# Creep at a frictional interface

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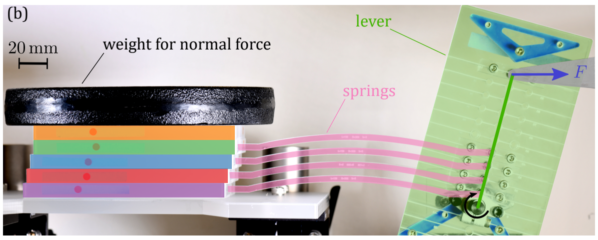
April 4, 2024

**Impact.** Understanding how slip at a frictional interface initiates is important for e.g. earthquake prediction and precision engineering. It is commonly accepted that the “static friction coefficient” grows logarithmically in time due to creep. However, it remains a mystery how creep relates spontaneous slip nucleation.

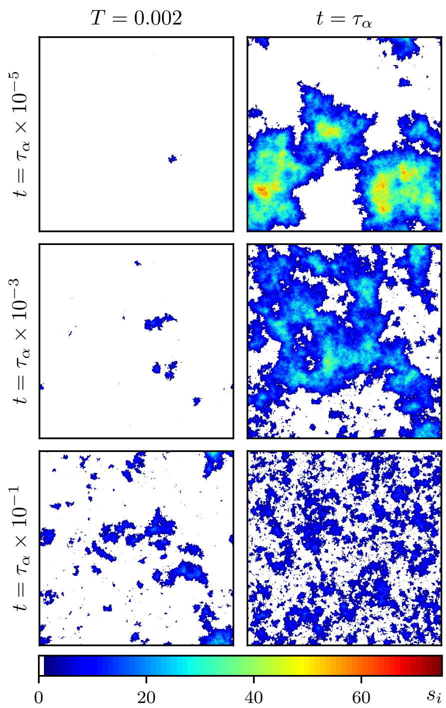
**Measurements.** Spontaneous slip nucleation happens when the system is driven using a weak spring. The system then displays stick-slip. However, although creep is present, its effect is not trivially observed as stick-slip is quasi-periodic. We propose a setup in which multiple, coupled, interfaces are driven by weak springs, see below. This forces the stick-slip cycles to de-synchronize, such that the effect of creep becomes visible and the creep rate can be measured.




**Model.** The simplest model is that of an elastic interface driven over a disordered pinning potential. It consists of $N$ particles that interact with their nearest neighbours. Each particle, furthermore, experiences a driving force (by connecting the particle to a driving frame using a weak spring) and an elastic force due to the pinning potential.

**Depinning.** In the overdamped limit, such a model displays a depinning transition. The system is pinned below a critical driving force, and slips above it. At the critical force, the system displays critical behaviour, i.e. the correlation length diverges. Thereby, the dynamics are intermittent: it displays avalanches whose size, extent, and duration, are power-law distributed. Under these assumptions, the exponents are now well understood. What happens in the presence of inertia and temperature is less clear.

**Thermal avalanches.** Still neglecting inertia, but assuming a finite temperature, the system displays creep at any force: the depinning transition is “rounded”. Intriguingly, the creep regime is also intermittent. The activations are spatially correlated due to elastic coupling: thermal avalanches occur (shown below: activity at different times at a fixed temperature, left, and at different temperatures at fixed time, right). We predict these exponents to be the same exponents as the depinning transition itself.




**Key question.** How thermal avalanches and inertial avalanches co-exist and interact around the inertial critical force is even quantitatively unknown.

## Selection of publications

[1] S. Poincloux, P.M. Reis, and T.W.J. De Geus. Stick-slip in a stack: How slip dissonance reveals aging. *Phys. Rev. Research*, 6(1):013080, 2024. doi: 10.1103/PhysRevResearch.6.013080. arXiv: 2301.13745.

[2] T.W.J. de Geus, A. Rosso, and M. Wyart. Dynamical heterogeneities of thermal creep in pinned interfaces. *arXiv preprint: 2401.09830*, (arXiv:2401.09830), 2024. doi: 10.48550/arXiv.2401.09830.