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Geochemical measurement of the half-life for the double-beta decay of 96Zr (G)*

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Double-beta (ββ) decay measurements are a class of nuclear studies with the objective of detecting the neutrinoless (0ν) decay variants. ^{96}Zr is of particular interest as a ββ decay candidate as it has one of the shortest ββ decay half-lives and largest Q-values. A geochemical measurement of its ββ decay half-life was previously performed by measuring an isotopic anomaly of the ^{96}Mo daughter in ancient zircons. This measurement yielded a value of 0.94(32)x10^{19} a [1]. More recently, the NEMO collaboration measured the half-life by a direct count rate measurement to be 2.4(3)x10^{19} a [2], twice as long as the geochemical measurement. ^{96}Zr is also distinctive in that it can undergo a highly forbidden single β decay to ^{96}Nb, which then immediately decays to ^{96}Mo, with a theoretical half-life > 10^{20} a. The geochemical measurement of the ^{96}Zr half-life does not discriminate between these two decay channels, and thus could provide a way to measure the single-beta decay rate.

We aim to study this system through a series of experiments combining nuclear physics and geochemical techniques. We are measuring the amount of daughter product of the decay of ^{96}Zr→^{96}Mo in 2.72 Ga zircons ($ZrSiO_4$). The zircons, which have remained a closed system over their lifetimes, are especially suitable for this investigation due to their high Zr content and low natural Mo content. This makes it possible to detect the small amount of accumulated decay product as an excess compared to the natural Mo isotopic composition.

A discussion of advances in the techniques required for the geochemical measurement will be presented. These advancements have enabled us to produce the first measurements of Mo isotope composition from 2.76 Ga zircons using MC-ICP-MS. The implications for the single and double β decay half-life will be discussed along with future directions.

[1] Wieser and De Laeter (2001), Phys. Rev. C 64, 024308.

[2] NEMO-3 Collaboration (2010) Nucl. Phys. A 847, 168-179.

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