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Challenging studies by accelerator mass spectrometry for the development of environmental radiology 環境放射能学の発展を目指した加速器質量分析による挑戦的研究

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Accelerator mass spectrometry (AMS) is an analytical method that combines mass spectrometry with a tandem accelerator, which has been used mainly in nuclear physics experiments. AMS is used to measure radionuclides with half-lives of 10^3-10^8 years. For radionuclides with half-lives of this order, the method of measuring their mass is 10^3-10^6 times more sensitive than measuring their activity [1]. Because of this advantage, AMS has been widely applied in Earth and planetary sciences, atomic energy research, and other fields. Among the various studies, Wallner et al. (2021, 2016) have achieved excellent work in Earth and planetary sciences [2, 3]. For example, they have attained the ultra-sensitive analysis of ^{6}0Fe and ^{2}44Pu in environmental samples. These are radionuclides produced by rapid-neutron-capture (r-process) nucleosynthesis. Our recent work shows that a new AMS system (VERA, University of Vienna), which combines laser isobaric separation and a typical AMS system, has been successfully applied to the ultra-sensitive determination of ^{9}0Sr and ^{1}35Cs in environment. For ^{9}0Sr in environmental samples, the β-ray measurement by the milking of the daughter nuclide ^{9}0Y is still the principal method, which takes 3-6 weeks. The new AMS method has a detection limit of <0.1 mBq, which is comparable to that of β-ray measurement, with a more straightforward chemical treatment than β-measurement [4]. Our achievement demonstrates that AMS can be a practical new method for determining ^{9}0Sr in the environment. This presentation will report the technical development on ultra-sensitive analysis, focusing on ^{9}0Sr and ^{1}35Cs AMS.

[1] C. Tuniz et al., "Accelerator Mass Spectrometry: Ultrasensitive Analysis for Global Science", CRC Press, Boca Raton, 1998, pp. 3-18.
[2] A. Wallner et al., Science. 372 (2021), 742-745.
[3] A. Wallner et al., Nature 532 (2016), 69-72.
[4] O. Marchhart et al., Proceedings of ENVIRA 2019, 275.

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