Bi-Isotope 0ν2β Next Generation Observatory

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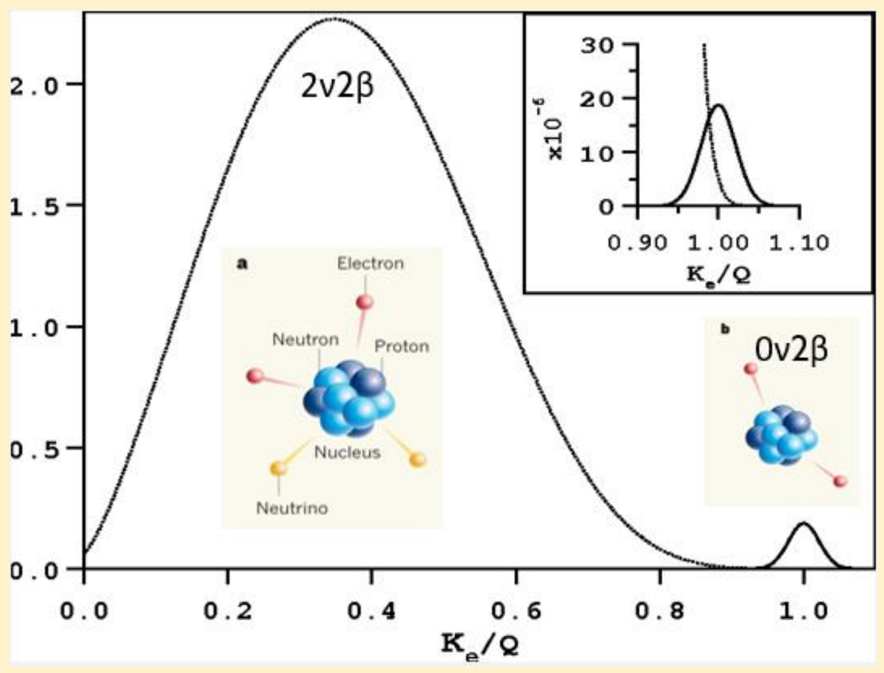
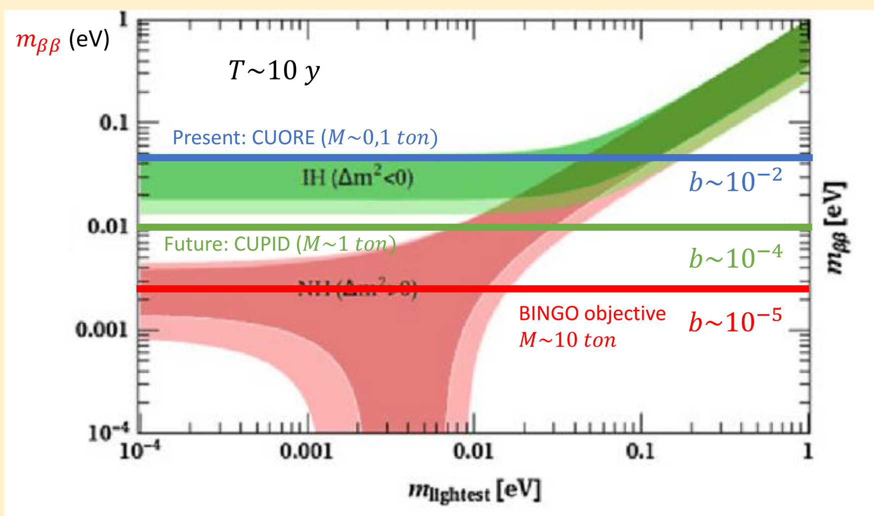
What is neutrinoless double beta decay ?



