AN ACCURATE VALUE FOR THE HALF-LIFE OF ^{10}BE

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INTRODUCTION

^{10}Be, after ^{14}C, is the most frequently used isotope in AMS, and plays an eminent role in several fields of natural science with emphasis on geo- and cosmo-sciences. However it is also of interest in non AMS related fields, for example, as a radioactive clock for Galactic cosmic-ray studies. Here the ratio of ^{10}Be/^{9}Be, formed by spallation reactions induced by cosmic rays on interstellar dust, reveals the time between formation and their arrival on Earth [1]. Also, material in the early solar nebula irradiated by energetic particles yielded ^{10}Be, whose decay product, ^{10}B, bears information on solar system evolution [2]. All these studies demand a precise measure of the half-life of ^{10}Be.

RESULTS

There have been several determinations of the half-life in the past but they show a scatter between roughly 1.3 and 1.6×10^{6} years. We have re-evaluated the half-life using a new measurement method to precisely determine the ^{9}Be/^{10}Be atom ratio of a rather large quantity of enriched ^{10}Be (around 10^{19} atoms) which was in our possession.

The enriched material was originally manufactured by long-term neutron irradiation of the Be moderator in the Materials Testing Reactor at Arco, Idaho, USA. The enrichment, quoted at that time, was around 60% (i.e. ^{9}Be/^{10}Be 0.6). A 1mg extract from this material, in a solution of nitric acid, was purchased in 1986 in order to produce a macroscopic ^{10}Be beam for nuclear reactions studies, which did not eventuate.

Since a quantitative measurement of concentrations for low masses like ^{10}Be and ^{9}Be can easily be compromised by mass fractionation when using a mass spectrometer, we considered a different and new approach. Precise ratios of low mass isotopes can be determined via Heavy-Ion Elastic Recoil Detection (HI-ERD) [3]. We prepared a set of 13 isotope dilutions of the master ^{9}Be/^{10}Be solution using precise amounts of ^{9}Be. The resultant ^{9}Be/^{10}Be ratios of the dilution series was measured by HI-ERD. From a least square fit to the data we calculated an accurate value for the ^{10}Be concentration of the master solution. The activity was measured by Liquid Scintillation Counting (LSC.) The combination of both results yields the half-live. Our value for the ^{10}Be half-life based on our LSC and HI-ERD measurements is obtained by using the following expression:

$$T_{1/2} = \ln(2)\cdot\frac{C_{10}(B)}{A_{10}(B)} \qquad (1)$$

where $C_{10}(B)$ [atoms/g] = $(3.871\pm0.049)\times10^{18}$ atoms/g-solution and the activity $A_{10}(B)=(61268\pm151)$ Bq/g-solution. Thus the new half-life is (1.388 ± 0.018) My [4].

In a parallel and independent study, commencing from a separate aliquot of our master solution-B, and using different equipment and methods to determine the value for $C_{10}(B)$ and $A_{10}(B)$, J.Chmeleff et al, found a half-life of (1.386±0.016) My [5]. Both results agree perfectly. The weighted mean of both of the measurements yields to a half-life of (1.387±0.012) My. We recommend the use of this half-life.

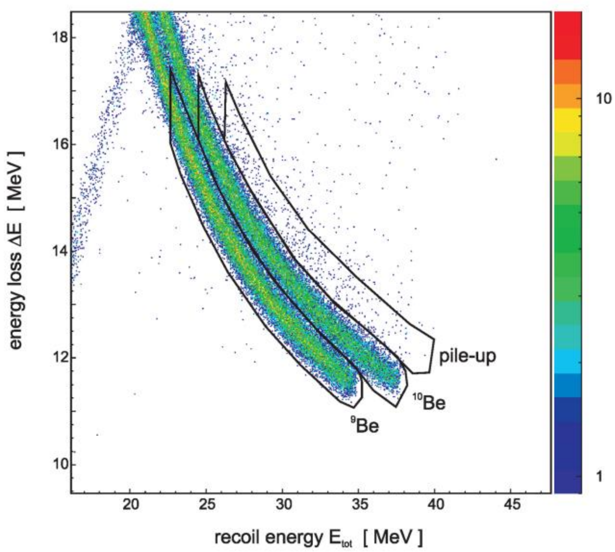

Figure 1. ERD measurement of ^{9}Be and ^{10}Be. Shown is the energy loss versus the total energy of both ^{9}Be and ^{10}Be. Indicated are the regions of interest as well as the region which we took for the pile up correction.

REFERENCES

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