Can be large nn' mixing angles excluded from the known heavy water absorption x-sections?

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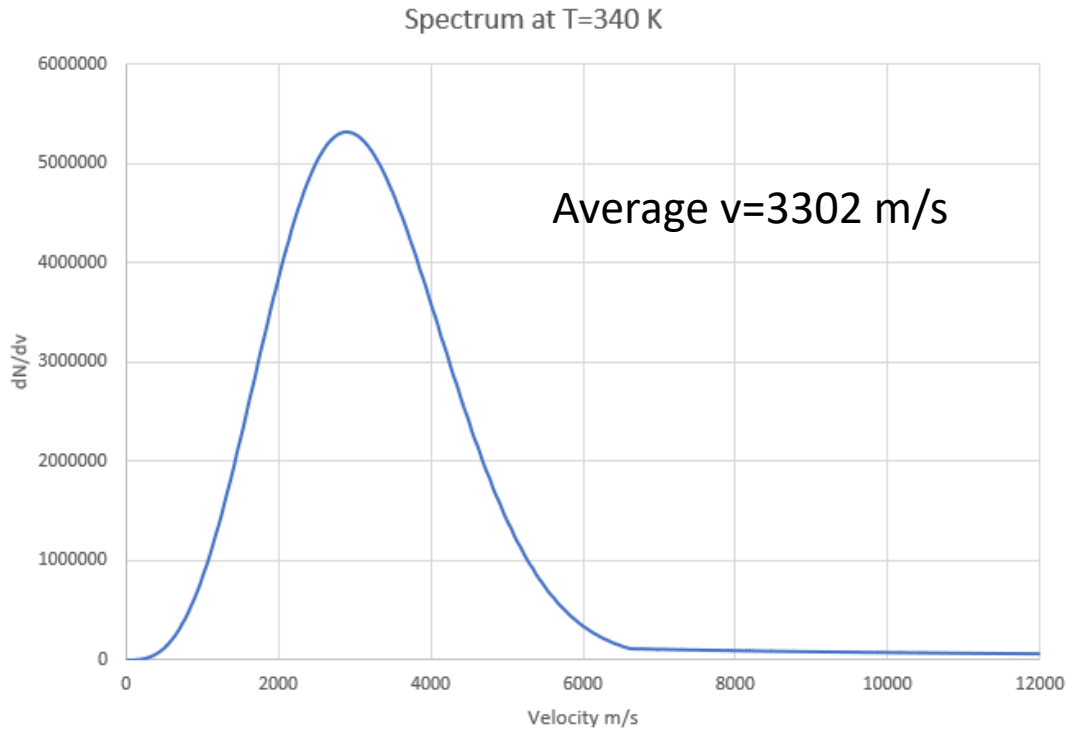
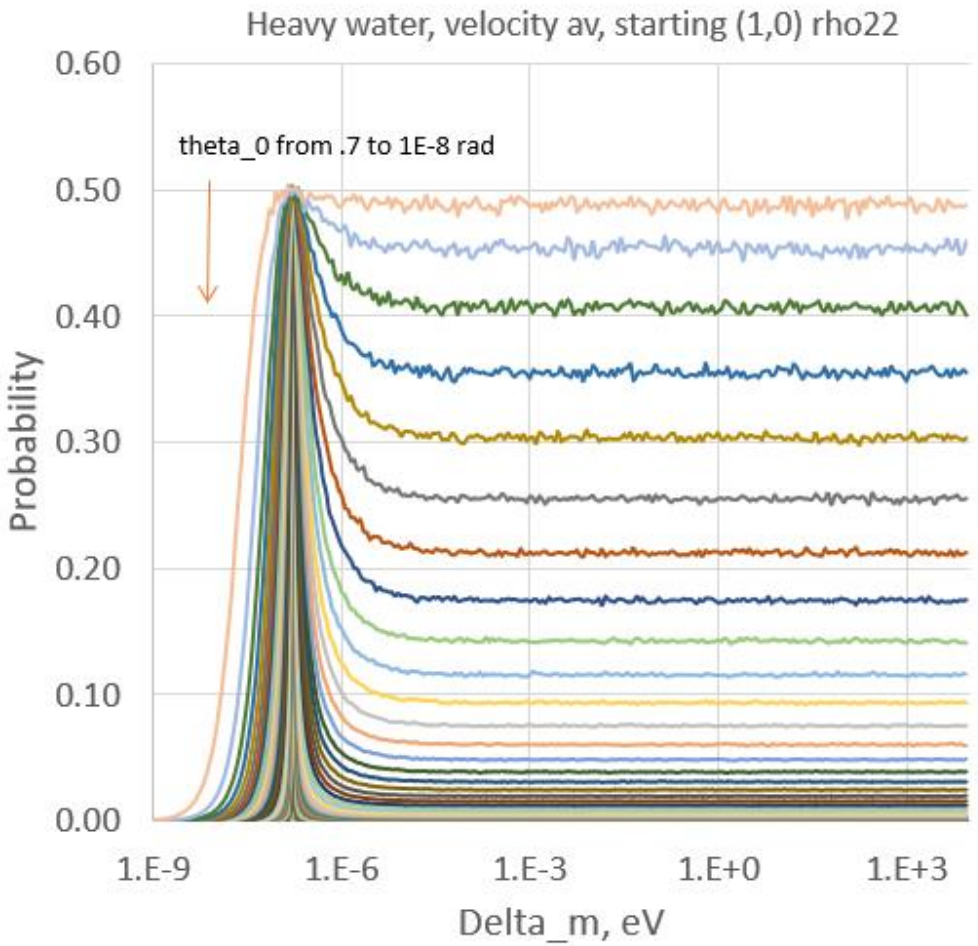
- As side outcome of STEREO calculation for 2.2 cm (average scattering length) heavy water layer with S.E. complex Hamiltonian solution from eq. (11) of https://arxiv.org/abs/2111.01791