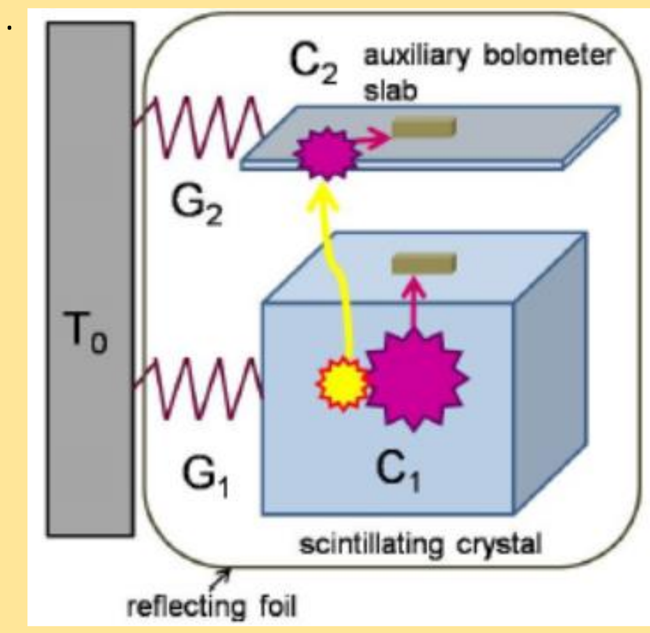


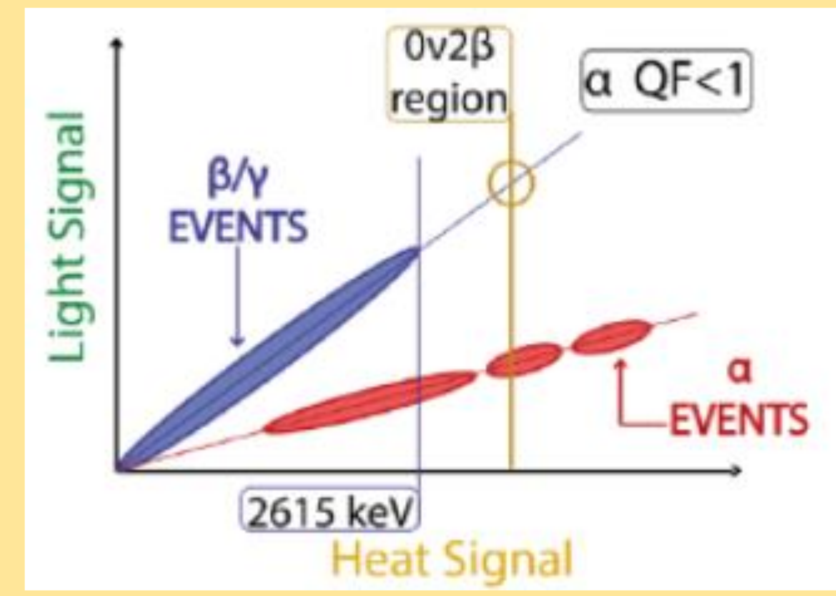
- An hypothetical and extremely rare process.
- Forbidden by the Standard Model since it violates the lepton number conservation.
- Possible if the neutrino is a so-called Majorana particle. (i.e $\nu = \bar{\nu}$).
- Could explain the small mass of neutrinos, the asymmetry matter/antimatter…

$$(T_{1/2}^{0\nu})^{-1} = G^{0\nu}(Q,Z)|M^{0\nu}|^2 \frac{m_{\beta\beta}^2}{m_e^2}$$

$$T_{1/2}^{0\nu} \propto a \times \epsilon \times \sqrt{\frac{M \times t}{b[ckky] \times \Delta E}}$$

