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# The nature of the two scaling laws in interfacial fracture.

Arne Stormo, Olivier Lengliné, and Jean Schmittbuhl
Strasbourg, France (arne.stormo@gmail.com)

Since Mandelbrot in 1984 first began to study fracture in the language of fractals, the fracture surfaces have been found to be self-affine, i.e. that the height of the surface scales with the relation

$$h(r) \sim \lambda^{\zeta} h(\lambda x). \tag{1}$$

$h$ is the height of the surface above a reference point, $x$ is the position, $\lambda$ is an arbitrary scaling factor and $\zeta$ is the *roughness exponent*.

The fracture surface morphology of vastly different materials have been studied and have been found to have eerily similar roughness exponents. In refined studies by Ponson et al. they found that there were two regimes of behaviour, leading to different roughening of the surface, depending on length-scale and specimen properties. However, these experiments were done in three dimensions, and it could only describe the fracture post mortem.

In order to study the developing fracture front, Måløy et al. introduced a two dimensional, optically transparent experiment where the fracture propagated through a weak heterogenous plane between two Plexi glass plates. In 2010, Santucci et al. found that also this interfacial fracture had two regimes of morphology. Later, Tallakstad et al. found that the front also displayed Family-Vicek scaling. The question that is emerging is: Why is there tho regimes of behaviour, and can we create a model that captures this transition?

We present a numerical bottom-up model able to reproduce this change of morphology and scaling. Our model is a variant of the fiber bundle model presented by Batrouni et al. The model consists of a two dimensional set of fibers that are attached to two clamps with elastic response. As the clamps are torn apart, the fibers experience stress and, depending on a distributed stress threshold, will fail at some point. When this happens the rest of the fibers will have to carry the load dropped by the broken fiber.

Depending on the elasticity of the clamps and the width of the threshold distribution, the failure of the fibers will be brittle or quasi brittle. When we introduce a gradient to the model we get an interface between a large group of broken fibers, and a large group of surviving fibers. By interpreting the interface between these two groups as a developing fracture front, we can reconstruct the scaling laws found in the laboratory.

When we investigate the release of energy in our model, we find that the amount released in each event is distributed as a power-law, similar to the Gutenberg Richter distribution. The exponent of this distribution is dependant on the properties of the system. We thus want to find a connection to the exponent of the Gutenberg Richter distribution, especially the varying exponent found during the hydraulic injection of the deep geothermal reservoirs at Soultz-sous Forêts.