Detection of solar neutrinos from the CNO cycle

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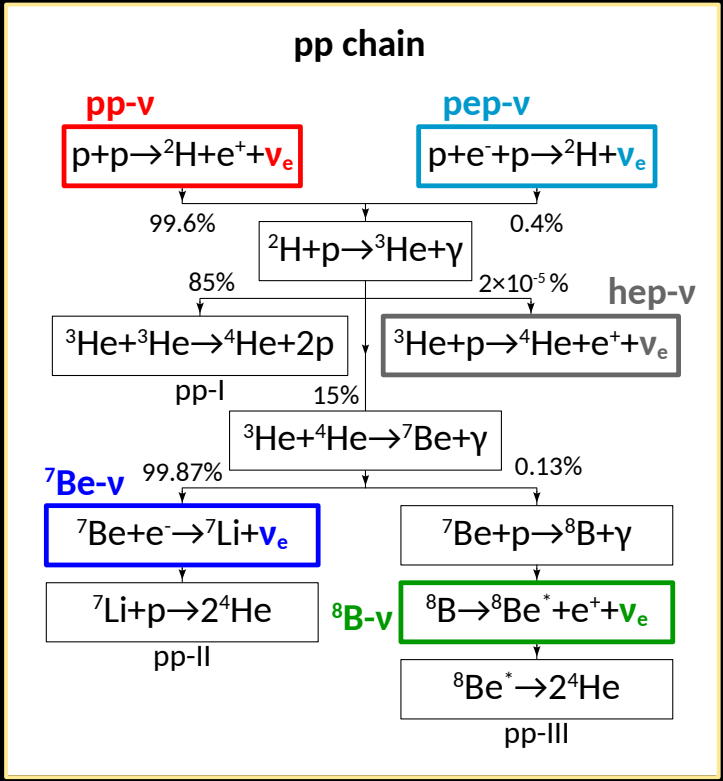
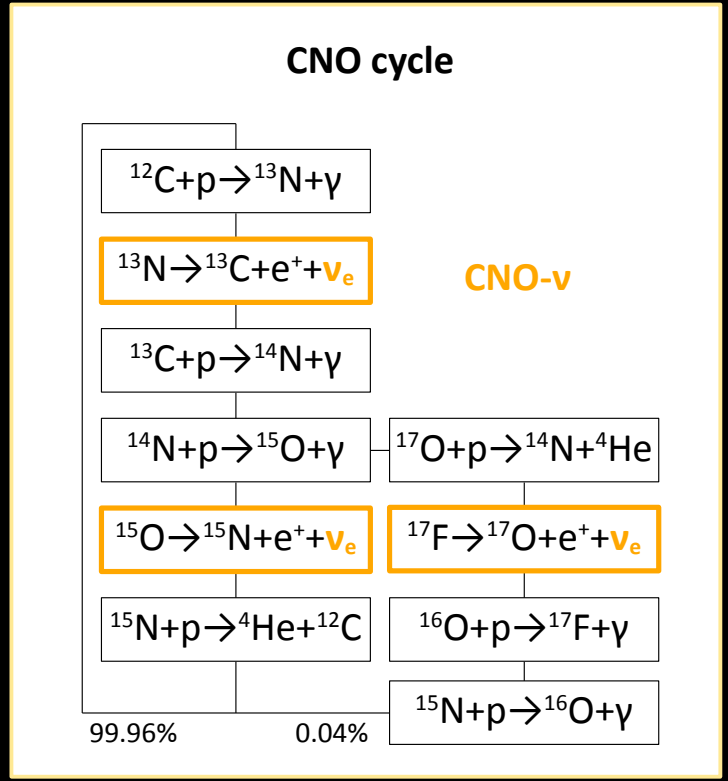
What fuels the Sun

