

Interpretation of Representation Theorems by Continuous-Time Random Walks

*Kota Fukuda¹, Kimihiro Mochizuki¹

1. Earthquake Research Institute The University of Tokyo

The representation theorem is a fundamental equation that is widely used in many areas of seismology. It is generally recognized that this representation theorem is derived from the framework of linear elastic mechanics. However, its equality is described in the form of a convolution with the response function, which has similarities with the master equation describing nonequilibrium dynamics. Based on this inspiration, I present a derivation of a representation theorem from the master equation for continuous-time random walks.

The derivation is carried out in the following steps.

(1) By considering the representation theorem as a theoretical system of nonequilibrium dynamics, we propose a "generalized representation theorem" which is not limited to linear elastic mechanics. (2) By adding the condition of linear elastic dynamics to the generalized representation theorem, we derive the representation theorem used in seismology.

By considering the representation theorem as a theoretical system of non-equilibrium dynamics, We can interpret the stress propagation as the motion of a random walker. In such an interpretation, the determination of the Green's function corresponds to the determination of the waiting time and jump distributions of the random walker.

Helmstetter and Sornette, (2002) proposed that aftershock diffusion can be expressed as anomalous diffusion by continuous-time random walk. The Brownian model (Ide, 2008), which has been proposed as one of the slow earthquake models, shows that rupture propagation is diffusive. Since the continuous-time random walk is a theoretical system that includes anomalous diffusion from the wave equation, in the future, interpreting the representation theorem with the continuous-time random walk may lead to the new theoretical system that discusses these various types of stress propagation in a unified manner.

Keywords: Continuous-time random walk, Representation theorem