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The slippery slope of frictional layered structures

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Two sliding frictional surfaces can display a strong intermittent response known as stick-slip, characterized by a succession of loading phases, interrupted by sudden macroscopic slip events. The static friction coefficient describes the onset of these events; however, it is now known not to be a well-defined material constant [1]. A stochastic nature of this friction coefficient has recently been suggested, with macroscopic slips triggered by microscopic avalanches. Such small-scale events act as scars where inertia leads to local weakening; when a critical size is reached, a slip-event propagates along the interface [2]. We use experiments and simulations to investigate the role of inertial interactions through bulk elasticity of a frictional layered system. Specifically, we investigate a system of stacked plates with frictional interfaces forced to slide simultaneously. We observe that the statistical properties of the stick-slip events in the multilayered set-up deviate from that of a single layer, suggesting a nontrivial coupling across the stack. This work may bring a better understanding of the shear response of structures featuring a multitude of frictional interfaces, such as the seismic behavior of layered geological formations.

[1] Ben-David, O., & Fineberg, J. (2011). PRL, 106(25), 254301.
[2] de Geus, T. W. J, et al. (2019). PNAS, 116(48), 23977-23983.

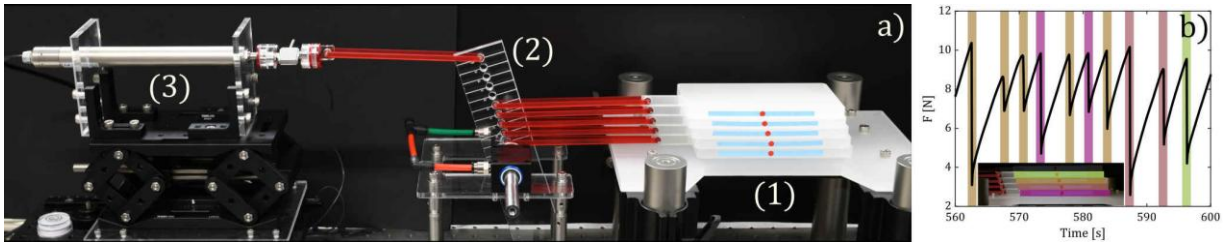

Figure 1 : a) Experimental set-up: a stack of frictional PMMA slabs (1) are pulled using a lever (2) enforcing a constant relative speed between the slabs. The total displacement is imposed at the top of the lever (3), where the total force F is also measured. b) Resulting force signal for 4 slabs pulled together. For each slip event, or drop in the force, we identify the corresponding sliding slab, identified by different color defined in the inset. Each interface displays a wide range of drops amplitude and frequency, deviating largely from the classic stick-slip response of a single interface.