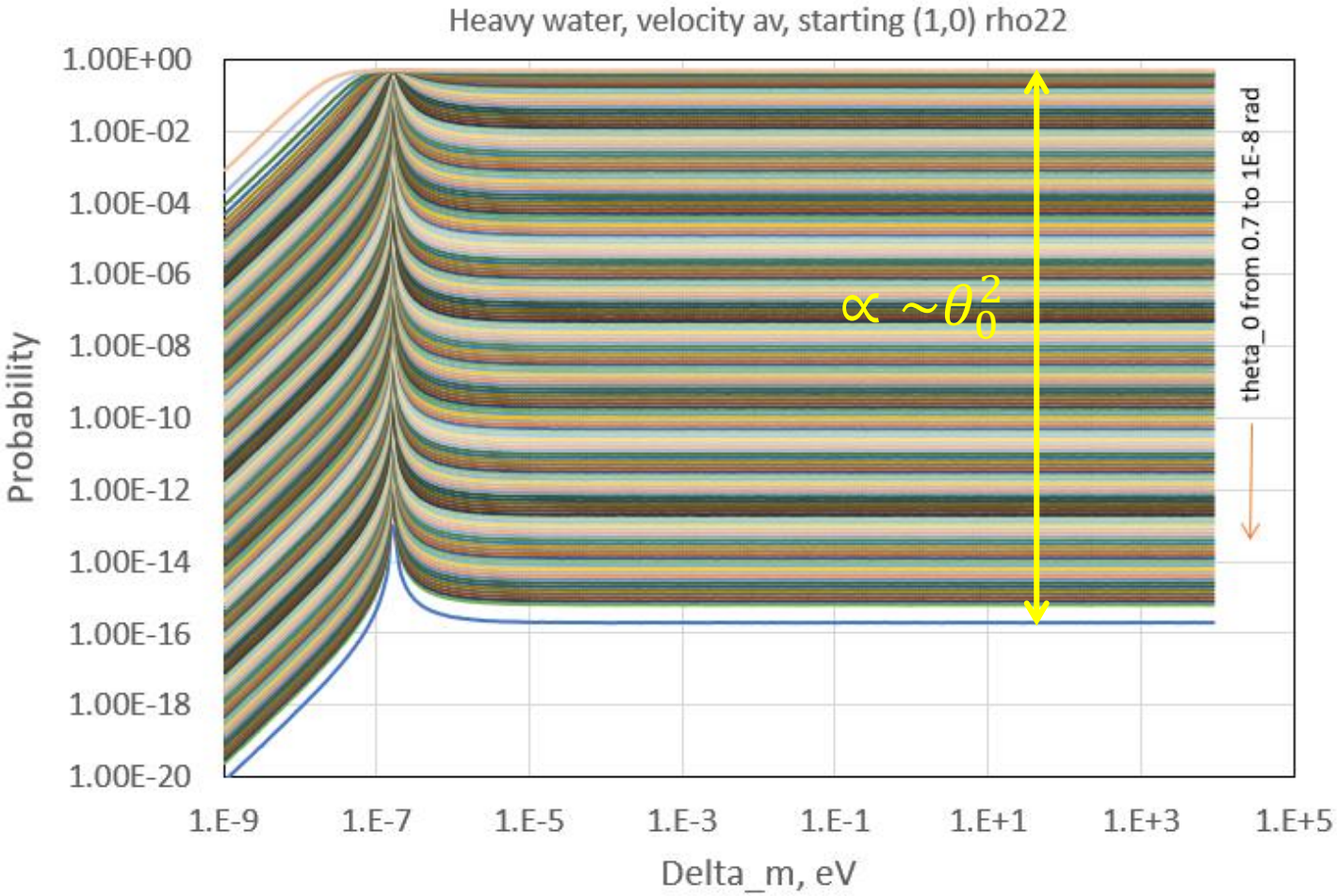
- In the range of parameters:
  $\Delta m \in (10^{-9} \rightarrow 10^{+4})$ eV
  $\theta_0 \in (10^{-8} \rightarrow 0.7)$ radians