How to detect it ? The bolometric technique



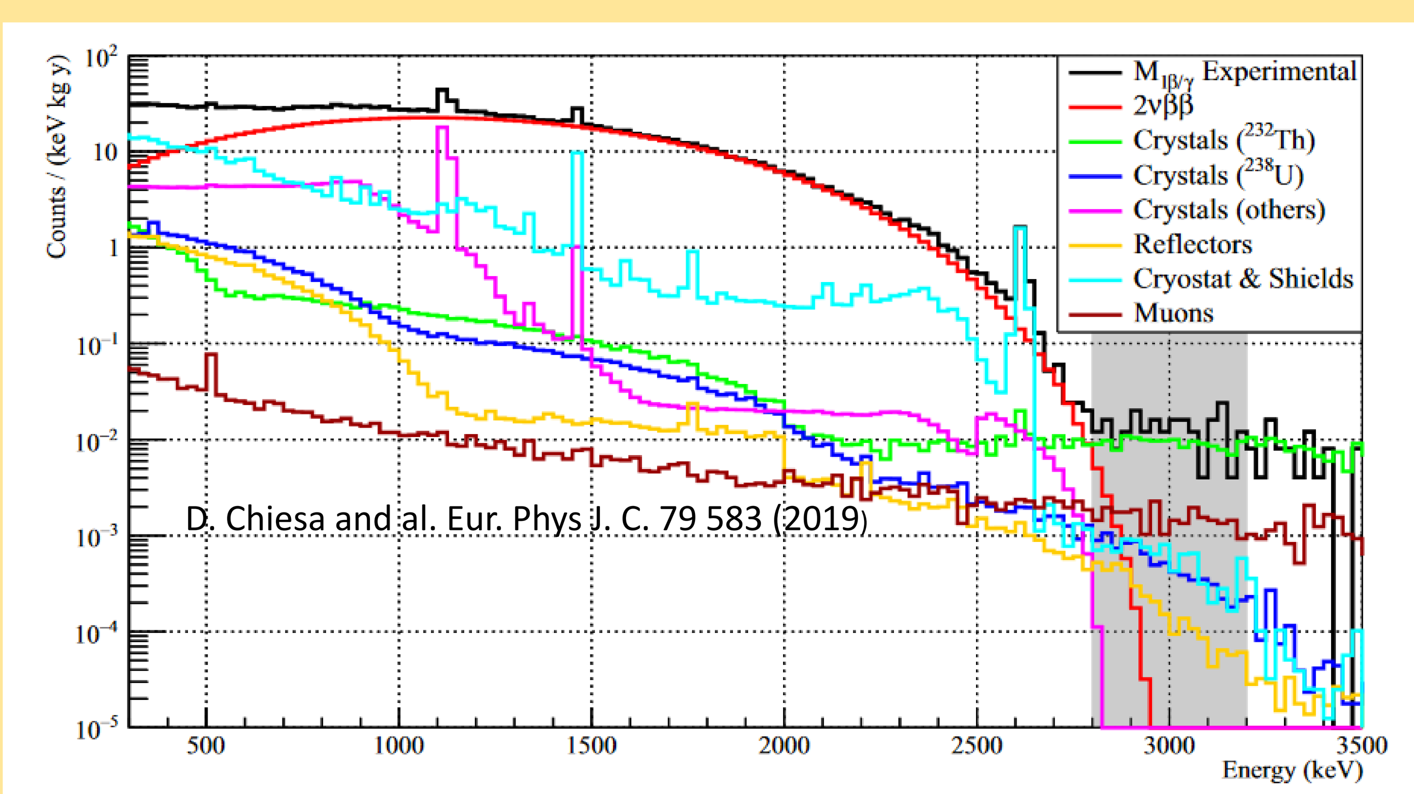


- Scintillating crystal embedding a 0ν2β candidate.
- Particles release their energy inside the crystal and heat up the absorber which emits also light.
- A smaller Ge bolometer acts as a scintillation light detector.
- Two signals : Heat and light, allow α events discrimination. No more α background !
- High efficiency and energy resolution, easily scalable.

The BINGO improvements

The main objective of BINGO is to reduce significantly the number of background events in the region of interest compared to what is currently achievable and so to increase the experimental sensitivity. BINGO proposes innovative technologies and methods in order to prepare the next-next generation of 0ν2β bolometric experiments allowing to explore the normal ordering region for the neutrino mass.

The γ/β background sources to fight :



