}^+(\mathbf{q})|\Phi_n >$$
$$\left[\frac{1}{E_n\delta_{n,n'} - \omega - i\eta} + \frac{1}{E_n\delta_{n,n'} + \omega + i\eta}\right]$$
$$< \Phi_{n'}|\mathcal{O}(\mathbf{q})|\Phi_0 >$$

$$S(|\mathbf{q}|,\omega) = \frac{1}{\pi} Im \sum_{n,n'} < \Phi_0|\mathcal{O}^+(\mathbf{q})|\Phi_n >$$
$$\left[\frac{1}{E_n\delta_{n,n'} - \omega - \Sigma_{n,n'}(\omega) - i\eta}\right.$$
$$\left. + \frac{1}{E_n\delta_{n,n'} + \omega - \Sigma_{n,n'}(-\omega) + i\eta}\right]$$
$$< \Phi_{n'}|\mathcal{O}(\mathbf{q})|\Phi_0 >$$

$$\Sigma_{n,n'}(\omega) \rightarrow \Sigma(\omega)\delta_{n,n'} \rightarrow \Delta(\omega) - \frac{i}{2}\Gamma(\omega)$$

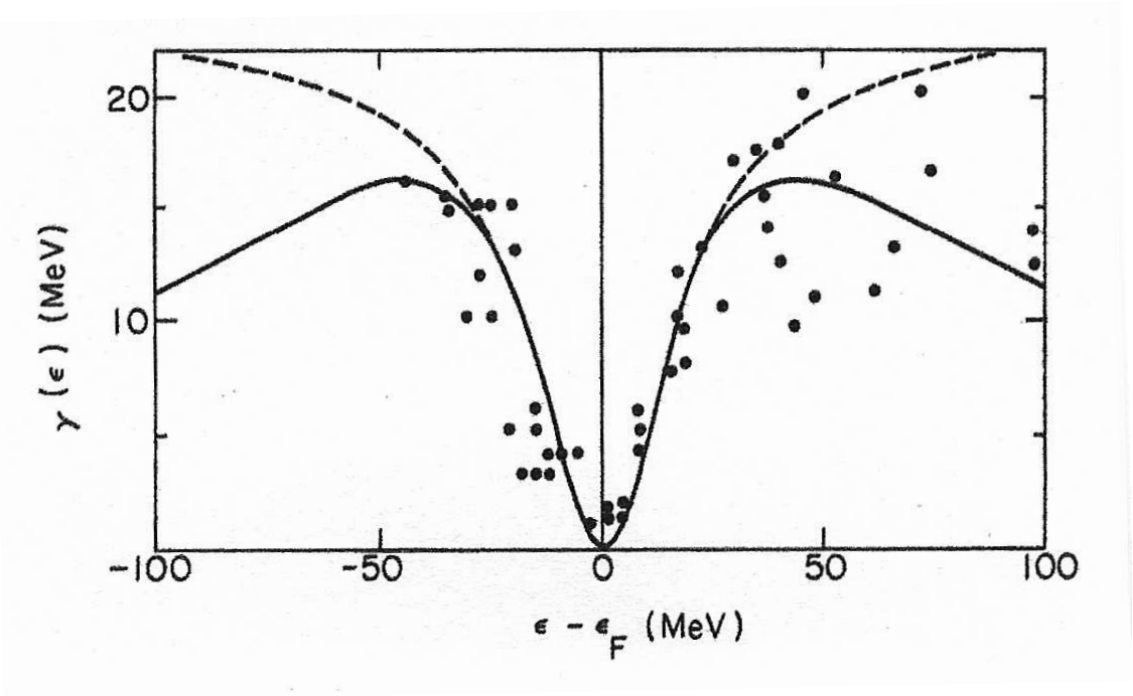
$$S(|\mathbf{q}|,\omega) = \int_0^\infty dE \;\; S^0(|\mathbf{q}|,E)\left[\rho(E,\omega) + \rho(E,-\omega)\right]$$

$$\rho(E,\omega) = \frac{1}{2\pi}\frac{\Gamma(\omega)}{[E-\omega-\Delta(\omega)]^2 + [\Gamma(\omega)/2]^2}$$

