A qualitative model to describe microscopic 'jumps' by adhesive tape unwinding from a roll

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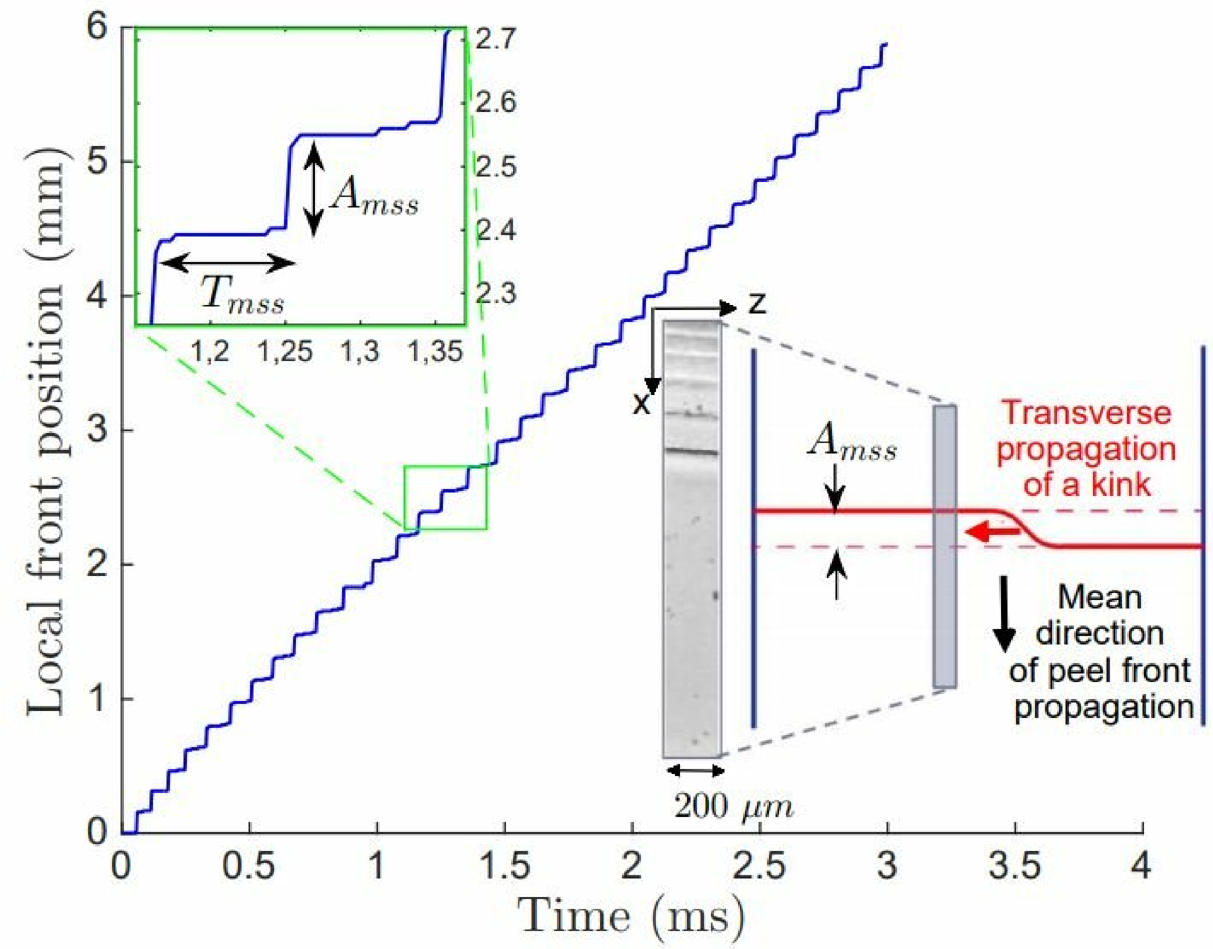

Micro-stick-slip dynamics of the local longitudinal position of the peel front during an experiment at V = 1.8 m/s, L = 50 cm and θ = 90°, with periods of rests T_{mss} preceding slips of size A_{mss}, as a result of the transverse propagation across the tape of a kinked fracture of amplitude Amss. We also display a typical image recorded by the fast camera (the grey zone in inset gives its reduced field of view). Credit: arXiv:1812.11394 [cond-mat.soft]

A team of researchers from Universite de Lyon and Centre National de la Recherche Scientifique has developed a qualitative model to describe microscopic "jumps" that happen when adhesive tape is unwound from a roll. In their paper published in the journal *Physical Review Letters*, the group describes their study of the process using high-speed cameras and what they found.

Extracting a length of duct tape from a roll rarely goes smoothly. First, you have to get your nails under the end, then you have to pull up and back as you attempt to unroll it. But this unwinding always happens in fits and starts, rather than as a smooth removal process, making it difficult to obtain the desired length. Back in 2010, a group of scientists filmed the process with a high-speed camera hoping to better understand what happens. They found that the longer macroscopic jumps were actually a series of much smaller jumps. Also, the line formed at the juncture of the unwound tape and the tape still stuck to the roll was not straight.

In 2015, another team studied the process using the same technology—high-speed cameras. But this time, they pasted one layer of tape on a flat surface and then applied another to it before pulling it free. This removed the roundness part of the process. They found that the peeling cycles were determined by energy held in elastic deformations which built up and released repeatedly as the tape was peeled.

In this latest effort, the researchers used Scotch tape instead of duct tape. They also added extra adhesive to make the fits and starts more pronounced. Upon close examination of the process, the researchers found that the amplitude of the jumps was proportional to the cubic root of their period. They also found that the speed of the wave that ran along the tape border was inversely proportional to the rigidity of the tape. The team used both pieces of information to create a model to describe the process—a model that could accept parameters associated with tape rolls to predict how they would behave when unrolling.

More information: V. De Zotti et al. Bending to Kinetic Energy Transfer in Adhesive Peel Front Microinstability, *Physical Review Letters* (2019). DOI: 10.1103/PhysRevLett.122.068005 , On *Arxiv*: arxiv.org/abs/1812.11394