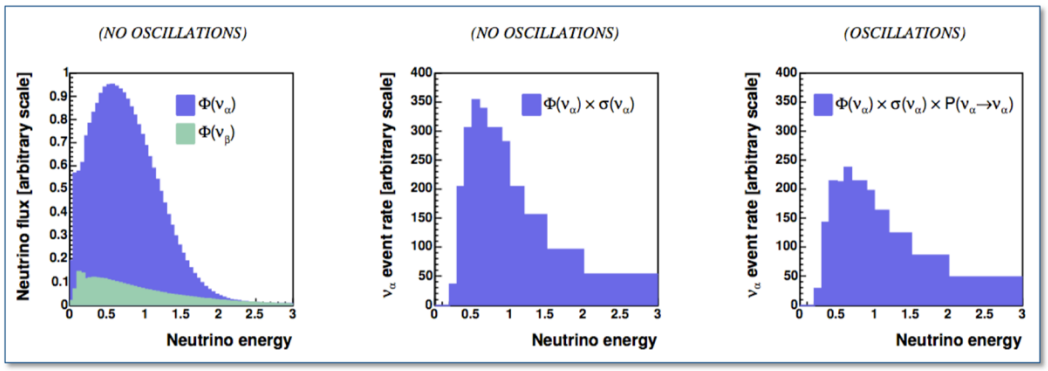
Neutrino Physics (Experimental)

Neutrino disappearance signature: $\nu_\alpha \rightarrow \nu_\alpha$

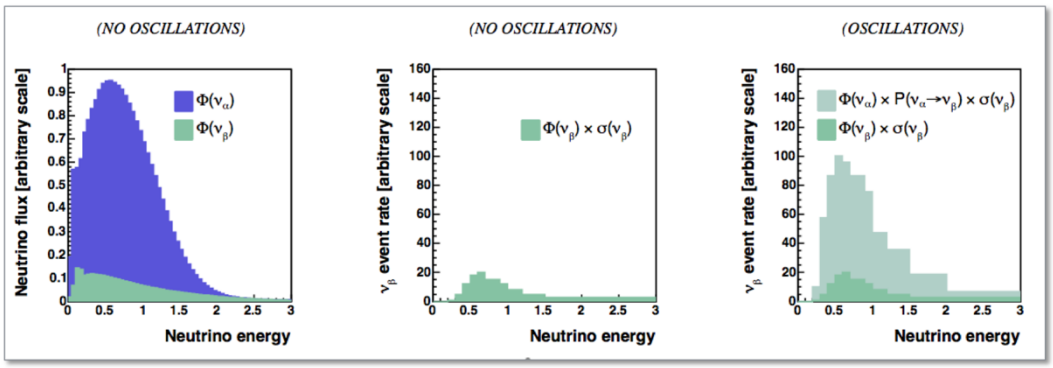


$$P\left(\nu_\alpha \rightarrow \nu_\alpha\right) = 1 - \sin^2 2\vartheta_{\alpha\alpha} \sin^2\left(1.27\Delta m^2 L / E\right)$$

number of signal events (E) =

ν_α flux (E) x oscillation probability (E) x ν_α cross section (E) x detector efficiency (E)

Neutrino appearance signature: $\nu_\alpha \rightarrow \nu_{\beta\neq\alpha}$



$$P\left(\nu_\alpha \rightarrow \nu_{\beta\neq\alpha}\right) = \sin^2 2\vartheta_{\alpha\beta} \sin^2\left(1.27\Delta m^2 L / E\right)$$

number of signal events (E) =

ν_α flux (E) x oscillation probability (E) x ν_β cross section (E) x detector efficiency (E)

Exercise 1

In the salt phase, SNO (1kton) detected solar neutrino induced NC and CC events for 391 days.

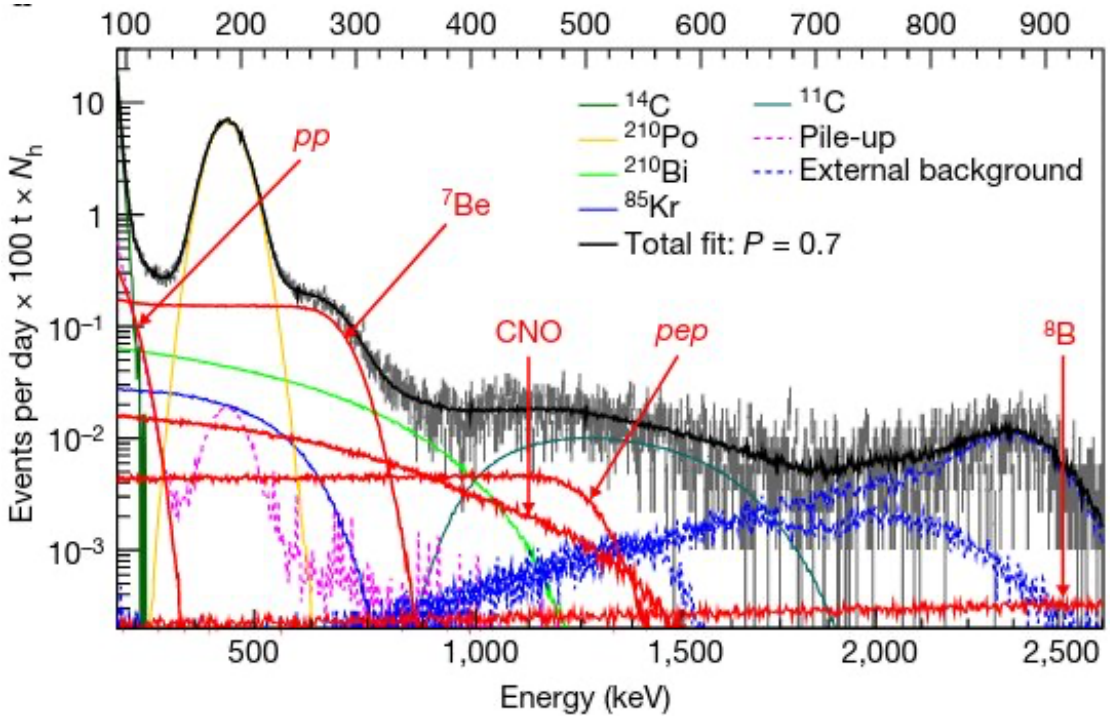
A) From the number of detected events, efficiencies and cross-section given in the table below, compute Φ_{CC} and Φ_{NC}, the neutrino fluxes measured by CC and NC processes.

Process	Number of events	Cross-section (cm^2)	Efficiency
CC(ν_ed->e-pp)	2176±78	0.6×10^{-42}	1
NC(ν_xd->$\nu_x$np)	2010±85	0.4×10^{-42}	0.5

B) Using the values of Φ_{CC} and Φ_{NC} found in A), compute the probability of an electron neutrino to convert into a muon or tau neutrino, P(ν_e->$\nu_{\mu,\tau}$)

Exercise 2

Borexino experiment has measured the spectrum of solar neutrinos in a wide energy range.



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A) How can the solar-neutrino fluxes be determined from the electron neutrino measured rates?

B) Which assumptions are needed to measure the electron neutrino survival probability?

C) Borexino is a liquid scintillator detector with a design similar to KamLAND and Double Chooz. Why does it use the neutrino-electron scattering instead of the Inverse beta decay reaction?