Lorandite from Allchar, a long-term double detector for pp-neutrinos and fast myons

Pavicevic M. K.1, Amthauer G.1, Anicin I.2, Bosch F.3, Boev B.4 and Pejovic V.2

1 University of Salzburg, faculty of material engineering & physics, A-5020 Salzburg
2 University of Belgrade, faculty of physics, RS-11000 Belgrade
3 GSI – Gesellschaft für Schwerionenforschung mbH, D-64220 Darmstadt
4 University of Stip, faculty of mining and geology, MK-92000 Stip

The Sb-As-Tl-Au deposit at Allchar, providing one of the world-wide largest concentrations of thallium and also numerous other Tl-bearing minerals, may open an outstanding scientific perspective. Allchar belongs to the Serbian – Macedonian metallogenic province located near the border between Macedonia and Greece. By a long-lasting international research it has been shown that Lorandite from Allchar can serve, together with cogenetic monitor minerals, as a geochemical detector for both, the flux of solar pp-neutrinos, averaged over the geological age of Lorandite, and for the average flux of fast cosmic myons within the same period of time.

By the capture of (mainly) solar pp-neutrinos with an unprecedented low threshold of only 52 keV for them, $^{205}$Tl is transformed to $^{205}$Pb. Our investigations show that about 22 atoms $^{205}$Pb in 1g Lorandite for the geological time range of 4.2 Ma and a palaeozoic depth of 570 m should be expected, by supposing the present solar neutrino luminosity and by taking into account its reduction due to neutrino flavour oscillations. However, an additional production of $^{205}$Pb occurs via the interaction of cosmic radiation (stopped and fast myons) with decay products of $^{238}$U and $^{232}$Th. The amount of this "underground" of $^{205}$Pb depends on the palaeozoic depth (actual depth plus eroded sheets) and the geological age of of the Tl-mineralization. Calculations based on known nuclear cross-sections show that fast myons generate by far the largest part of "underground" $^{205}$Pb atoms. The present state of research predicts, for palaeozoic depths of 350 m and 570 m, respectively, total numbers of 106 and 48 $^{205}$Pb atoms per gram of Lorandite for 4.2 Ma, whereby the contributions from fast myons add up to 84 and 26 atoms of $^{205}$Pb, respectively. For the detection of the few $^{205}$Pb atoms we will apply SMS (Schotty Mass Spectrometry) at the ion storage ring of GSI (Gesellschaft für Schwerionenforschung, Darmstadt), where single fully-stripped $^{205}$Pb ions can be detected.

References:
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