Contribution ID: **140** Type: **Poster**

Production and characterization of high-purity natural and enriched ZnMoO4 crystals to search for neutrinoless double beta decay of 100Mo

Radiopure zinc molybdate (ZnMoO4) crystals operated underground as cryogenic scintillating bolometers are promising devices for highly sensitive double-beta-decay searches, as the one under development in the LUMINEU program. Growth of high-quality radiopure crystals is a complex task, since there are no commercially available molybdenum compounds with the required levels of purity and radioactive contamination. This contribution discusses approaches developed at the Nikolaev Institute of Inorganic Chemistry (NIIC, Novosibirsk, Russia) to purify the initial molybdenum oxide and to synthesize the compound required for the growth of high-quality radiopure ZnMoO4 crystals. A combination of double sublimation (with addition of zinc molybdate) with subsequent recrystallization in aqueous solutions (using zinc molybdate as a collector) was used. Zinc molybdate crystals up to 1.5 kg were grown at NIIC by the low-thermal-gradient Czochralski technique. Their optical, luminescent, diamagnetic, thermal and bolometric properties were tested. The developed purification, synthesis and growth techniques were used also to produce enriched Zn100MoO4 crystals, which were operated successfully as scintillating bolometers in a dedicated aboveground facility at Centre de Sciences Nucléaires et de Science de la Matière (CSNSM, Orsay, France). The results achieved by the enriched detectors are described in detail. They show encouraging performance in view of their use in future double beta decay experiments.

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Track Classification: Neutrinoless Double Beta Decay