Avalanches in fluid imbibition fronts

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Avalanche phenomenon is observed in many different physical situations and it exhibits scale–invariant statistics[1,2]. One example is fluid imbibition which occurs when a viscous fluid gets into a porous media displacing the in-present air. The two phases, liquid/air, are separated by a rough interface whose fluctuations have generally scaling properties. Imbibition processes can be classified in different types depending on the mean velocity of the interface[?]. Then we have driven imbibition when we impose a constant mean velocity V, and spontaneous imbibition when it follows Washburn's law $V \sim t^{-1/2}$. In addition, one can impose an external pinning force like gravity, obtaining an interface that gets pinned at a given time.
In this work[4], we focus on the avalanche behavior of the interface when advances through a porous medium. We consider all the different imbibition cases. By using a mesoscopic phase field model, we can reproduce the imbibition phenomenon and analyze the statistical properties of the interface fluctuations by means of a scaling treatment. We observe that the typical quantities describing avalanches, such as size distribution, follow clear power-laws with well defined exponents (see Fig. 1). A comparison to experimental work is also given.

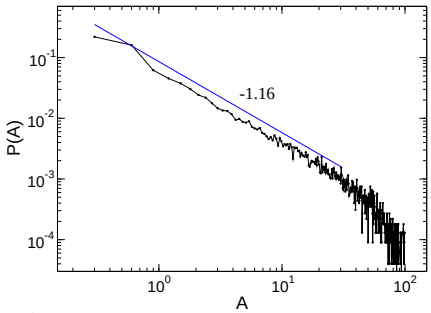

Figura 1. Avalanche size distribution of the interface in the case of imbibition with gravity. The distribution is well described by a power-law $P(A) \simeq A^{-\tau}$ with $\tau \simeq 1.16$.

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