The stick-break instability of extended fractures

Gabriele Albertini*[1], Thomas Cochard , Ilya Svetlizky , Viesca Robert , and David Weitz

[1]University of Nottingham – United Kingdom

Abstract

Fractures can lead to catastrophic failure of materials. Although crack propagation in a two-dimensional plane is well understood, all cracks are extended in a three-dimensional (3D) space, through which they propagate. When cracks slowly move forward in a 3D brittle material, they do so in a discontinuous way with long pauses of no motion followed by rapid forward jumps. We call this a stick-break instability. These forward jumps are short-lived dynamic ruptures propagating perpendicular to the main direction of motion at velocities as high as the Rayleigh-wave speed. We study the crack propagation experimentally in a circular geometry that achieves an uninterrupted extended fracture front and use a fluid to control the loading conditions that determine the amplitude of the forward jump. We find that this amplitude correlates with the transverse velocity. Here we further investigate this observation with dynamic rupture simulations to shed light on the underlying mechanics. These results emphasize the importance of transverse dynamics in the forward propagation of extended fractures.

*Speaker