Non-Destructive Analysis of Cultural Heritage Using Muon-Induced X-Ray Emission.

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Abstract

The continuous, high-rate negative muon beam at the Paul Scherrer Institute provides a unique environment for applying the non-destructive muon-induced X-ray emission (MIXE) method across diverse fields [1]. These include the analysis of archaeological artifacts [2, 3], Li-ion battery studies [4], meteorites [5], and environmental samples, producing innovative insights and remarkable outcomes without damaging the samples.

The sample to be analyzed is positioned downstream of the beam-line and is surrounded by an array of germanium detectors of the instrument GIANT [6]. Muons are initially captured in the Coulomb field of a nearby nucleus within the sample, forming a muonic atom, typically in an excited state with the muon occupying a higher energy orbit. The muons subsequently relax to the lowest energy orbit by emitting muonic X-rays. Like electronic X-rays, these muonic X-rays have energies specific to the element, and are subsequently detected by the GIANT array. By controlling the momentum of the muons, which ranges from 20 MeV/c to 50 MeV/c, we can probe the sample at depths between tens of micrometers to centimeters (depending on the density of the sample under question).

References

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