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Heterogeneity, visco-elasticity and the universality class of earthquake occurrence

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The organization in time, space and energy of earthquakes exhibits scaling laws with exponents α, β, γ and p which are universal, i.e. they are independent of time and of the geographic region.
A possible explanation of this critical-like behavior is provided by the possibility to describe the evolution of a seismic fault
under friction within the general context of the depinning transition. In fact, minimal models for the seismic fault, such as the Burridge-Knopoff model, can be mapped to classical quenched Edwards-Wilkinson (qEW) interfaces. Nevertheless the exponents of the scaling laws
of the qEW interfaces are different from those exhibited by instrumental earthquakes.
In this talk I will present a more realistic description of the seismic fault which can be viewed as a qEW interface evolving over
a viscous-ductile substrate. I will show that this description produces scaling laws with exponents α, β, γ and p in very good agreement with experimental values. More precisely, the values of the exponents α, β and γ are quite independent of model parameters and this explains their universal character. Conversely the exponent p, controlling the temporal clustering of seismic sequences,
depends on the specific law implemented for the viscosity. The value $p = 1$ of instrumental data is recovered assuming a velocity-strengthening law for the viscous layer, which is a quite realistic description of real fault systems.

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