$4\ {}^{1}H \rightarrow {}^{4}He$





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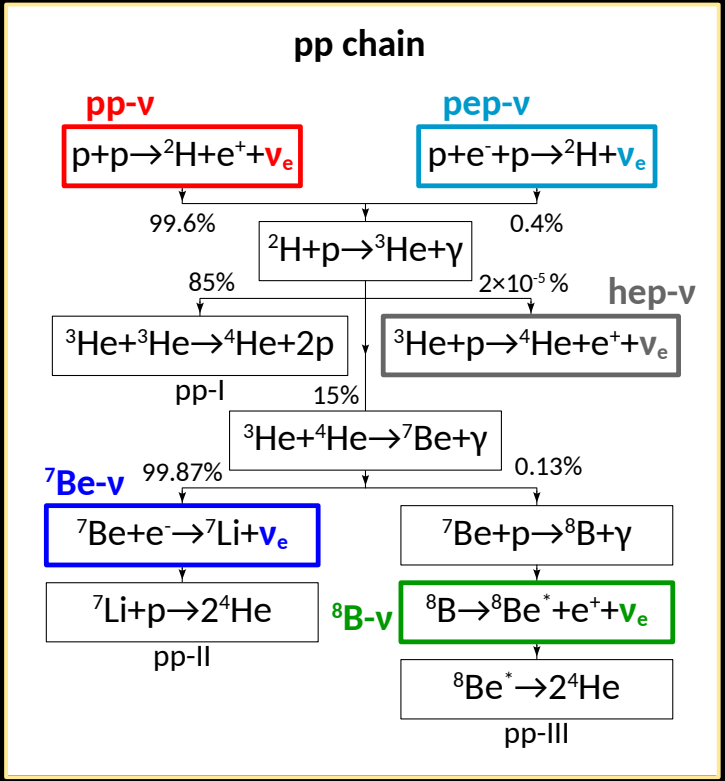
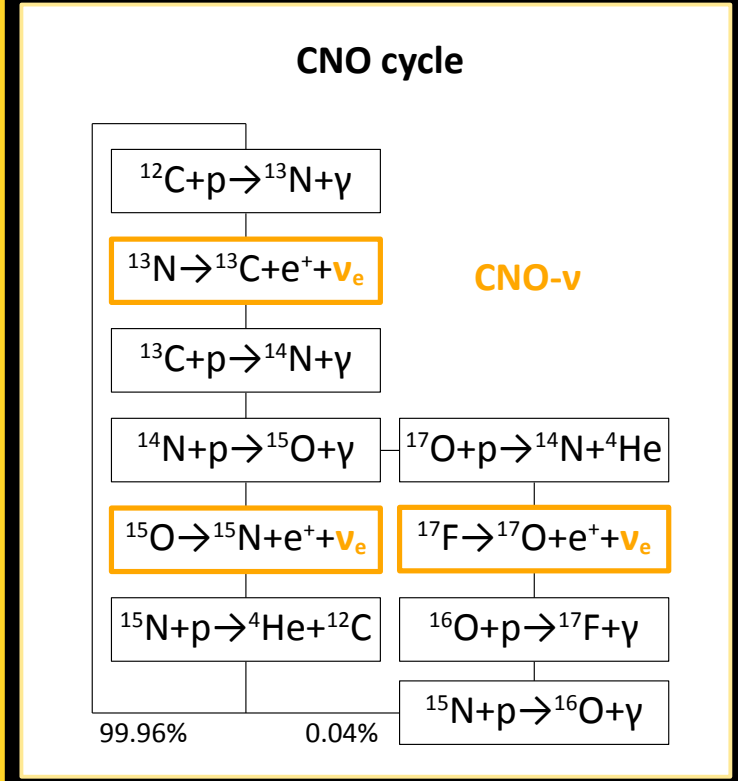




