The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

RICH STATISTICS IN MULTI-LAYERED FRICTIONAL SYSTEMS: DO THEY COME FROM RICH FRICTIONAL PROPERTIES?

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Keywords: *Friction, Disorder, Statistics, Earthquakes*

Frictional systems are omnipresent, and it is thought that earthquakes essentially correspond to slip at frictional fault systems [1, 2]. One of the challenges of our time is unraveling the statistics of earthquakes, which are distributed according to a power law only when averaged on several faults systems [3].

We pose the following question: Can a system of frictional interfaces display rich (earthquake-like) statistics? And if they can, is that a result of interfaces modifying each others' constitutive properties? We treat this question through a combination of experiments and numerics [4]. The experimental system consists of a stack of PMMA plates driven in constant shear using a lever attached to the plates by springs (Fig. 1a). The numerical model is geometrically comparable, with the hallmark feature of presenting mesoscopic disorder and inertia, such that no constitutive friction law is prescribed but does display the common rate-and-state law [5]. We observe, both experimentally and numerically, that the macroscopic distribution of slip events is distributed and seemingly dependent on the number of plates (Fig. 1d). We argue, supported by our dynamics, that in our set-up, these rich statistics result from compliant driving as a periodic stick-slip cycle is observed in the case of rigid driving (cf. Figs. 1b and 1c). However, we do show that these rich statistics are only observed macroscopically, as their wide distribution disappears if the interfacial properties are considered (Fig. 1e).

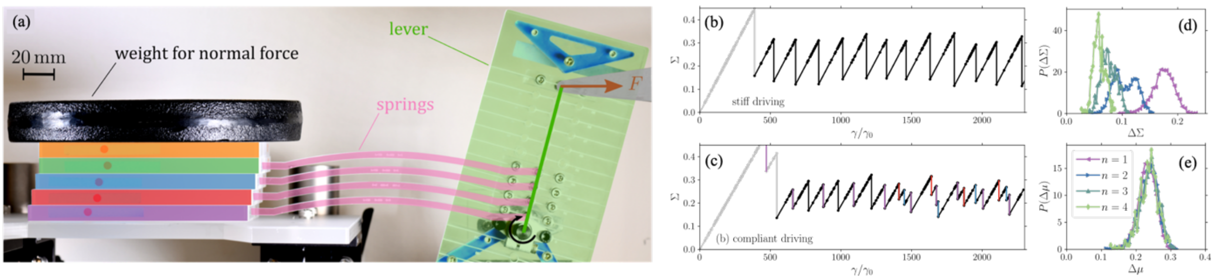

Figure 1. (a) Experimental set-up where we drive N layered plates, applying the same amount of shear by pulling a lever that rotates around a fixed point. We accurately capture the average position of each layer and the force acting on the lever (denoted F). We numerically model the same system by combining mesoscopic disorder and inertia. We show that the system displays stick-slip with a stress Σ *vs.* slip (lever rotation γ) relationship that is (b) periodic of a rigid driving frame, while (c) it is seemingly disordered for compliant driving. Indeed, the latter results in a broad distribution of stress jumps during slip events. *We show, however, that the rich statistics in (d) is not due to the constitutive frictional properties at the interface" ?*

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