Thermal velocity spectrum assumed for the heavy water reflector in the reactor

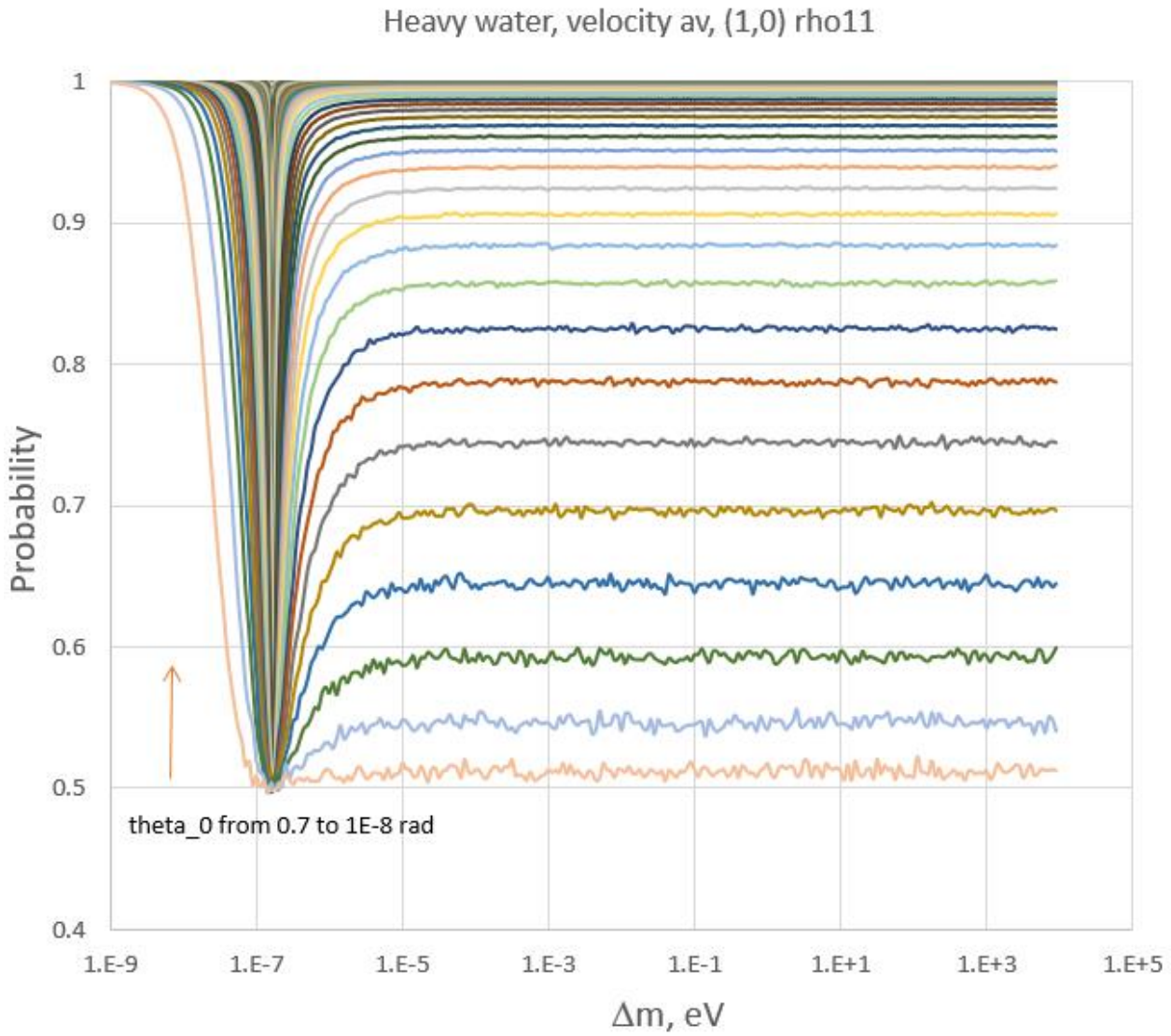


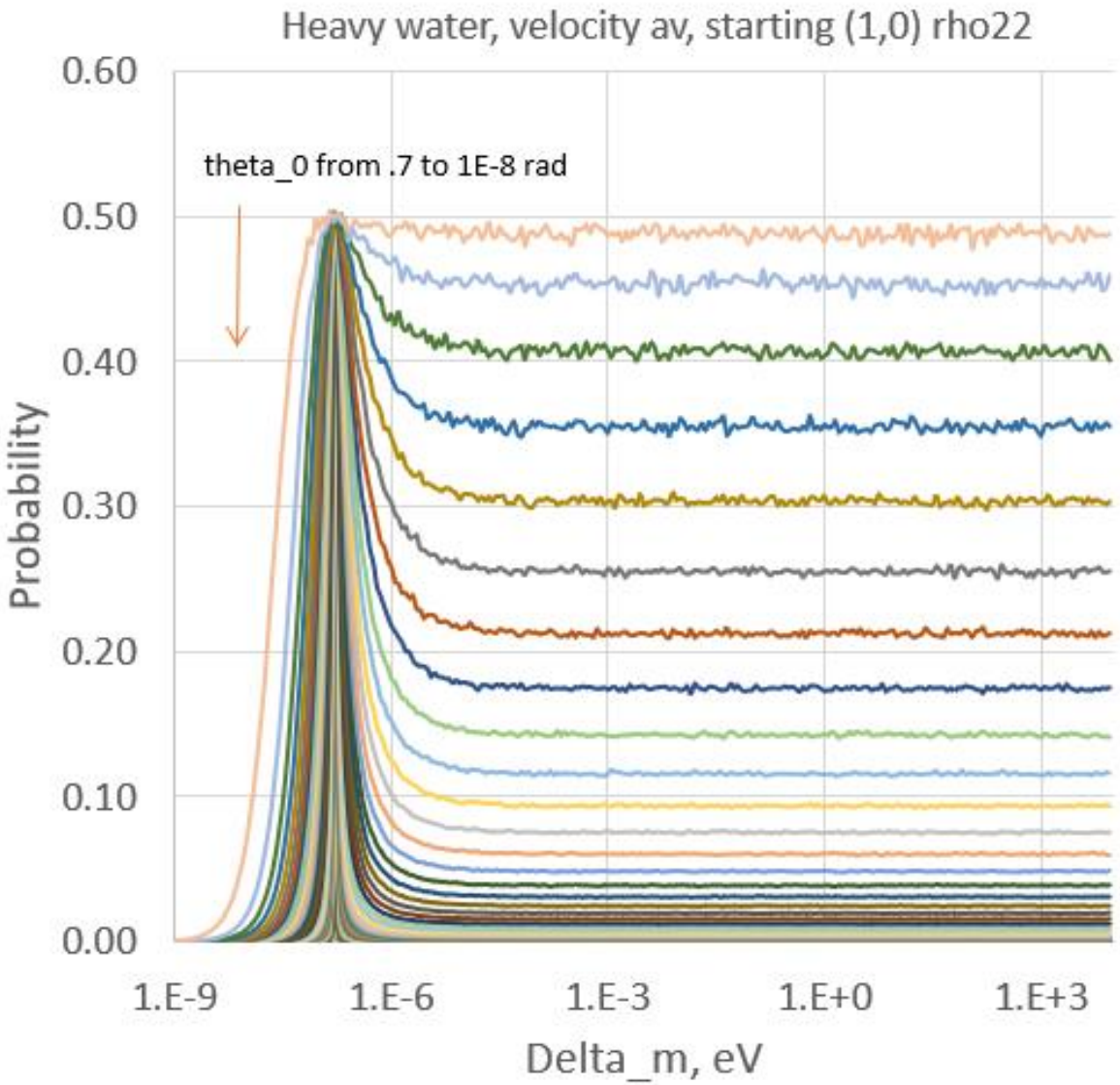
Mirror neutron probability after 2.2 cm of heavy water (elastic scattering length) averaged over the spectrum of thermal neutrons, starting from the state (1,0) = pure neutron, as function of $\Delta m = m_{n'} - m_n > 0$ and mixing angle θ_0. Note, that at mixing angles closed to the maximum probability of n' production is 0.5.



