The elasticity of metals deviates from the Hook's law and fluctuates at low frequency. The deviations observed are explained in terms of Self Organized Criticality behavior of the dislocations inside the metal crystalline structure

Riccardo DeSalvo
University of Sannio and KAGRA, ICRR, University of Tokyo

Abstract

Soft non-linear springs were designed for seismic attenuation in Gravitational Wave detectors. Anomalous hysteresis, transient changes of the modulus defect and strange spontaneous instabilities were observed when tuning these springs to low frequency.
The observed effects were traced to coherent dislocation activities in the metal, operating under what we believe is a Self organized Critical regime. The transition to this regime happens only at sufficiently low frequency that the collective effects (dislocation avalanches) can develop.
Our proposed explanation allowed us to design a method to control the observed instabilities (to some extent).
We believe that this behavior is common, to different extents, to all polycrystalline metals.
Following our theory, an independent group observed a shift of an elastic oscillator resonant frequency when vibrations are injected. With the gathered information we designed a tiltmeter with >100x better low frequency sensitivity than previous instruments.

Reference

Riccardo DeSalvo, Arianna DiCintio and Mark Lundin, The role of Self-Organized Criticality in elasticity of metallic springs: Observations of a new dissipation regime, Eur. Phys. J. Plus (2011) 126: 75