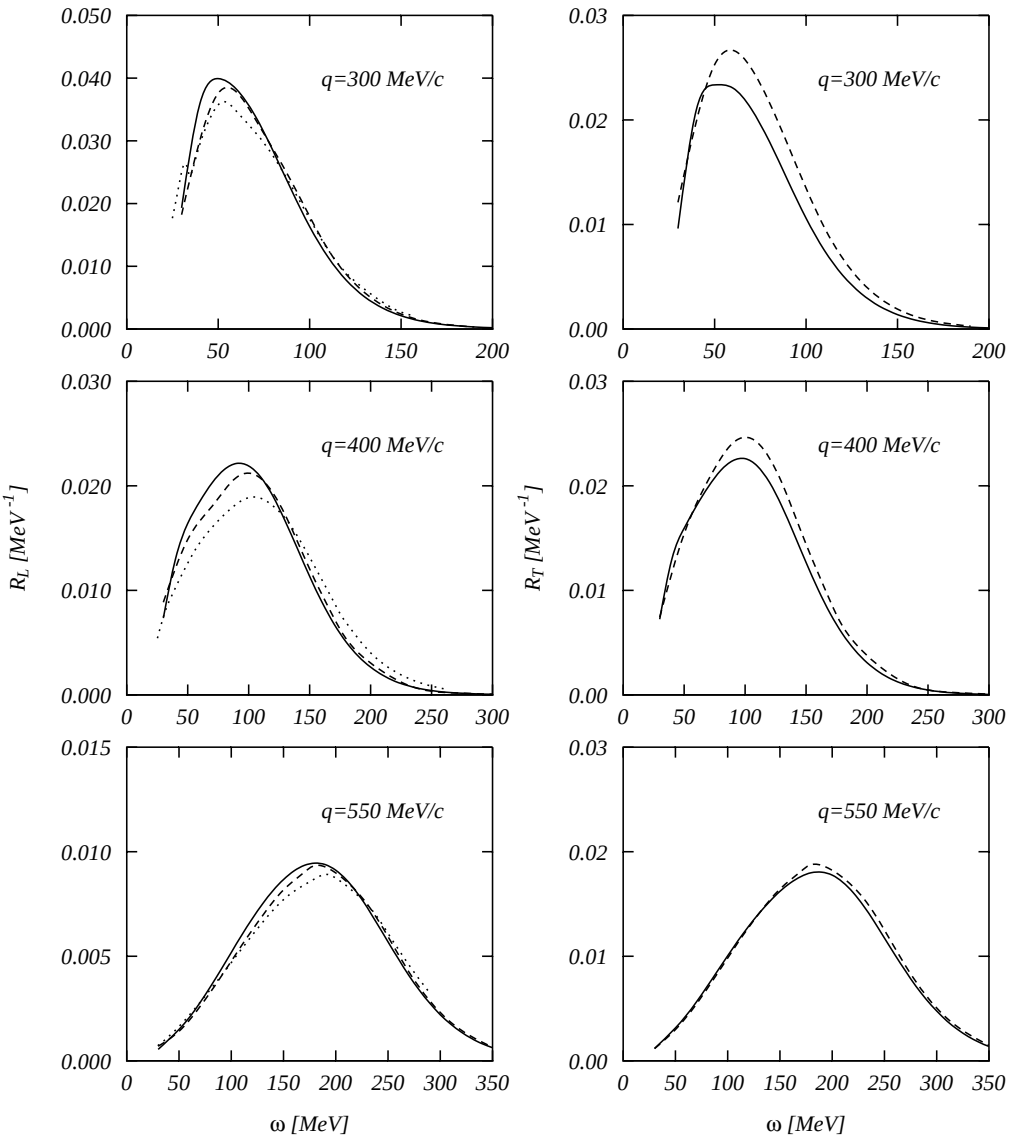
$$\Delta(\omega) = \frac{1}{2\pi}P\int_0^\infty d\omega' \;\; \frac{\Gamma(\omega')}{\omega'-\omega}$$