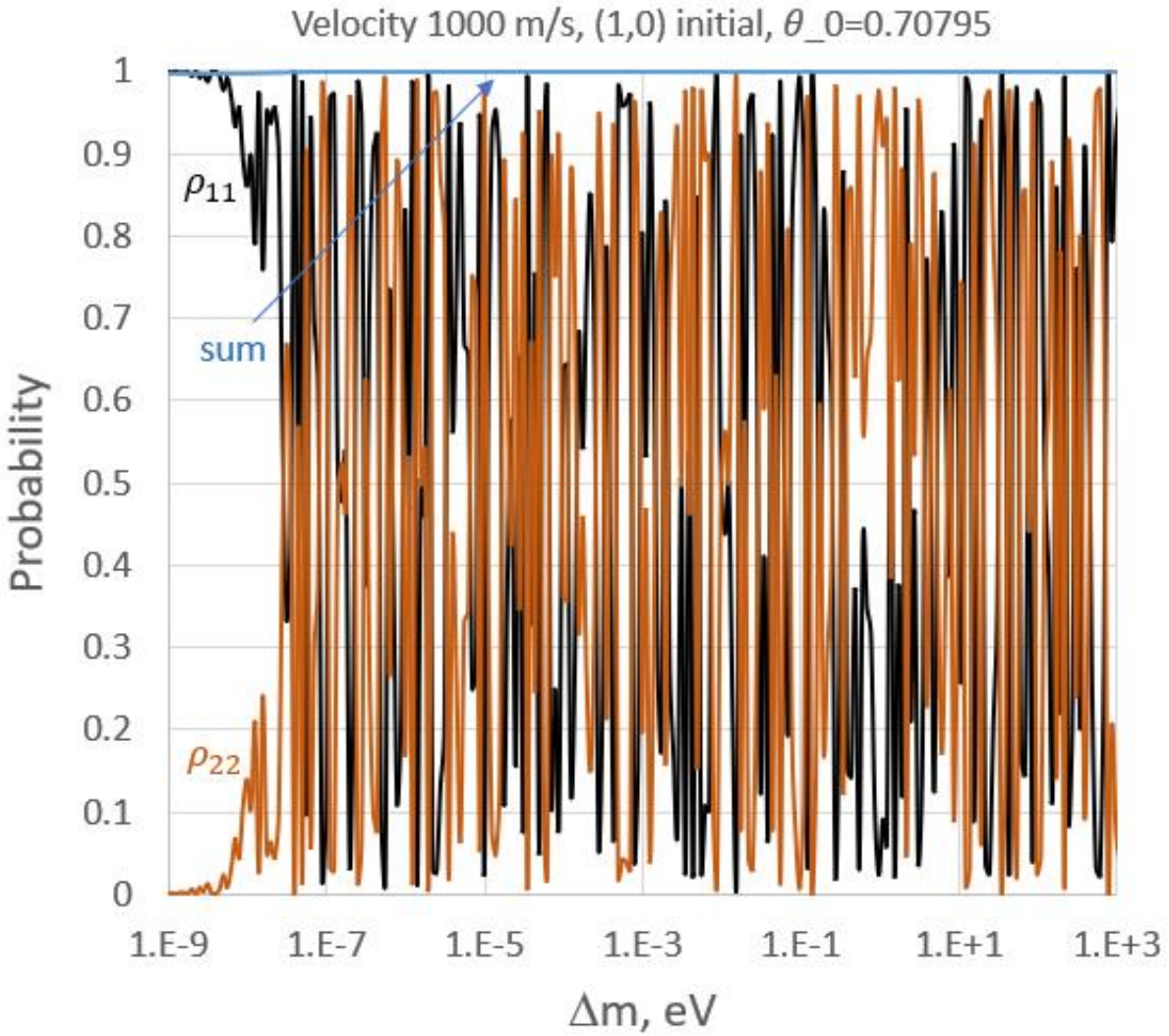


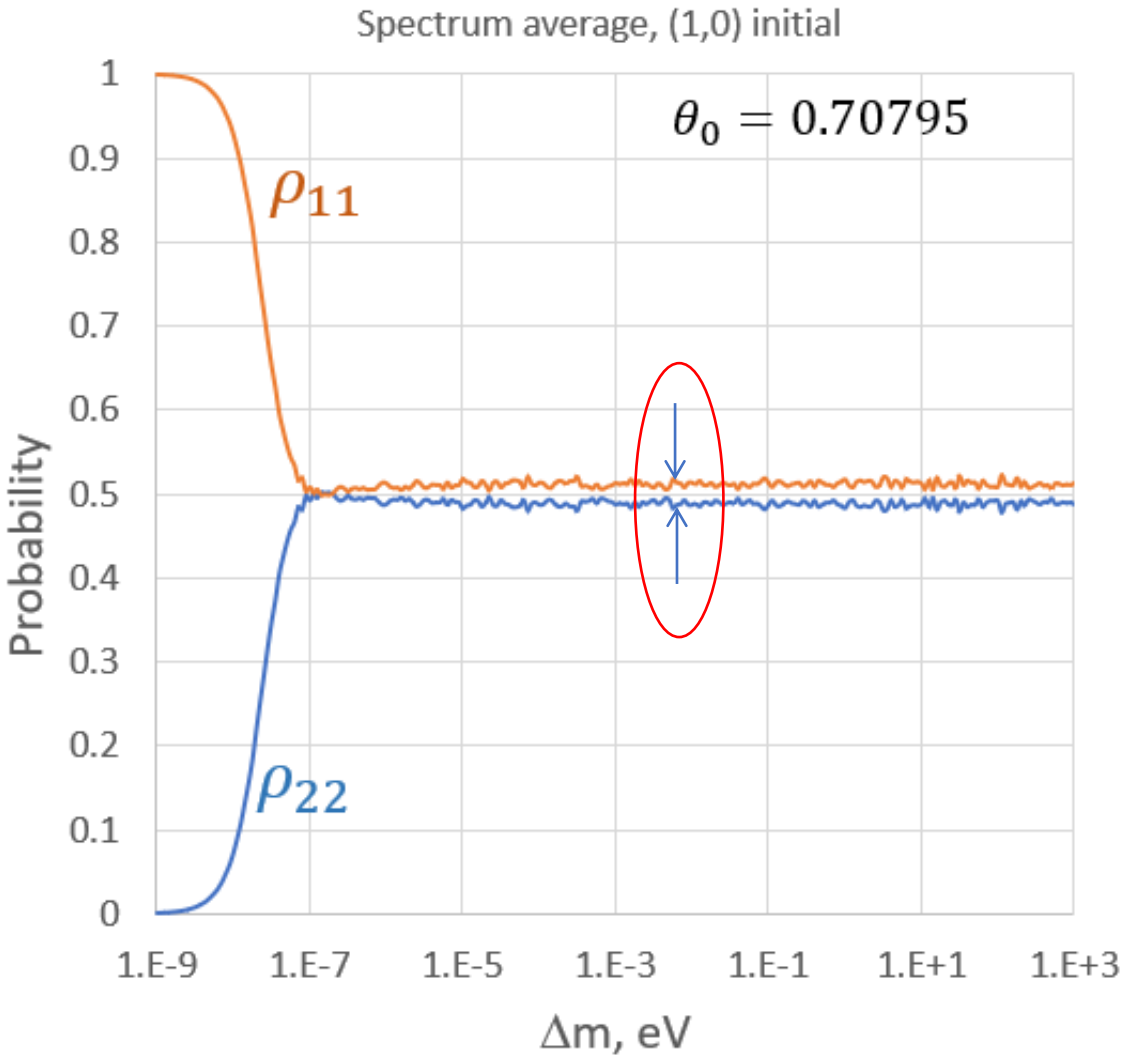
$P_n = \rho_{11}$ (left) and $P_{n'} = \rho_{22}$ (right) probabilities after 2.2 cm of heavy water (elastic scattering length) averaged over the spectrum of thermal neutrons, starting from the state (1,0) = pure neutron, as function of $\Delta m = m_{n'} - m_n > 0$ and mixing angle. Note, the maximum of n' production is 0.5.



