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Dynamical fracture: a continuum derivation of the velocity gap

Abstract: In dynamical fracture mechanics, the existence of a velocity gap has been debated - a minimum speed necessary for propagation, requiring driving above the Griffith point. A monolayer of aqueous foam has provided a model system exhibiting fracture under sudden applied pressure by rupturing successive liquid films. Using fluid dynamics principles such as film instability and viscous resistance, this process is mapped to brittle fracture. In line with experiments, the model finds a velocity gap and a critical driving pressure above the Griffith limit. We show that these features are also observed in a one-dimensional continuum model of the foam, from which we obtain explicit scaling predictions of the velocity gap and the critical driving pressure in terms of the model parameters. The model reveals the competition of dissipation processes in the thin films and the Plateau borders as the cause of the velocity gap phenomenon, confirming concepts advanced in the fracture mechanics of solids.