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LOREX - Geochemical Detection of the pp-Neutrino flux with 205Tl

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LOREX (LORandite EXperiment) [1] is based on determining the solar (pp) neutrino flux for the period of 4.31(2) My from the reaction 205Tl + ve →205Pb + e-, the lowest threshold (52 keV) for neutrino capture. For this purpose, one employs the naturally occurring lorandite (TlAsS2) minerals. The goals of LOREX [2] are (i) to determine the probability for capturing Solar neutrinos on 205Tl leading to the first excited state in 205Pb, (ii) to collect sufficient amount, around several kilograms, of lorandite and to determine background contributions producing 205Pb, (iii) to chemically extract Pb from lorandite, and (iv) finally to determine the ratio of 205Pb/205Tl.
(i) The weak interaction matrix element for the transition of interest will be determined through the bound-state beta decay of fully-ionized 205Tl81+ ions [3]. The measurements will be conducted at the experimental storage ring ESR at GSI and are planned for 2018. The experiment is supported by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 682841 "ASTRUm");
(ii) The collection of lorandite is ongoing at the Allchar mine in FYR Macedonia. The background 205Pb atoms are predominantly produced via fast-muon-induced reactions, which depend critically on the paleo-depth of lorandite including the eroded layer over 4.3 My. The paleo-depth is obtained by using cosmogenic nuclides.
(iii) Identification of the 205Pb nuclei in the lead sample extracted from the lorandite mineral requires 10-10 to 10-11 overall detection sensitivity for 205Pb/Pb and a comparable suppression of the 205Tl isobar. Therefore, a chemical extraction of Pb from lorandite is foreseen.
(iv) The determination of the 205Pb/205Tl ratio will be done with the storage-ring mass spectrometry, which is sensitive to single ions. Pilot experiments are planned at RIKEN-RIBF ion-beam factory in Japan as well as at the GSI accelerator facility.
In this contribution we will present the present status of the LOREX project and outline the future steps to finally achieving the major objective of the project, namely the determination of the solar pp-neutrino flux integrated over the last 4.31(2) My.

References

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