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R&D for neutrinoless double beta decay with Borexino

Poster presented on behalf of the Borexino Collaboration.

The discovery of neutrino oscillations have proved that the three Standard Model neutrinos are mixed and not massless. Being the only neutral fermions of the theory, their mass term is not uniquely defined.
The only known and practical way to investigate the mass term, and therefore distinguish between Dirac and Majorana neutrinos, is the search of neutrinoless double beta decay.

Since the beginning of the Borexino project in the early nineties, the idea to perform a neutrinoless double beta decay experiment with 136Xe dissolved in the scintillator was considered (Ref. [1, 2]). The beautiful results obtained by the Borexino experiment [3, 4], which achieved a purity far exceeding design goals, and a new concept for dissolving large quantities of Xe in the scintillator, make this possibility even more interesting for a third generation experiment in the next decade.

The developed purification techniques allowed to reach an exceptional radio-purity (238U<6x10e-18 g/g and 232Th<5x10e-18 g/g, Ref. [3]) and consequently, almost zero background coming from impurities in the region of interest. Taking advantage of Henry's law (the solubility of a gas in a liquid increases with its pressure) by increasing the pressure of the xenon dissolved in the scintillator, it is possible to reach an active mass of 10-15 tons and possibly even more.

In this poster, we present the ongoing R&D studies to look for the neutrinoless double beta decay using liquid scintillators. More precisely, we show the status and the main results about the characterization of the optical properties of the Borexino scintillator when xenon is dissolved in large quantity and with high pressure.
We measured the light yield of the compound xenon-scintillator with respect to the pure Borexino scintillator case at different pressures.
Our setup consists in a 50 liters chamber able to reach the pressure of 5 bar. Besides keeping under control the system, we can measure the amount of scintillator inside the chamber, the gaseous xenon partial pressure, and the amount of xenon dissolved in the scintillator.
By dissolving xenon at the pressure of 1 bar in the scintillator, we measured a light yield 15% lower than the Borexino light yield, while at 5 bar the decrease is about 45%.

In the next future, we are planning to fully characterize this mixture by also measuring the attenuation length and testing the pulse shape discrimination capability. Besides, we will characterize the light yield loss as a function of the fluor concentration. We will also study the behavior of other liquid scintillators and wavelength shifters.

[1] Phys. Rev. Lett. 112, 068103 (1994);
[2] Borexino Proposal edited by G. Bellini and R. Raghavan (1991);
[3] arXiv:1308.0443 [hep-ex];
[4] Phys. Rev. Lett. 108, 051302 (2012).

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