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CNO solar neutrino detection with Borexino: directionality measurement and spectral analysis

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Borexino was a large liquid scintillator experiment designed for real-time detection of low-energy solar neutrinos, located at the underground Laboratori Nazionali del Gran Sasso in Italy. During more than ten years of data taking, it has measured all the neutrino fluxes produced in the proton-proton chain, i.e. the main fusion process accounting for 99 % of the energy production of the Sun.
Moreover, the last stages of Borexino data taking were devoted to the first observation of solar neutrinos emitted from the Carbon-Nitrogen-Oxygen (CNO) fusion cycle, in which the reactions producing neutrinos are catalyzed by carbon (C), nitrogen (N), and oxygen (O). To disentangle signal and background rates, a multivariate analysis has been performed by simultaneously fitting energy and radial distributions of the events. The key difficulty of this measurement is represented by the 210Bi contaminating the liquid scintillator, which is constrained in the multivariate fit by independently determining an upper limit on its contamination.
More recently, Borexino has developed a new technique, called "Correlated and Integrated Directionality" (CID), to exploit the fast directional Cherenkov information for sub-MeV solar measurements. This method exploits the correlation between the known position of the Sun and the direction of reconstructed photons. In particular, Cherenkov hits originated by solar neutrino interactions exhibit a clear correlation with the position of the Sun, while isotropic scintillation and background events don't. Borexino has demonstrated the validity of this new method by providing the first directional measurement of sub-MeV 7Be neutrinos. In this talk, we present the first observation of the CNO solar neutrinos with CID and thus, without any prior knowledge on the 210Bi contamination using all Borexino data. Furthermore, this result is combined with an improved two-dimensional multivariate analysis of the Phase III dataset, leading to an unprecedented level of precision for CNO neutrino measurement.

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