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Non-monotonic dependence of the friction coefficient on heterogeneous stiffness

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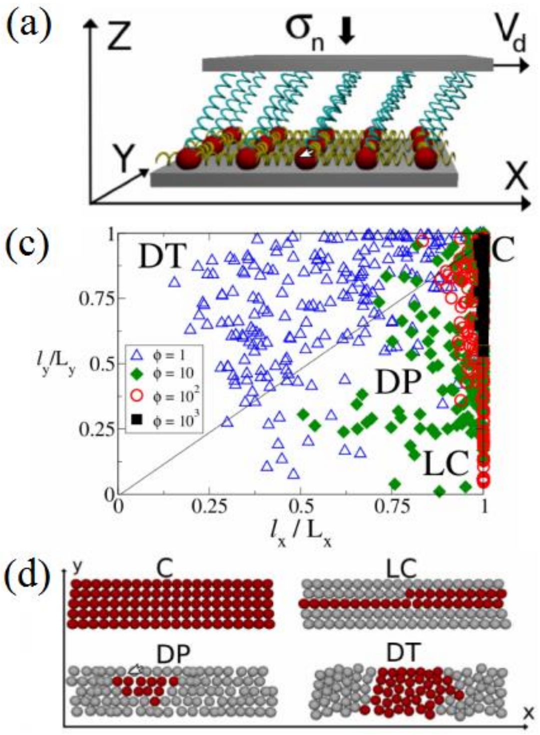
The complexity of the frictional dynamics at the microscopic scale makes difficult to identify all of its controlling parameters. Indeed, experiments on sheared elastic bodies have shown that the static friction coefficient depends on loading conditions, the real area of contact along the interfaces and the confining pressure. We have shown, by means of numerical simulations of a two dimensional spring-block model with a simple local friction law, that the macroscopic friction coefficient depends non-monotonically on the elastic properties of the system. This occurs because elasticity controls the geometrical features of the rupture fronts during the stick-slip dynamics.



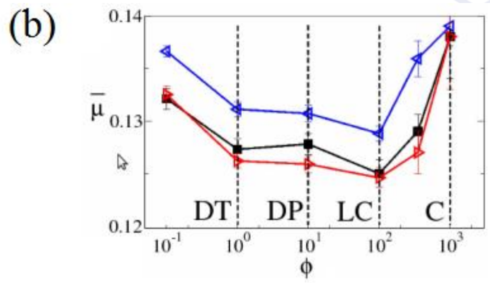


Fig: (a) Schematic representation of the 2D Burridge-Knopoff spring-block model. (b) The macroscopic friction coefficient μ depends non-monotonically on the degree of elastic heterogeneity ϕ. The dashed vertical lines indicate four regimes: crystalline C, laminar crystalline LC, disorder-parallel DP and disorder-transverse DT. (c) Scatter plot of the dimensions of the clusters of moving particles, along the directions parallel and transverse to the shear. By reducing the stiffness of the system, ϕ, we observe regions with different cluster morphology. (d) Sketch of the cluster geometries corresponding to the regions indicated in (c).