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Accurate half-life measurement of ^{176}Lu

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The ^{176}Lu-^{176}Hf system has the potential as the geochronometer or cosmochronometer. However, the half-life has been to be established accurately because the half-life values reported by various methods including the radiation measurements and the isochron methods show inconsistent values. The previous values measured by radiation detectors have the uncertainties caused by the uncertainties of detection efficiency, calibration radioisotope sources, and gamma-ray emission probability. In our experiment, we measure all radiations from ^{176}Lu using a windowless 4p solid-angle scintillation detector, where a natural Lu sample is located inside of the scintillation crystal [1]. This method has the advantage that the measured value is almost insensitive to the uncertainties from the detection efficiency, calibration radioisotope sources, and gamma-ray emission probability. The detection efficiency of our detector is 99.9% with the uncertainty of 0.1%. Thus, the uncertainty from the detection efficiency is very small. Our value does not depend on the uncertainty of the calibration radioisotope sources, because we do not use calibration sources. This detector measure almost all radiations from ^{176}Lu and thus the measured half-life is free from the gamma-ray emission probability. We finally obtain the half-life of $(3.719\pm0.007)\times10^{10}$ yr. To the best of our knowledge, this is the most accurate and precise value among the previous values. This half-life is consistent with the values measured using the isochron method for terrestrial rocks with the age comparison of the U-Pb system. This means that even if the U-Pb system cannot be used for a sample, the age of the sample could be measured using the Lu-Hf system with the present half-life. It is known that the Lu-Hf is useful for the study of the crust-mantle formation and evolution. Thus, it is expected that samples from various astrophysical objects such as the earth, other planets, moon, and asteroids will be studied using the Lu-Hf system with the presently measured half-life.

[1] T. Hayakawa, et al. (2023), *Communications Physics* 6, 299.