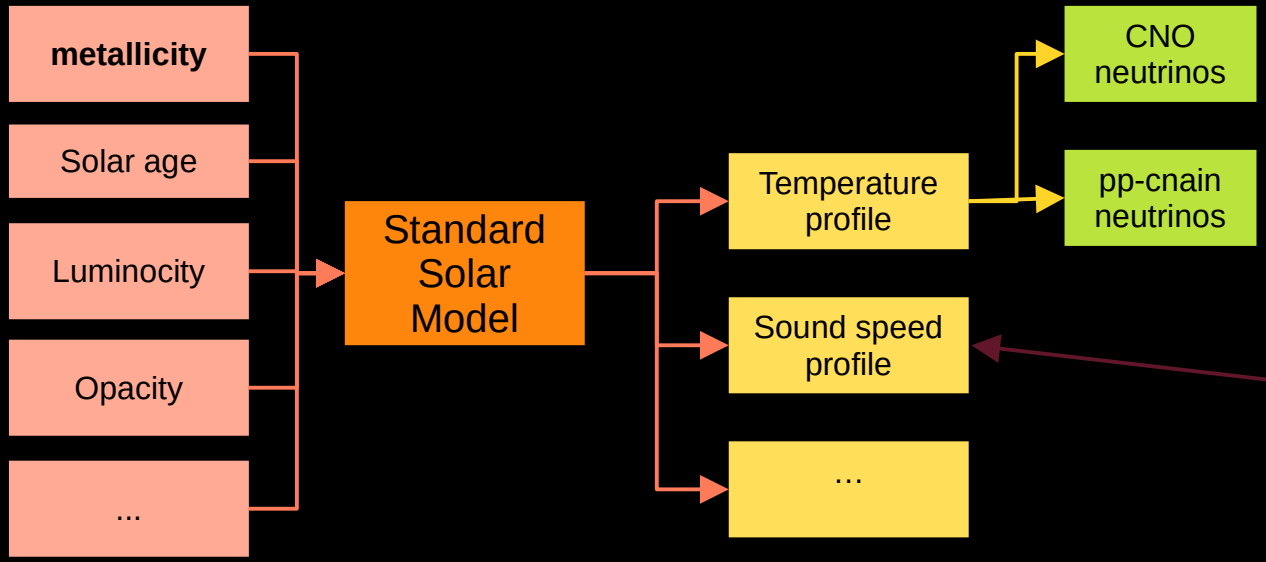
- Calatyzed by **C**, **N** and **O** nuclei
- Rate directly depends on solar **metallicity**

Solar metallicity problem

Metallicity is an abundance of elements heavier than helium (including C, N, O)

Obtained from spectroscopic measurements

One of key inputs of the **Standard Solar Model**



Metallicity measurements

- **GS98, MB22**
High metallicity (HZ)

- **AGSS09, C11, AAG21**
Low metallicity (LZ)
In disagreement with helioseismology

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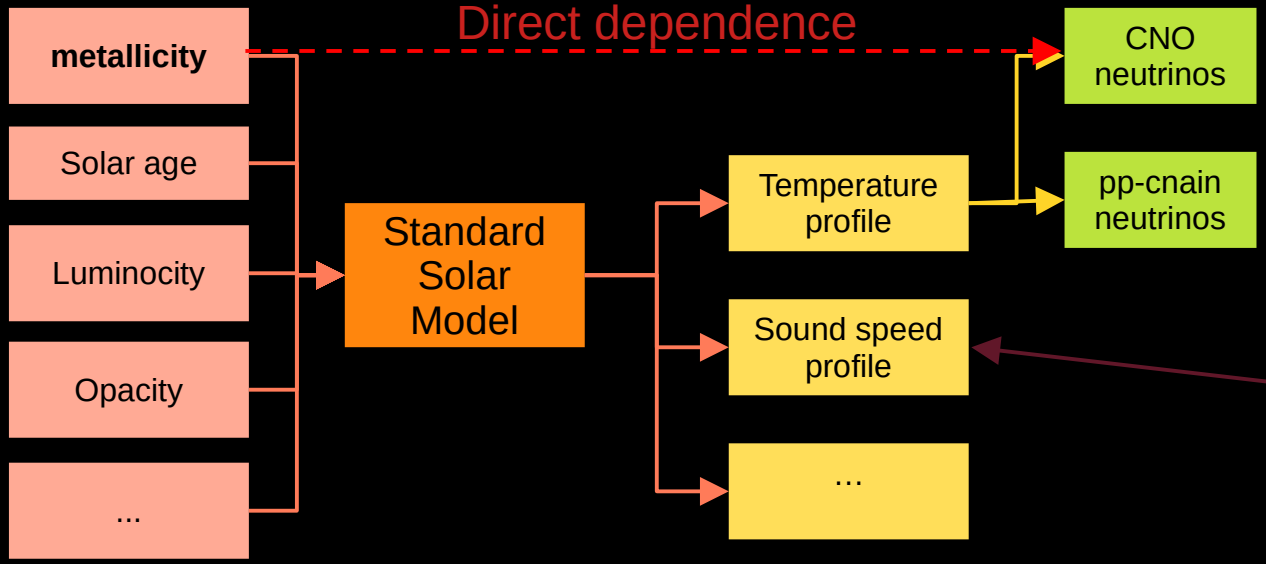

