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Random Tensors with Applications in the Earth Sciences*

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ランダム テンソルとその地球科学への応用

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要　旨

本稿では地球科学への応用ができるランダム テンソルについての研究を紹介する．具体的には以下の通りである：(1)ランダム的な歪みと応力テンソルの厳密な確率分布について；(2)ランダム的なスペクトルの偏りについて；(3)高次項を含めるランダム的なスペクトルの精度評価について；そして，(4)その地球科学への応用と可能な応用について．

Abstract

Tensors in the Earth Sciences are practically random, since they are either directly measured or indirectly inverted from other types of geo-measurements. Although random tensors have its root in multivariate analysis and nuclear physics, they are now actively investigated more as an independent topic of research; the results of random eigenvalues and eigenvectors from these investigations are mainly of asymptotic nature. In the Earth Sciences, an early result on random tensors was the accuracy of the random spectra of a random stress/strain tensor with a first order approximation. Recently, we have been working on random stress/strain tensors, the results from which are clearly borne in mind for use in the Earth Sciences. The purpose of this paper is to briefly summarize the progress of our recent studies of random second-rank symmetric (SRS) tensors. More specifically, we will mainly focus on: (i) the exact distribution of the random spectra, which is numerically manageable since the dimension of tensors of geo-interest is low; (ii) the biases of the random spectra, which are physically important but not investigated; and (iii) the accuracy of higher order approximation, which is needed if the ratio of signal to noise in stress/strain measurements is not sufficiently large. Since the eigenvector parameters are as important as the eigenvalues in the Earth Sciences, for example, in inferring fault strength and earthquake dynamical simulations, we have been paying due attention to them. On the other hand, we often encounter constrained tensors (deviatoric stress/strain tensors, pure shear tensors and seismic moment tensors, for example) in the Earth Sciences. Thus we also include the spectral theory of constrained random SRS tensors.

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