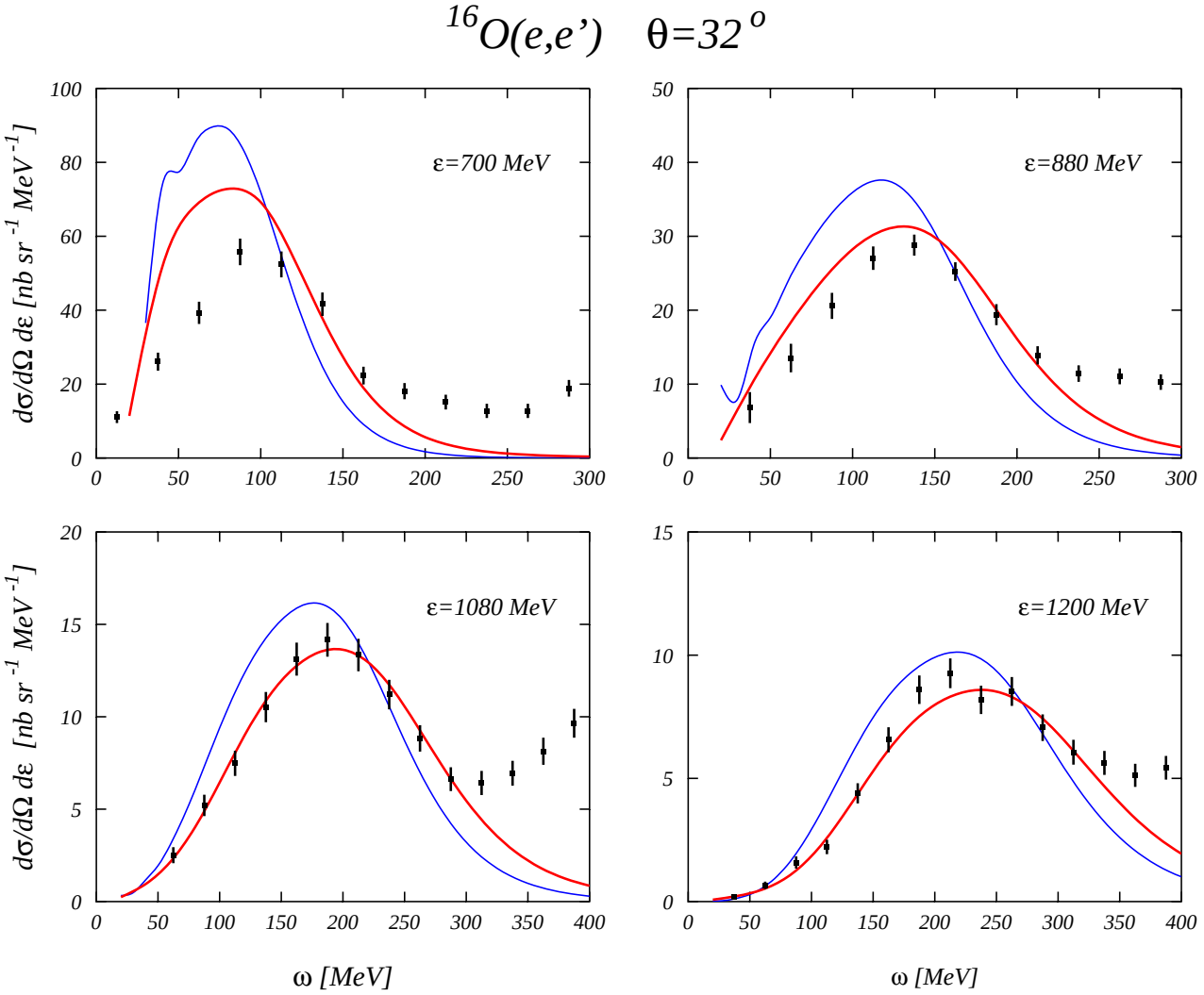
$$\Gamma(\omega) \sim \frac{1}{\omega}\int_0^{\omega} d\epsilon\,[\gamma(\epsilon_F+\epsilon+\omega)+\gamma(\epsilon_F+\epsilon-\omega)]$$

$$\gamma(\epsilon) = A_\Gamma\left(\frac{\epsilon^2}{\epsilon^2+{B_\Gamma}^2}\right)\left(\frac{{C_\Gamma}^2}{\epsilon^2+{C_\Gamma}^2}\right)$$



