On the variation of $^{210}$Po Half-Life at low temperature

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Motivation
If these claims are real, this would have a considerable impact in radionuclide metrology because the half-life of an isotope, could not be anymore considered of an intrinsic constant and must be temperature and matrix-dependent.
Moreover, this would also open new perspectives in radioactive waste management.

Experimental approach
Cooling in liquid He at 4 K

$A_i$: Activity before cooling

$A_f$: Activity after cooling

Cooling time: $t$

Defined solid angle alpha measurement

Vacuum chamber equipped with a PIPS detector

 DSTA chamber

Typical uncertainty budget

<table>
<thead>
<tr>
<th>Uncertainty components</th>
<th>Relative standard uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net counting statistics</td>
<td>2.6 $10^{-4}$</td>
</tr>
<tr>
<td>Spectrum extrapolation</td>
<td>1.4 $10^{-4}$</td>
</tr>
<tr>
<td>geometric factor</td>
<td>6.0 $10^{-5}$</td>
</tr>
<tr>
<td>backscattering</td>
<td>1.0 $10^{-5}$</td>
</tr>
<tr>
<td>dead time</td>
<td>1.0 $10^{-5}$</td>
</tr>
<tr>
<td>alpha scattering in the detector</td>
<td>1.0 $10^{-6}$</td>
</tr>
<tr>
<td>Temperature</td>
<td>6.0 $10^{-6}$</td>
</tr>
<tr>
<td>Reproducibility</td>
<td>1.0 $10^{-3}$</td>
</tr>
<tr>
<td>quadratic combination</td>
<td>2 $10^{-6}$</td>
</tr>
</tbody>
</table>

Source preparation

Source deposited on silver
Spontaneous deposit of $^{210}$Po liquid source on a silver disk (Ø: 25 mm, ø: 2 mm).
Disk placed in a PTFE cell filled with 4.10 ml of $^{210}$Po in HCL 2M, (4.10 ± 0.12) kBq/g 28/04/09.
Deposition during 60 min at room temperature with agitation.
Room temperature drying.

Source embedded in silver
Surface source covered with a silver foil, thin enough to only slightly decrease the energy of the alpha particles.
Thickness: (170 ± 40) nm (from the shift of the alpha peak using the SRIM software).
Foil pressed on the silver disk, using a polished silicon wafer and heated under vacuum at 320 °C during 1 h.

Results

Source deposited on silver

$A_i = (2 185 ± 4)$ Bq

Cooling during 29 days at 4.2 K

$A_f = (1 834 ± 5)$ Bq

Expected activity using $T = 138.3763 \text{d} : (1 834 ± 4)$ Bq

Difference between measured and calculated results: (0 ± 0.8) Bq

No relative change of the half-life of $^{210}$Po at 4 K, in these specific conditions > 0.6 %

Source embedded in silver

Weaker activity A chamber with a larger G was used

Counting rate before cooling: $N_i = (13.550 ± 0.009)$ s$^{-1}$

Cooling during 11 days

Counting rate after cooling: $N_f = (12.652 ± 0.009)$ s$^{-1}$

Expected counting rate using $T = 138.3763 \text{d} : (12.629 ± 0.009)$ s$^{-1}$

Difference between measured and calculated results: (0.023 ± 0.013) s$^{-1}$

No decrease of the half-life of $^{210}$Po at 4K observed

Uncertainty is higher because of lower counting statistics

Conclusion: no evidence of $^{210}$Po half-life reduction at 4K