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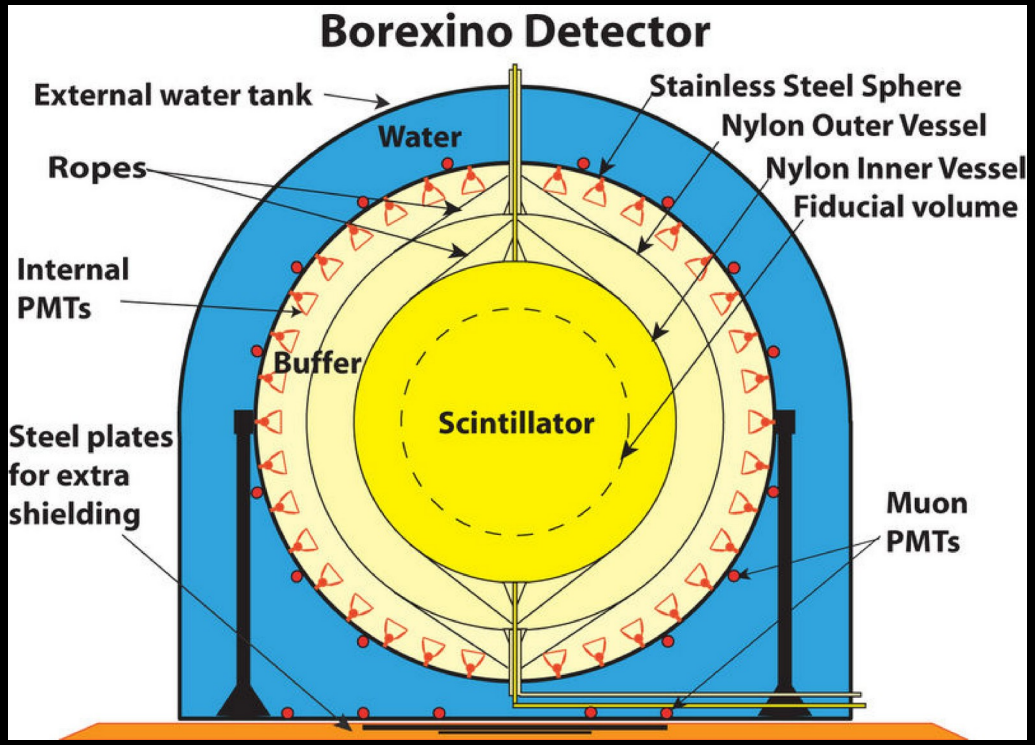
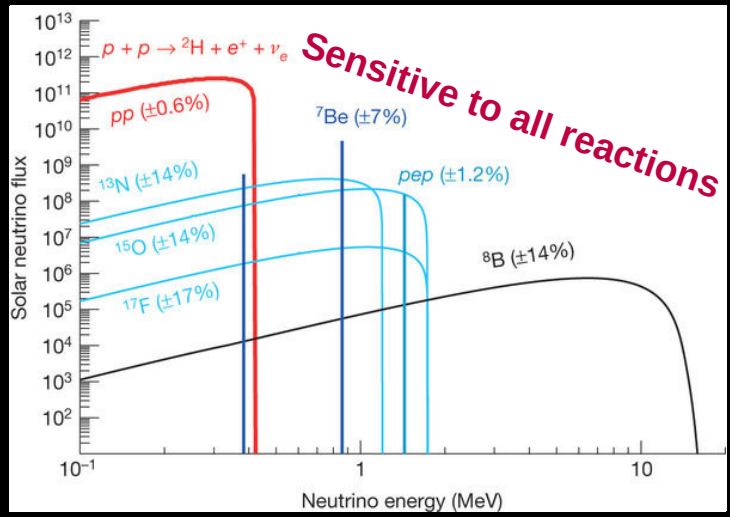
Borexino experiment

