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Transitions in stick-slip synchronization due to electromagnetic modification of Coulomb stress

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In our earlier papers the phenomenon of stick-slip synchronization by superposition of periodic mechanical or electromagnetic forcing (which is orders of magnitude weaker than pulling force) was reported. During mechanical forcing we observe the 1:1 correspondence of stick-slip and mechanical oscillation frequencies, whereas at electromechanical forcing by only alternating current the stick-slip events occur twice per forcing period (1:2 correspondence).

In present report the effect of addition of a direct current component to the alternating one is investigated. The laboratory stick-slip experiments on saw-cut basalt samples with varying amplitudes of superimposed direct+alternating electromagnetic fields show that at the certain ratio of amplitudes the 1:2 correspondence between forcing and stick-slip frequencies changes to 1:1 correspondence. The transition looks like some kind of bifurcation, generated by changing some slip process parameters, such as the state of adhesion between plates.

The above experiments open new way to control and reveal fine details of stick-slip process.

The transition from 1:1 to 1:2 synchronization reflects the change of stick-slip response to electromagnetic forcing from electrostriction-like (when the deformation is proportional to the square of electric field intensity) to the piezoelectricity-like, implying linear interdependence between deformation and voltage.