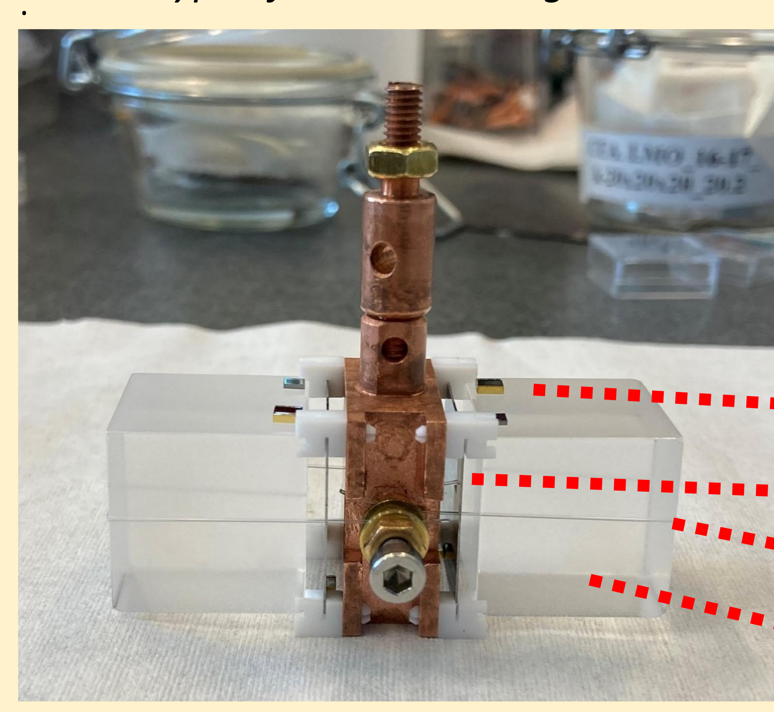
CUPID-0 bakground model

Solutions brought by BINGO

- The use of two of the most promising isotopes for the 0ν2β search : ^{100}**Mo** $(Q_{\beta\beta} = 3034\ keV)$ and ^{130}**Te** $(Q_{\beta\beta} = 2527\ keV)$.
- **(I)** A revolutionary detector assembly to minimize the amount of materials close to the crystals, and so the surface radioactivity.
- **(II)** For the first time, a cryogenic active veto surrounding the detectors area composed of scintillators (BGO or $ZnWO_4$) to reject the external γ background but also the β/α events coming from the crystal itself which deposed only a part of their energy inside.
- **(III)** Light detectors with a high sensitivity and a really low treshold by exploiting the Neganov-Luke effect which amplificate the signal thanks to a potential applied on electrodes.

(I) First test with the new structure idea

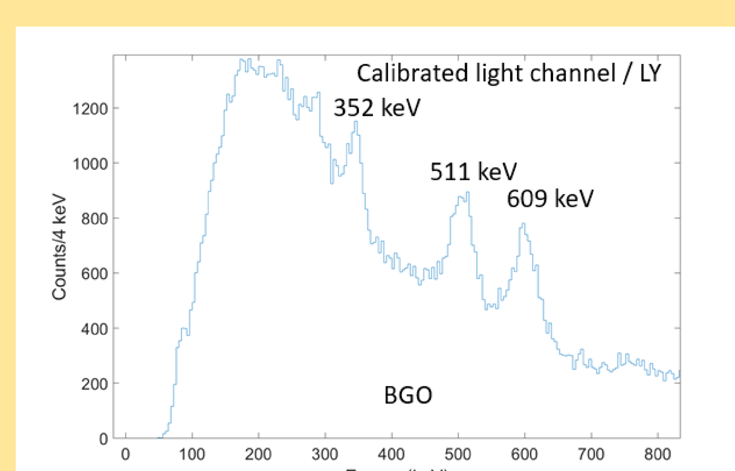
Prototype of the BINGO single module

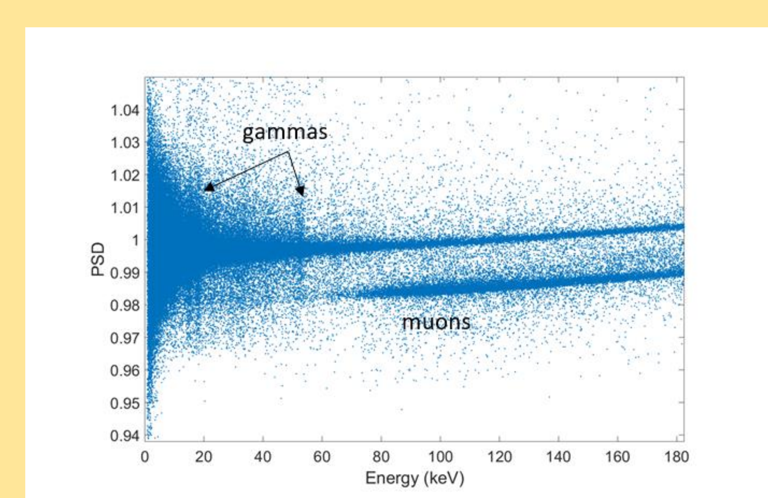


- Here the crystal isn't « seeing » any copper
- Kill surface radioactivity
- First test currently on going at IJCLab in Orsay.

(II) First results of the BGO veto

A first test with a cylindrical BGO crystal (⌀30x60mm) has been made in Orsay to determine its potential as a veto.





Promising result : Only with the light signal, it is possible to reconstruct the energy spectrum of the events crossing the crystal.

(III) Neganov-Luke light detectors

- Al electodes are evaporated on a Ge wafer.
- Applying a voltage difference on these electrodes makes the e-h pairs created by an event to drift
- Amplification of the signal : $E = E_0\left(1 + \frac{q \times V}{\epsilon}\right)$
- Baseline RMS <10 eV and an amplification factor >10 reached by actual prototypes.

Crucial for BINGO to detect the Cherenkov light emitted by TeO_2 crystals and possibly the scintillation of ZWO if used as veto.
R&D : Confirm NL LD performances for BINGO, study new geometries for electrodes, fabrication protocole suitable for large scale production…