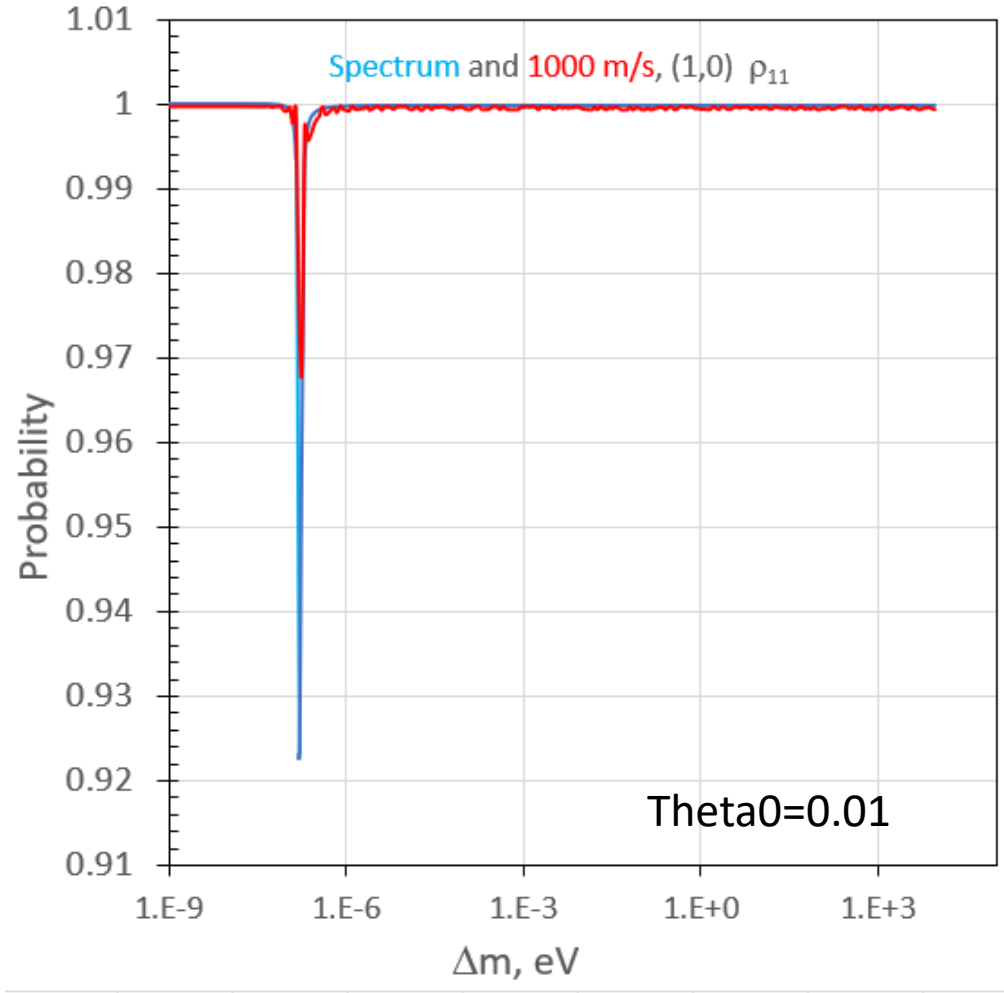


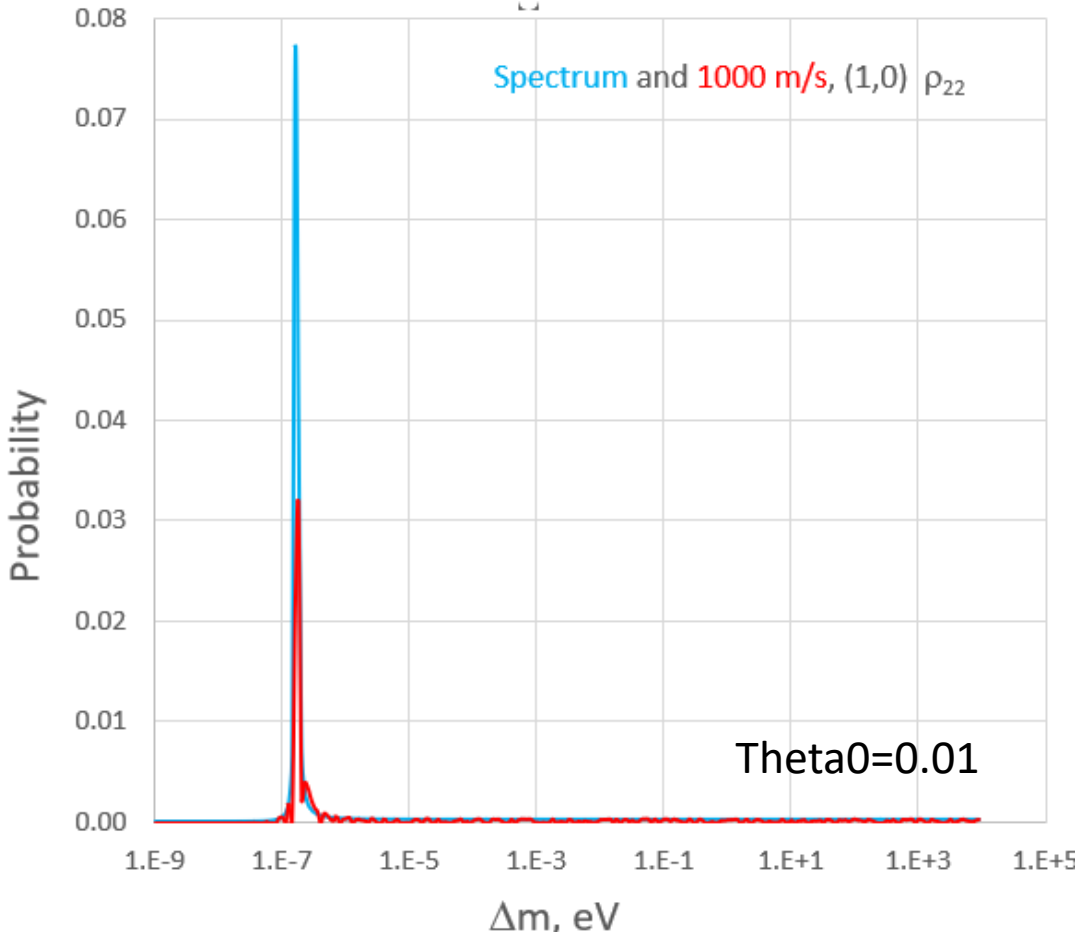
Compare probabilities for the fixed velocity = 1,000 m/s and velocity spectrum averaged for the mixing angle 40.56°
i.e., close to the maximum 45°