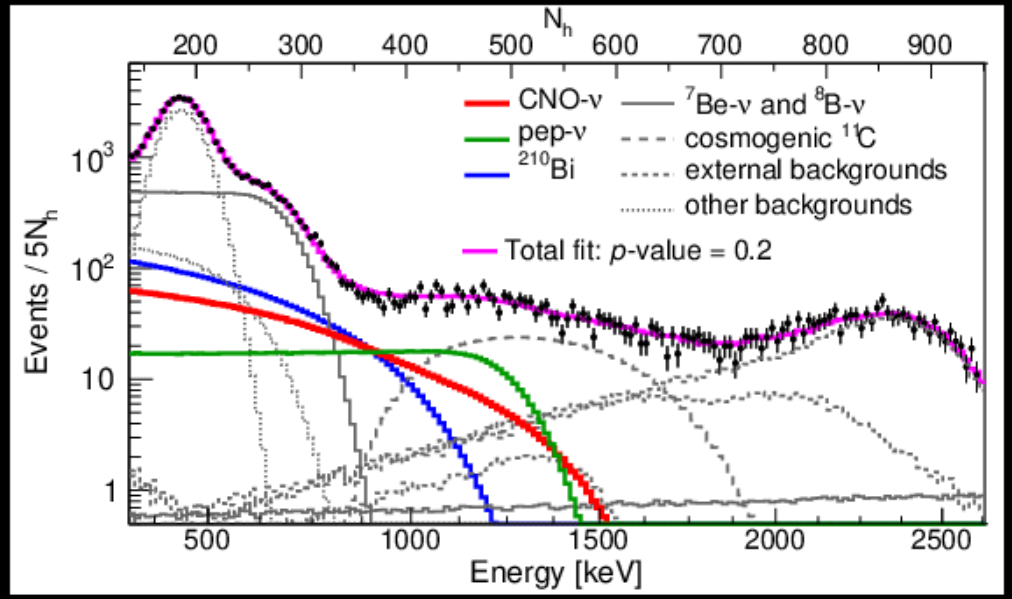


- Designed for solar neutrino detection in sub-MeV region
- Based on liquid scintillator
- Energy resolution ~ 5% @ 1 MeV
- Extremely radiopure!

