Effects of periodic stress perturbations on earthquake nucleation

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One of the important approaches to find underlying physics is to investigate a mechanical response. This idea is inherent not only in laboratory scale, but applicable to a kilometer-scale fault [1]. Recent studies have been showing a high susceptibility of tremors in slow earthquake [2], which may be sorted into an issue of the mechanical response. This study numerically investigates effects on earthquake nucleation growths of periodic stress perturbations like ocean tides. By assuming the rate- and state-dependent friction law on a flat fault embedded in an elastic continuum, we compute the earthquake occurrence rate as functions of the stress or the phase of stress perturbation.
The remarkable points in the results are as follows:
(1) The phase distributions do not show a large phase shift.
(2) The earthquake occurrence is defined as the moment when the slip rate exceed a given threshold value. The occurrences are represented by the normal or shear stress imposed at that moment.
(3) The dependences of earthquake rate on the shear or the normal stress appear to be exponential. This indicates existence of a characteristic stress.
(4) According to the rock experiments conducted by Linker and Dieterich [3], variation of the normal stress additionally alters the frictional condition on the interface. The Linker-Dieterich effect suppresses a gap between top and bottom on the phase distributions, and furthermore, if the effect is very large, we observe antiphase distribution (see fig. 1).

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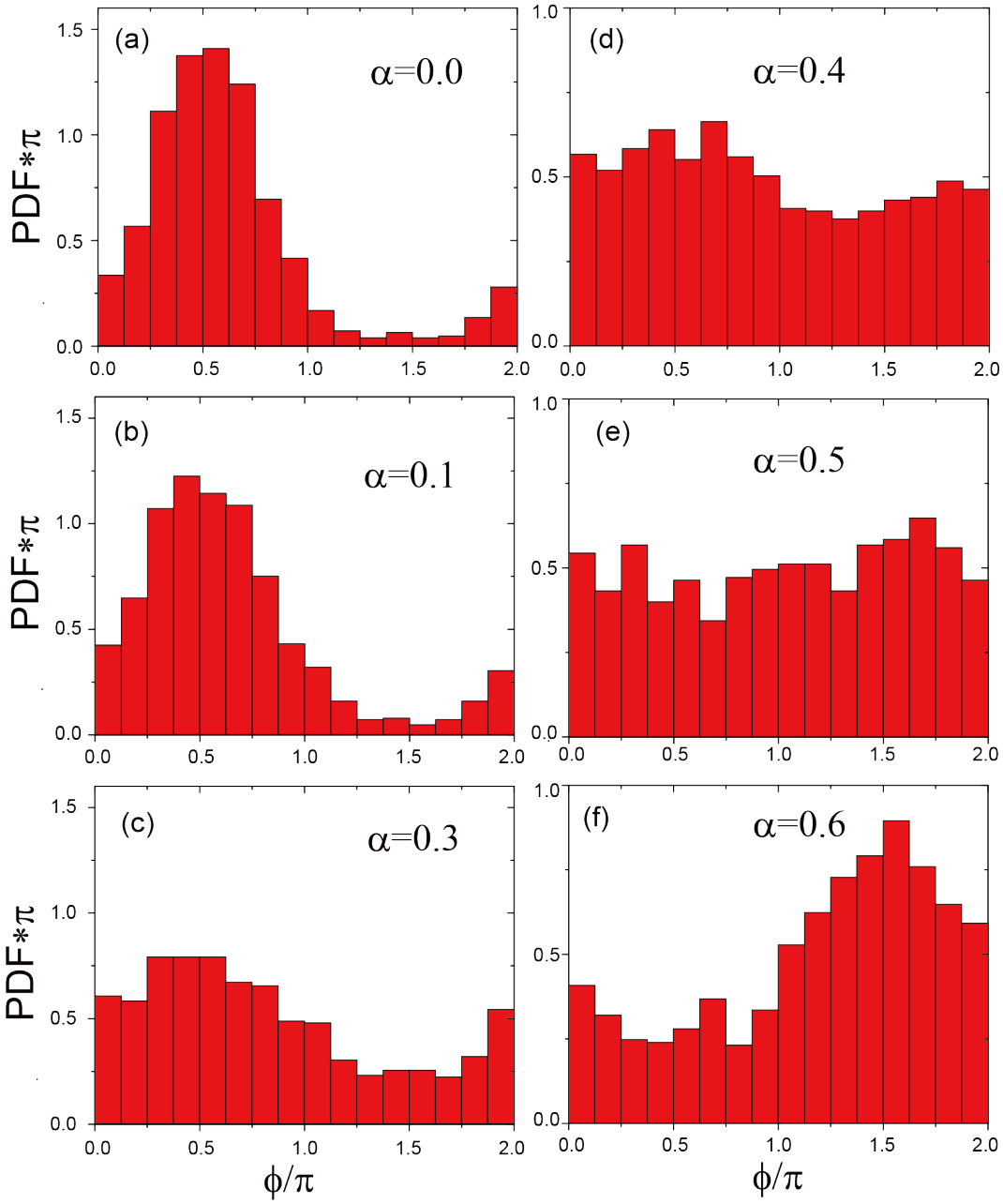

FIG. 1: Distributions of the normal-stress phase at the moment when the nucleation velocity reaches the threshold, which is regarded as the onset of seismic wave. As an increase of the Linker-Dieterich parameter α, a gap between the top and the bottom on the distribution becomes small, and then the phase distribution is eventually inverted.

