PhD thesis abstract

FIRST INDICATION OF SOLAR NEUTRINOS FROM THE CNO CYCLE REACTIONS WITH THE BOREXINO EXPERIMENT

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Solar neutrinos play a unique and irreplaceable role for the comprehension of the mechanisms powering our star. The study of solar neutrino fluxes allowed to definitely prove that the Sun is powered by thermonuclear reactions occurring in its core.

Several questions concerning solar neutrinos are still unsolved. In particular, neutrinos emitted in the CNO cycle of reactions are the only undetected piece of the solar fusion puzzle. This cycle is believed to be the main engine of very massive stars, while it is expected to contribute only $\sim 1\%$ to the solar luminosity. Observing neutrinos from the CNO reactions would have a striking importance in astrophysics, providing the first direct confirmation of the existence of this important energy source in the core of the stars.

This work is mostly related to the CNO solar neutrinos determination by means of the Borexino detector, an ultrapure liquid scintillator-based detector located at the Laboratori Nazionali del Gran Sasso. Throughout a more than ten-years long data taking, Borexino has achieved outstanding results about solar neutrino physics, measuring all the neutrino fluxes emitted from the pp chain nuclear reactions.

My thesis deals with several crucial topics of the CNO-ν analysis: the data selection strategy, analyzing the impact of the selection cuts on the new data and their stability; the Monte Carlo simulation of Borexino detector, including the critical re-tuning of the simulation input parameters, based on a re-analysis on the calibration data; the strategies for the determination of the ^{210}Bi background rate, along with the analysis of its time stability and homogeneity in the scintillator and the related systematic uncertainties.

The main result of this thesis consists in the first direct experimental proof of a signal from CNO neutrinos with a $> 3\sigma$ significance, achieved analyzing the latest three years of Borexino data taking. Implications of this result in terms of solar physics have been drawn: both for the solar metallicity discrimination, which has been slightly improved with respect to the previous Borexino results, and obtaining the first direct assessment of the C+N abundance in the solar core.