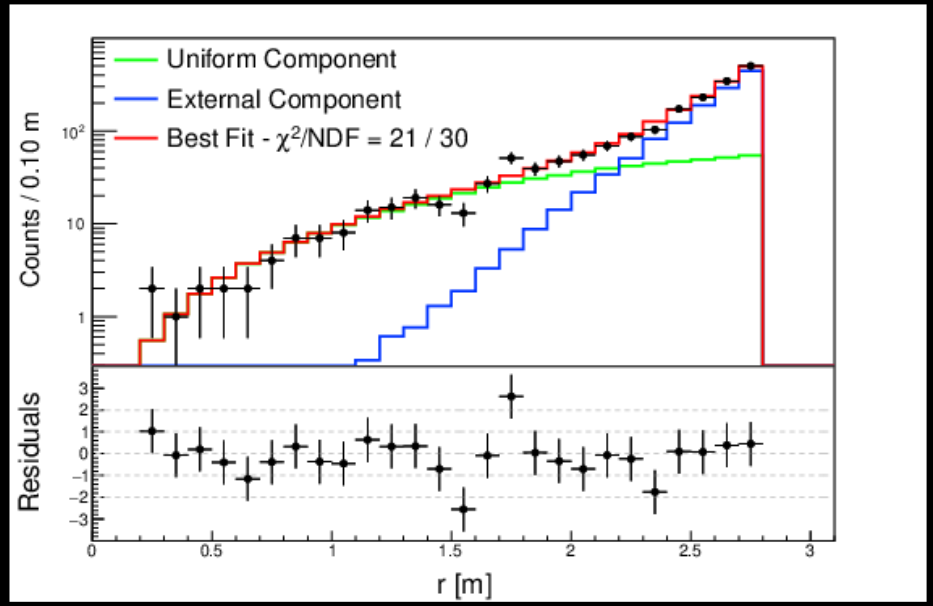


Data analysis

Energy fit with constrained rates of correlated spectral contributions



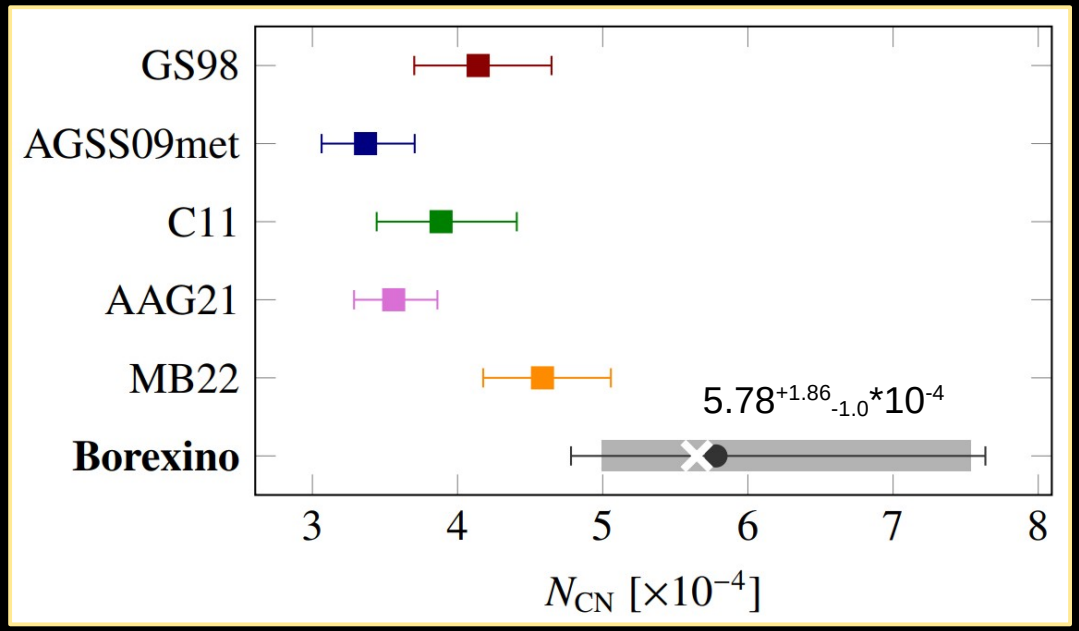
Radial distribution fit for additional external background discrimination



$F_{CNO} = 6.6^{+2.0}_{-0.9} * 10^{8}\ cm^{-2}s^{-1}$

Absence of signal is disfavored at 7σ level

Metal abundance



First direct measurement of C and N abundances in the Sun!

In agreement with high metallicity.

Summary

- First detection of solar neutrinos from the CNO cycle (7σ significance)
- First determination of C and N abundance in the Sun from neutrino data

More details: arXiv:2205.15975 [hep-ex]

Backup: metallicity probe method

Idea: W. C. Haxton and A. M. Serenelli,
Astrophys. J. 687, 678 (2008)