

Experimental realization of KPZ dynamics: Slow combustion of paper

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There have been many recent advances in the theoretical understanding of kinetic roughening of interfaces. However, in very few experimental systems have these processes been studied in great detail and with good statistics. With a high resolution experimental set-up, a lot of information was collected of slow-combustion fronts propagating in sheets of paper. The data gathered amounts to about those of a thousand individual burns, and involve experiments on four different grades of paper. Temporal and spatial properties of the roughening interfaces were thoroughly studied by monitoring the interface width, correlation functions, structure factor, amplitudes of the correlation functions, and by determining the relevant parameters by an inverse method.

Our results indicate that smouldering fronts in sheets of paper asymptotically obey KPZ dynamics with a roughening exponent of $\chi \sim 1/2$ and a growth exponent of $\beta \sim 1/3$. Below sample dependent crossover scales, higher 'apparent' temporal and spatial scaling exponents, and nontrivial effective noise, were observed. A natural source for this noise is local fluctuations in the paper density, and therefore also the correlations and distributions of these fluctuations were carefully investigated. Many, but not all, features of this short-range behaviour were qualitatively shown, by direct numerical integration of the KPZ equation in which a real paper structure was used as the input noise, to be a consequence of short-range correlations in the structure of paper.