^{12}C

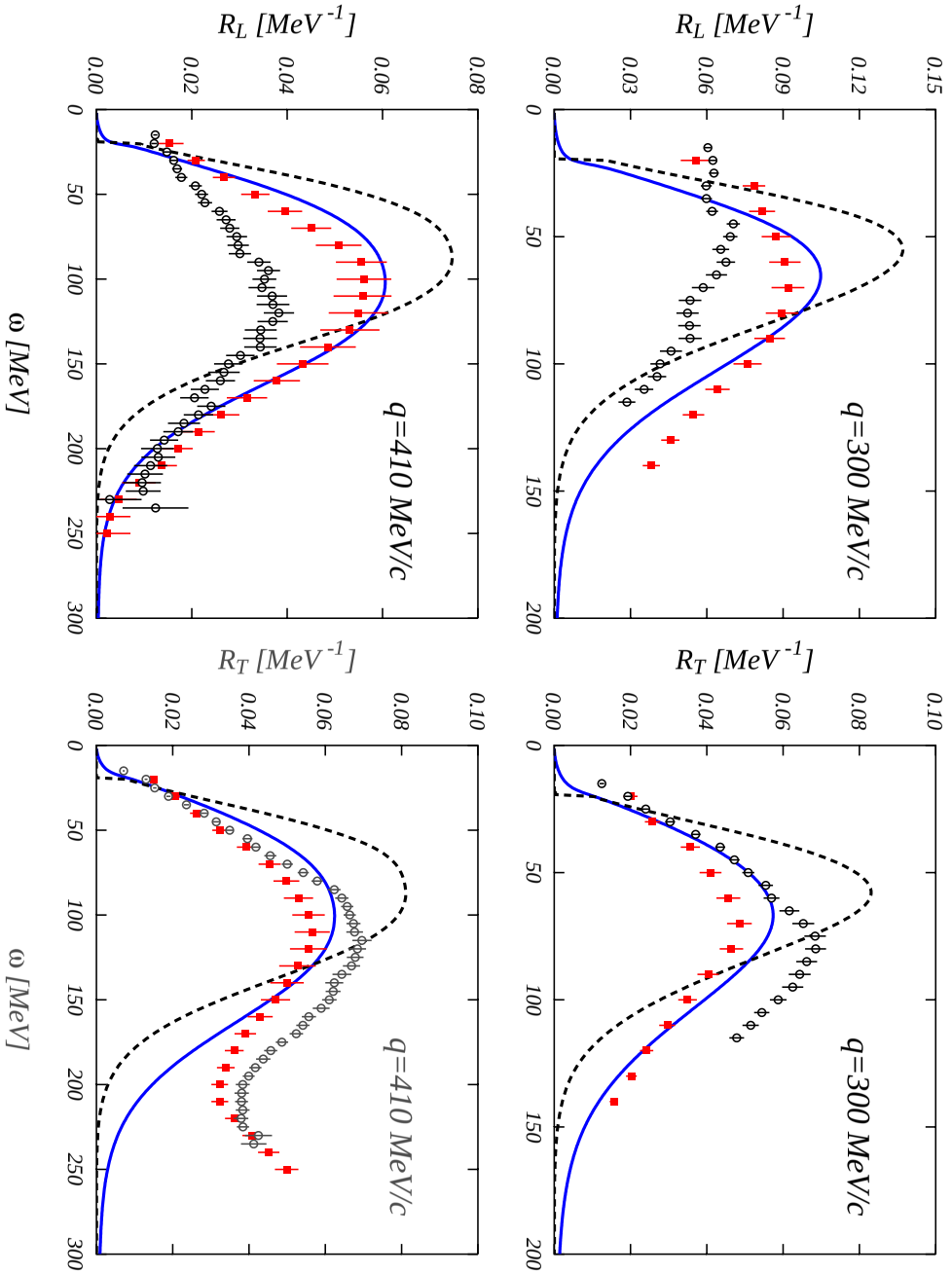


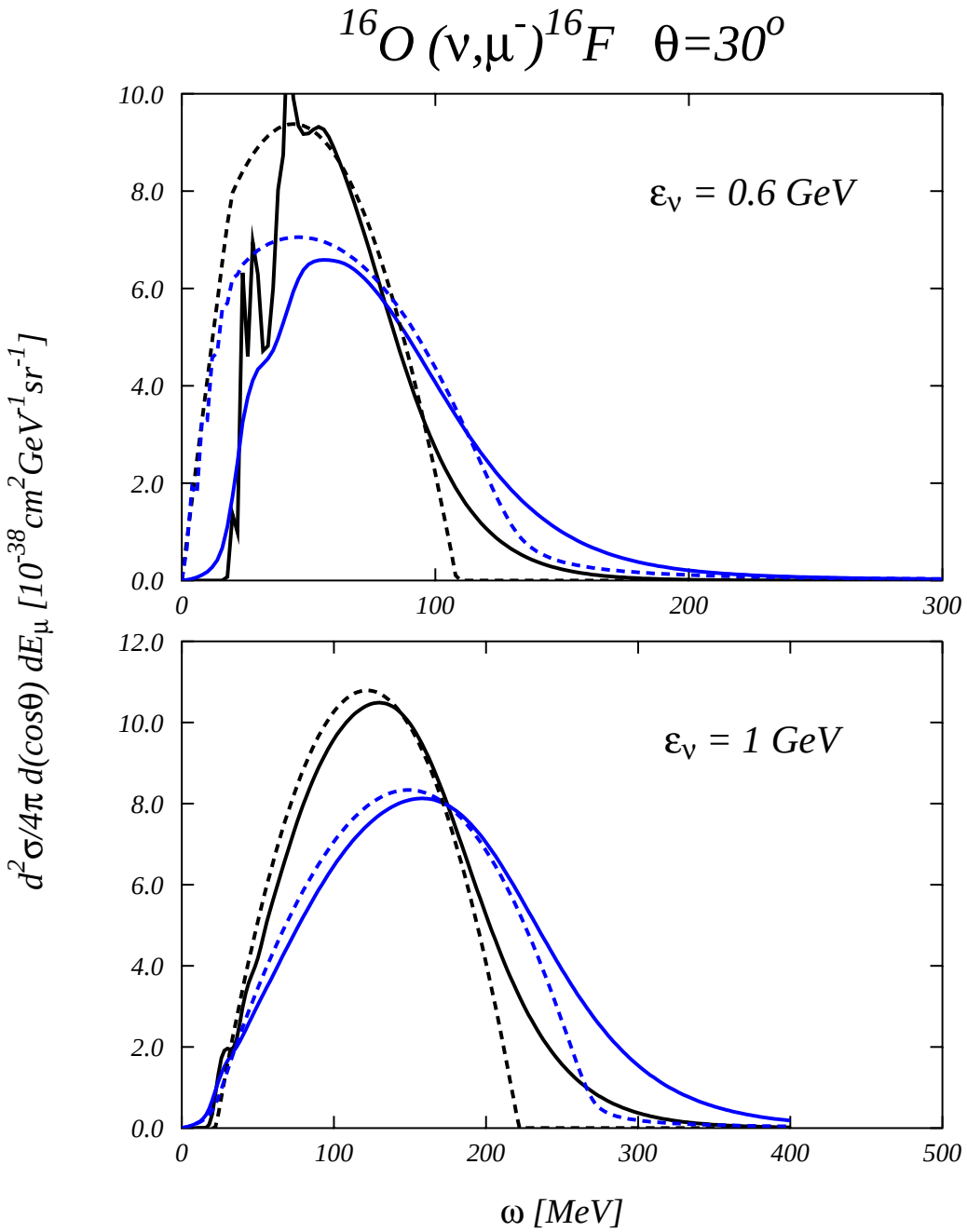

$^{16}O(e,e')$ θ=32°
ε=700 MeV
ε=880 MeV
ε=1080 MeV
