All may look smooth, but there are 'bumps' along the way: Scientists describe how friction works

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Friction in human relations is all too obvious and prevalent, but friction in physics has had a "secret life" of its own that has now been revealed by scientists at the Hebrew University of Jerusalem.

In an article appearing in the journal *Nature* (with a further reference to it in Nature Physics), the scientists show how frictional strength evolves from extremely short to long time scales. The new information could be useful in assessing a wide range of natural and man-made phenomena — from earthquakes to computer hard drives

"Although friction plays such an important role in so many aspects of our lives, it is surprising that many key processes embodied within frictional motion have been far from understood," said Jay Fineberg, the Max Born Professor of Natural Philosophy at the Hebrew University and author of the *Nature* article along with Ph.D. students Oded Ben-David and Shmuel Rubinstein.

Fineberg said that while frictional motion is often thought of as the motion of two bodies against each other, separated by a perfectly smooth plane, in fact, due to the microscopic roughness of sliding surfaces, all of the contact between sliding bodies takes place in only a tiny area. Thus, only a sparsely spaced microscopic "bumps" are responsible for maintaining the contact between two sliding bodies. It is the behavior of these bumps which governs friction.

These microscopic contacts have a life of their own that very much differs from that of bulk materials, commented Fineberg. It is that "secret life" that has now been described in the research of the Hebrew University researchers. Their study shows how frictional strength evolves from extremely short to long time scales.

Millionths of seconds before bodies start to slide against one another, a miniature "earthquake" tears through the interface and ruptures the contacts, said Fineberg. From that moment of contact rupture, four distinct and interrelated phases of evolution are identified, he said. These include the violent rupture phase, resultant contact weakening, and continuing through renewal and re-strengthening. These results provide a comprehensive picture of how frictional strength evolves.

Fineberg emphasized that a fundamental understanding of these processes is critical to a variety of important problems and applications, such as the evolution of frictional strength at short-time impacts as in, for example, the read/write cycle of hard drives, frictional dissipation in an internal combustion engine, and the dynamics of earthquakes.

At the other end of the spectrum, long-time strengthening processes are critical when considering the need for strengthening a fault or frictional interface. This understanding could lead the way to manipulation and control of such dynamics, at small and large scales alike, he said.

Provided by Hebrew University of Jerusalem

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