Physikalisches Kolloquium

Universität Konstanz

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Di 30.04.24
15:15 Uhr
P 603
im Anschluss Getränke und Snacks

Avalanches of Local Instabilities Govern the Ageing of Disordered Matter: from Crumpled Sheets to Seismic Aftershocks

Many complex and disordered systems fail to reach equilibrium after they have been quenched or perturbed. Instead, they sluggishly relax toward equilibrium at an ever-slowing, history dependent rate, a process termed physical ageing. The microscopic processes underlying the dynamic slowdown during ageing and the reason for its similar occurrence in different systems remain poorly understood.

Combining experiments on crumpled sheets and simulations of a disordered network of interacting elastic instabilities, we reveal the structural mechanism underlying logarithmic aging in disordered mechanical systems. We find that under constant external loading, the system self-organizes to a marginally stable state, where it can remain for long, but finite, times. The system's slow relaxation is intermittent, and advances via self-similar, slow avalanches of localized, micro-mechanical instabilities.

These avalanches are thermal – they span many timescales and they are driven by facilitation and noise. The avalanches' size and the inter-instability times are power-law distributed and exhibit a unique property – the distributions maintain their scaling exponents throughout the ageing process, but their cut-offs grow in time. Crucially, the quiescent dwell times between avalanches grow in proportion to the system's age, which leads to the observed dynamic slow-down and logarithmic ageing. We link this effect to a slow increase of the lowest local energy barriers, which we find govern the initiation of avalanches.

Applying our analysis to the temporal dynamics of seismic aftershocks reveals strikingly similar results, suggesting that a similar physical mechanism underlies aftershock dynamics and the celebrated phenomenology of Omori's law.

See:

D. Shohat, D. Hexner and Y. Lahini, PNAS 119 2200028119 (2022)

D. Shohat, Y. Friedman and Y. Lahini, Nature Physics 19, 1890-1895 (2023)

Host:
Prof. Zilberberg

Organisation:
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