ε=1200 MeV
dσ/dΩ dε [nb sr^{-1} MeV^{-1}]
ω [MeV]

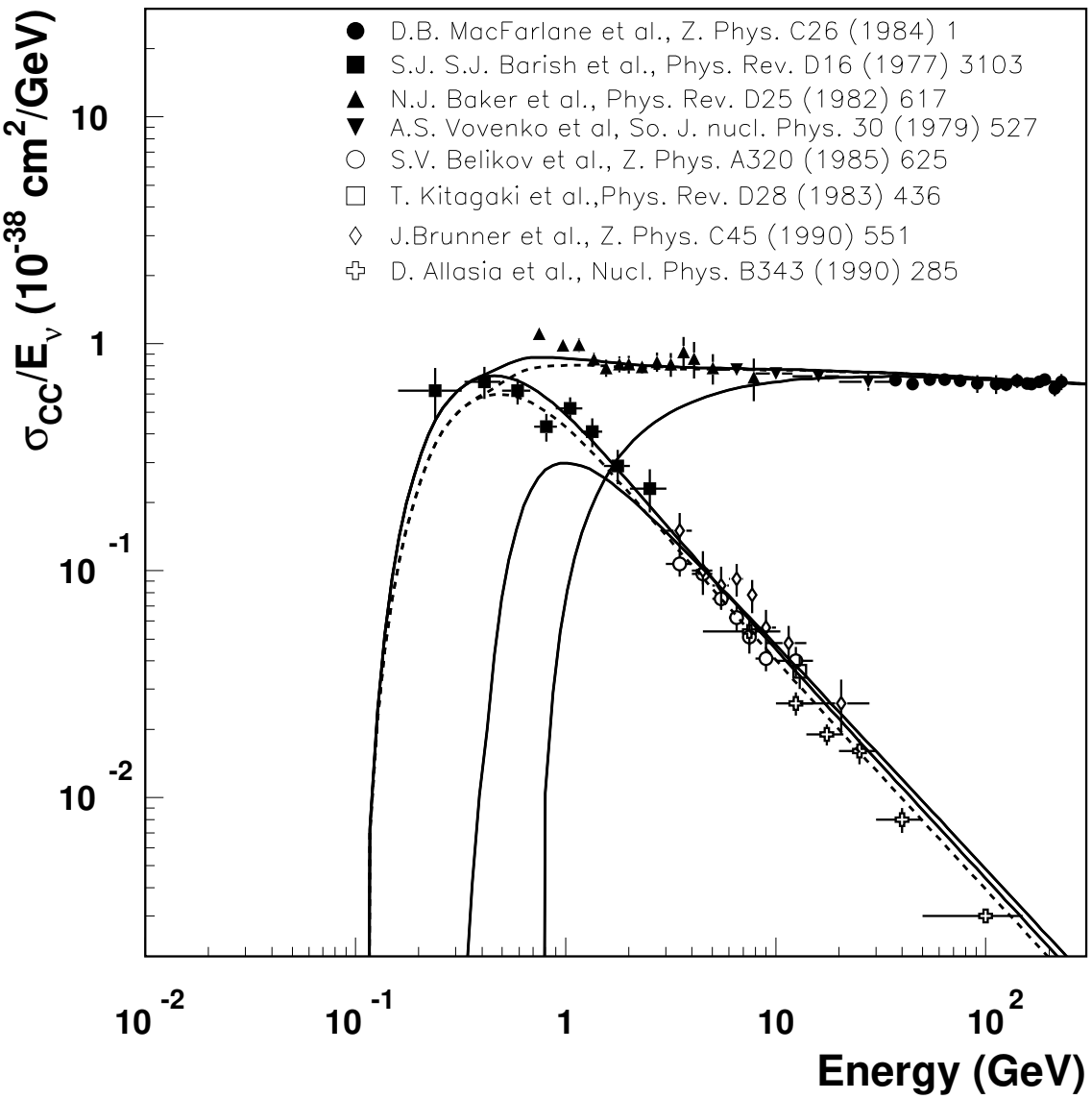
Z.E. Meziani et al. Phys. Rev. Lett. 52 (1984) 2130.

