Light Signal Study with the AMoRE Cryogenic Light Detector

Bijaya Sharma[1,2] on behalf of the AMoRE Collaboration

[1] *Center for Underground Physics, Institute for Basic Science (IBS), Daejeon, 34126, Korea*
[2] *IBS School, University of Science and Technology (UST), Daejeon, 34113, Korea*
Corresponding Author Email: bijayasharma22@gmal.com

The AMoRE experiment aims to search for neutrinoless double beta decay of ^{100}Mo using molybdate-based scintillating crystals operated as cryogenic calorimeters. Efficient detection of scintillation light at millikelvin temperatures is essential for particle identification and suppression of α-induced backgrounds. We will present the performance and scintillation light collection of the cryogenic light detector (LD) developed in the AMoRE-II R&D program.

The light detector consists of thin silicon or germanium absorbers instrumented with metallic magnetic calorimeter (MMC) sensors and operated in coincidence with molybdate scintillating crystals such as Li_2MoO_4, Na_2MoO_4 and $CaMoO_4$. We report on the signal characteristics and scintillation light collection performance measured in dedicated R&D setups. Energy calibration is performed using X-ray sources directly hitting the light absorber, while scintillation pulses are analyzed using convolution fitting techniques that account for the intrinsic scintillation time structure and detector response. The best-performing LD exhibits FWHM energy resolutions of 99 and 198 eV for baseline and ^{55}Fe X-ray energy of 5.9 keV, respectively [1].

Scintillation light collection measurements show that Li_2MoO_4 and Na_2MoO_4 crystals produce approximately 7 and 5 times less light, respectively, compared to $CaMoO_4$ for 2.6 MeV γ rays [2]. A strong quenching of α-induced scintillation signals is observed, with the α light yield in Na_2MoO_4 reduced by more than an order of magnitude and a quenching factor of about 0.25 measured for Li_2MoO_4 [2, 3] and 0.22 for $CaMoO_4$ [2].

These results demonstrate that the AMoRE light detector provides sufficient sensitivity and resolution for effective particle discrimination in next-generation cryogenic rare-event searches.

1. B. Sharma et al., "Light channel signal analysis with the lithium molybdate crystal R&D detectors for AMoRE-II experiments"*J. Low Temp. Phys*. **218**, 92 (2025).
2. B. Mailyan et al., "Light collection of some molybdate crystal absorbers for cryogenic calorimeters at millikelvin temperatures". *IEEE Trans. Nucl. Sci.* **70**, 1307 (2023).
3. A. Agrawal et al., "Development of MMC-based lithium molybdate cryogenic calorimeters for AMoRE-II" *Eur. Phys. J. C* **85**, 172 (2025)

Acknowledgments:

This research is supported by Grant Nos. IBS-R016-A2 and IBS-R016-D1.