Same for small mixing angle = 0.01 rad.





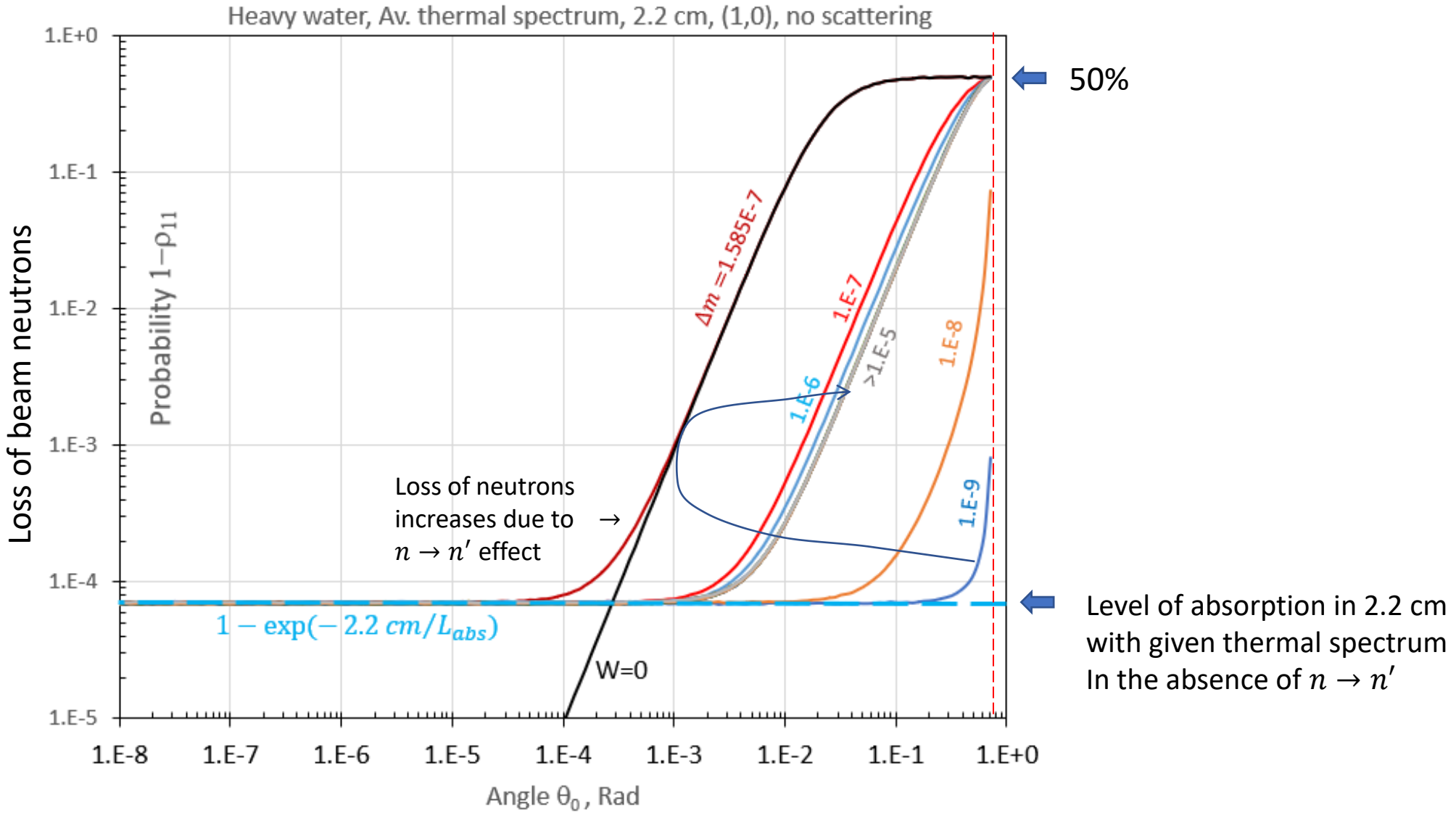
In the absence of $n \to n'$ transformations (and not considering neutron scattering) the absorption length is defined through W imaginary part of the optical potential as

