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Dynamics of sub-Rayleigh, Supershear and Bimaterial Ruptures

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We present new laboratory experiments where the rupture velocities, strain fields and the real area of contact variation are simultaneously measured at high speed during the propagation of a variety of different rupture fronts. We first show that the strains surrounding propagating sub-Rayleigh rupture tips within homogeneous interfaces are described by classical singular solutions, originally derived to describe rapid brittle shear cracks. In addition, the measured velocity evolution of these sub-Rayleigh frictional ruptures is in excellent agreement with the classical equation of motion for cracks for rupture fronts ranging from extremely slow to nearly asymptotic velocities that approach the Rayleigh wave speed.

We then briefly describe supershear rupture evolution within these homogeneous frictional interfaces. While, theoretically, supershear ruptures are not expected to obey a well-defined equation of motion, we derive (following Broberg (1994)) an approximate equation of motion for adiabatic rupture acceleration to supershear velocities and demonstrate that it well-describes both experimental measurements and numerically calculated supershear ruptures.

Finally, we turn to new experimental studies of bimaterial rupture. Ruptures that take place within interfaces formed by materials whose elastic properties differ. We show that very different modes of rupture take place. We present a characterization of these rupture modes which include both highly localized slip pulses and supershear cracks.