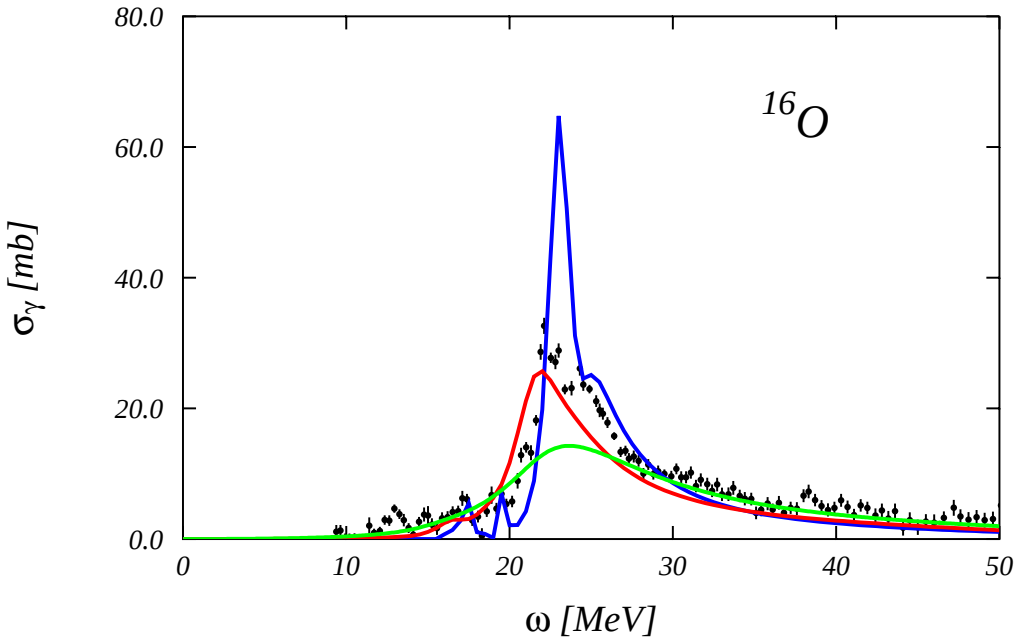
Z.E. Meziani et al. Phys. Rev. Lett. 54 (1985) 1233.

C.F. Williamson et al. Phys. Rev. C 56 (1997) 3152.

