MAR08-2007-000391

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Beller Lectureship Talk: Crack-like processes govern the onset of frictional motion

JAY FINEBERG, The Hebrew University

The dynamics of frictional slip have been studied for hundreds of years, yet many aspects of these everyday processes are not understood. One such aspect is the onset of slip. First described by Coulomb and Amontons as the transition from static to dynamic friction, the onset of frictional slip is central to fields as diverse as physics, tribology, the mechanics of earthquakes and fracture. We study the dynamics of how this transition takes place by performing real-time visualization of the *true* contact area which forms the interface separating two blocks of like material. The results show that the onset of frictional motion is driven by the interplay of three different types of coherent crack-like fronts, which propagate along the interface, reducing the contact area as they progress. Two of these, whose propagation speeds are, respectively, slightly below and significantly above the shear wave velocity, appear to be related to known propagation modes of shear cracks. The third type of front does not correspond to known fracture modes. It propagates over an order of magnitude more slowly, and is the most efficient of the three modes in reducing contact area along the interface. We first show that, at applied stresses that are well below the (Coulomb-Amontons) threshold for the onset of frictional motion, significant precursor activity occurs along the interface. This activity is comprised of propagating (subsonic) shear cracks which arrest before traversing the entire interface. In their wake, these "precursor" cracks systematically transform the intial spatially uniform contact area along the interface to a highly nonuniform one. *Only* at the transition to overall motion will these precursor cracks simultaneously excite, at their point of arrest, both the slow propagation modes and the intersonic ones. Until to this point, no overall frictional motion occurs. Frictional sliding only takes place when either the slow modes or additional shear cracks excited by the slow modes traverse the entire interface. These results suggest that to understand the transition to frictional motion, the dynamics of this entire chain of events must be taken into account.