$$L_{abs} = \frac{\hbar v}{2W}$$

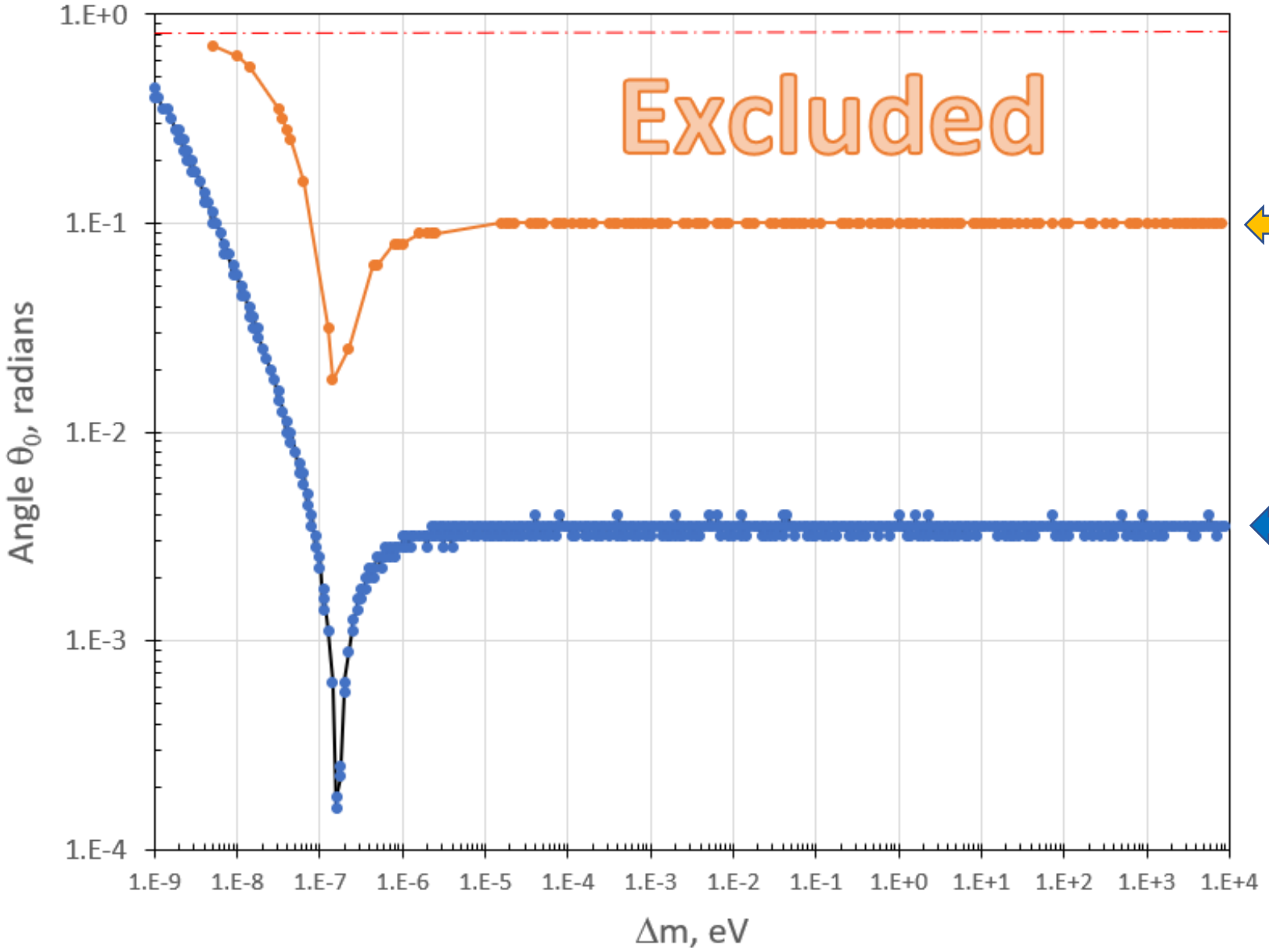
and effect of absorption can be calculated as $(1 - \exp\{-\Delta l / L_{abs}\}) \approx \Delta l / L_{abs}$, where $l = 2.2\ cm$

In the presence of $n \to n'$ transformations the same absorption can be assigned to the calculated $1 - \rho_{11}$

Probability of $1 - \rho_{11}$ was calculated on a matrix 260 values of Δm on log scale from $10^{-9} \to 10^{+4}$ eV
And 158 values of θ_0 on log scale from $10^{-8} \to 0.7$ radians.


Heavy water, Av. thermal spectrum, 2.2 cm, (1,0), no scattering
Loss of beam neutrons
Probability 1−ρ11
1.E+0
1.E-1
1.E-2
1.E-3
1.E-4
1.E-5
1.E-8
1.E-7
1.E-6
1.E-5
1.E-4
1.E-3
1.E-2
1.E-1
1.E+0
Angle θ0, Rad
Δm =1.585E-7
1.E-7
1.E-6
>1.E-5
1.E-8
1.E-9
Loss of neutrons increases due to → n → n′ effect
1 − exp(− 2.2 cm/Labs)
W=0
50%
Level of absorption in 2.2 cm with given thermal spectrum In the absence of n → n′

From known thermal absorption in 2.2 cm of heavy water
the mixing angles θ_0 above the line can be excluded



Cary can repeat this for 105 cm layer of D_2O with 170 scatterings included and claim that e.g. 10% effect is excluded.

If 2% loss of flux

If loss not exceeds $\sim 10^{-4}$ within 10% accuracy of absorption x-section.