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Applicability of Three-Dimensional Muon Tomography with the Radon Transform Technique

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The method of determining an inner density structure of an object by using cosmic-ray muons is termed as "muon radiography" or "muography". Tanaka et al. (2010) attempted to reconstruct the three-dimensional (3D) density structure by observing the volcano from multiple directions, but this study was underdetermined system, so prior information of internal density information and mountain shape were required. However, internal density information was seriously important problem because we did not know before observation.
In this study, we propose that we apply the analysis method of 3D density reconstruction using Radon transformation which does not require prior information. This method applied to practical use in X-ray Computed Tomography (CT). However, in the case of muon radiography, there is constraint on observation points. It is important that the number of observation points and elevation angle are limited. Especially, elevation angle is important of approximation of Feldkamp (1984). However, we can get the information of mountain shape in many cases of muon radiography, so we improved this approximation of elevation angle by using shape information.
We simulated and reconstructed density structure of Omuro-yama, located in Shizuoka pref., Japan, which we considered as an object of demonstration observation of this analysis method. We compared the two approximation methods, Feldkamp (1984) and the method by using shape information. We evaluated the relationship between the number of observation points and the systematic error. We also estimated the error range due to the accidental error of the number of observed muons.
In this publication, we will show the detail of new approximation method and the result of simulation.