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On some unsettled half-lives of AMS radionuclides

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Half-lives ought to be accurate, and preferably precise as well. In the recently published review on half-lives of long-lived radionuclides (Heinitz et al., 2022), several cases were mentioned where multiple half-life measurements on a specific radionuclide were incompatible with each other within the reported uncertainties. We call these "unsettled" half-lives. There are also cases where only very old half-life measurements (50 to 60 years ago) exist, which may need confirmation.

The direct way to determine a long half-life follows from the radioactive decay law: $dN/dt = -\lambda \cdot N$,
where N is the number of radionuclides, dN/dt is its decay rate (activity), and λ the decay constant related to the half-life via $\lambda = \ln 2/t_{1/2}$. Both N and dN/dt need to be measured accurately and independently to obtain the half-life.

The half-life of ^{10}Be can be considered as a good example of how early (trivial) mistakes were corrected and eventually an accurate and precise half-life value of $(1.387 \pm 0.012) \times 10^6$ y was established from two independent measurements (Korschinek et al., 2010, Chmeleff et al., 2010).

In this contribution, we want to discuss unsettled half-lives of some radionuclides where AMS was partly involved in the half-life measurement itself, and which are of interest for applications through AMS measurements. Among others, these comprise the radionuclides ^{32}Si, ^{39}Ar, ^{53}Mn, ^{59}Ni, ^{79}Se, ^{135}Cs, and ^{146}Sm.

We will discuss some ongoing and planned half-life measurements on these radionuclides, which hopefully will lead to a firmly accepted value. The number of radionuclides in the sample whose activity needs to be measured is a crucial input for a half-life determination. Different methods to measure radionuclide concentrations (e.g. AMS, ICP-MS) will be mentioned. In particular, a critical assessment of the measurement of absolute isotope ratios with AMS will be presented, In some cases, geophysical half-life measurements can also be combined with physical measurements to confirm or refute half-life values.

S. Heinitz, I. Kajan, and D. Schumann, How accurate are half-life data of long-lived radionuclides? Radiochim. Acta 110/6-9 (2022) 589-608.

G. Korschinek et al., A new value for the half-life of ^{10}Be by heavy-ion elastic recoil detection and liquid scintillation counting. Nucl. Instr. Meth. Phys. Res. B 268 (2010) 187–191.

J. Chmeleff et al., Determination of the half-life of ^{10}Be by multicollector ICP-MS and liquid scintillation counting, Nucl. Instr. Meth. Phys. Res. B 268 (2010) 192–199.

Student Submission

No

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