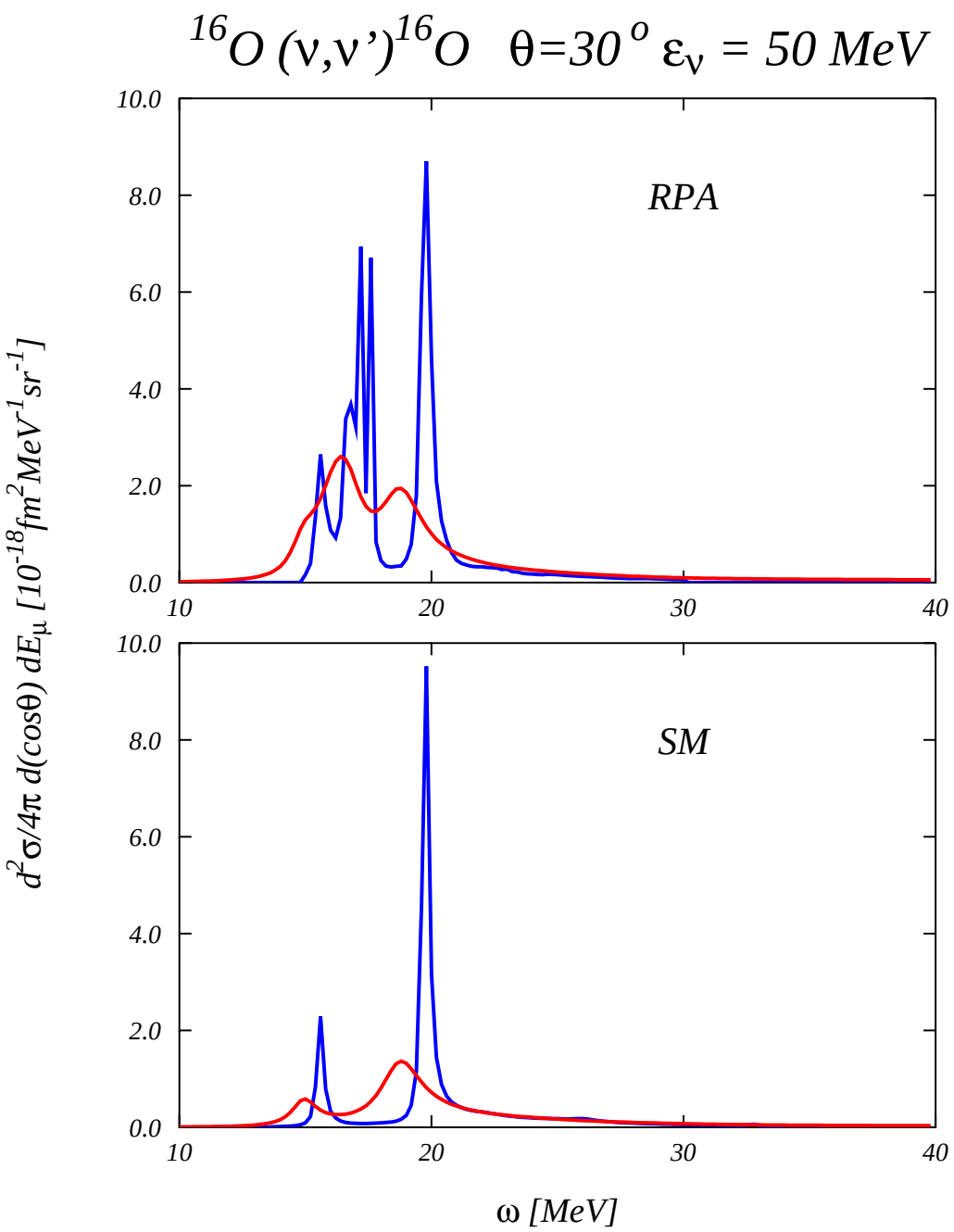


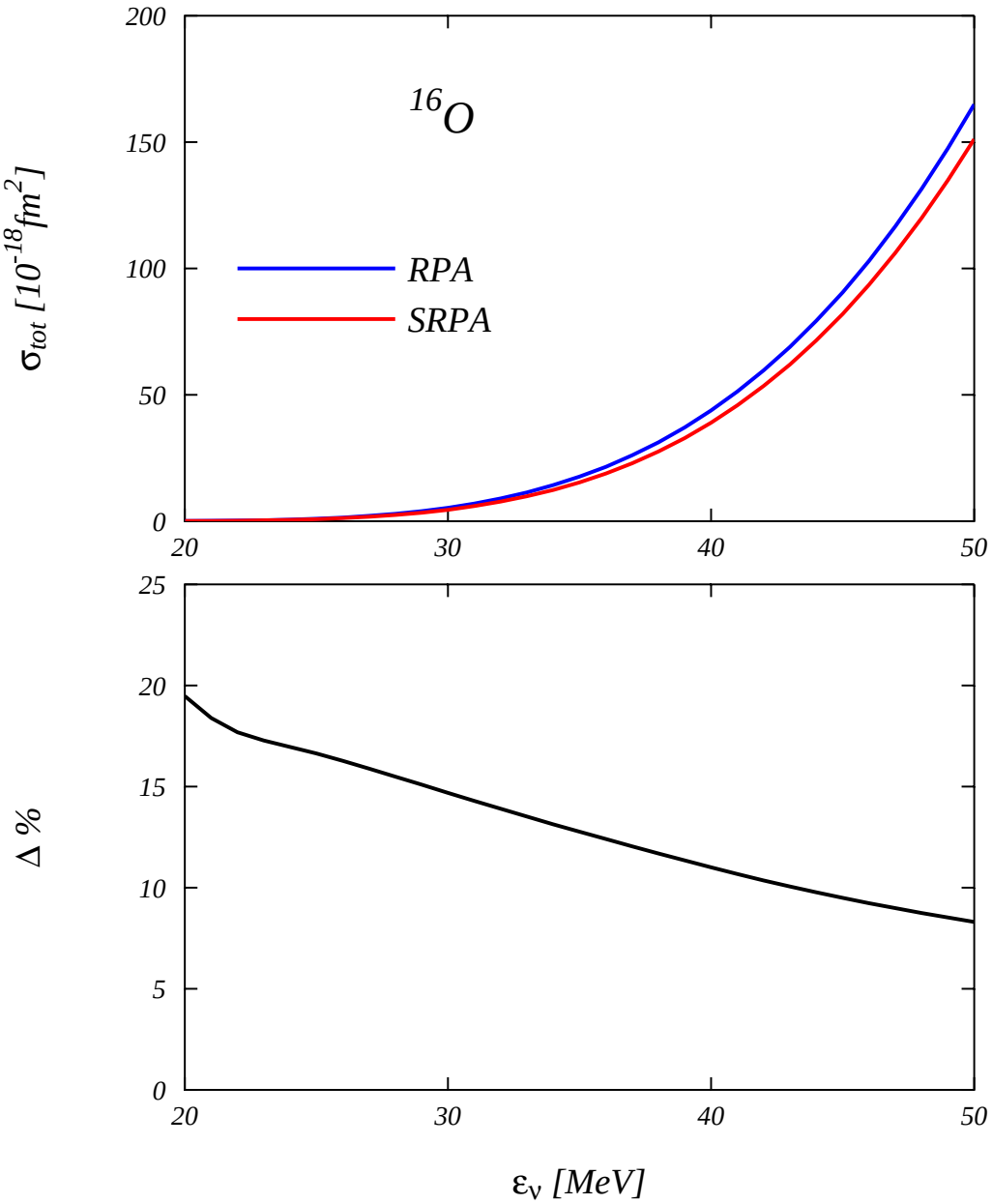

$^{16}O\ (\nu,\mu^-)^{16}F\quad \theta=30^o$
ε_ν = 0.6 GeV
ε_ν = 1 GeV
$d^2\sigma/4\pi\ d(cos\theta)\ dE_\mu\ [10^{-38} cm^2 GeV^{-1} sr^{-1}]$
ω [MeV]
0.0
2.0
4.0
6.0
8.0
10.0
12.0
0
100
200
300
400
500


D.B. MacFarlane et al., Z. Phys. C26 (1984) 1
S.J. S.J. Barish et al., Phys. Rev. D16 (1977) 3103
N.J. Baker et al., Phys. Rev. D25 (1982) 617
A.S. Vovenko et al, So. J. nucl. Phys. 30 (1979) 527
S.V. Belikov et al., Z. Phys. A320 (1985) 625
T. Kitagaki et al.,Phys. Rev. D28 (1983) 436
J.Brunner et al., Z. Phys. C45 (1990) 551
D. Allasia et al., Nucl. Phys. B343 (1990) 285
σ_{CC}/E_ν (10^{-38} cm^2/GeV)
10
1
10^{-1}
10^{-2}
10^{-2}
10^{-1}
1
10
10^2
Energy (GeV)



ω (MeV)	10.0	40.0
A_Γ (MeV)	8.0	11.0
B_Γ (MeV)	40.0	20.0
C_Γ (MeV)	60.0	110.0


^{16}O (ν,ν')^{16}O θ=30° ε_ν = 50 MeV
RPA
SM
$d^2\sigma/4\pi\, d(\cos\theta)\, dE_\mu$ [$10^{-18} fm^2 MeV^{-1} sr^{-1}$]
ω [MeV]
10.0
8.0
6.0
4.0
2.0
0.0
10
20
30
40


^{16}O
RPA
SRPA
σ_{tot} [$10^{-18}fm^2$]
200
150
100
50
0
20
30
40
50
Δ %
25
20
15
10
5
0
ε_ν [MeV]