Was da Vinci wrong? Experts show friction and fracture are related, with implications for earthquakes

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Overturning conventional wisdom stretching all the way to Leonardo da Vinci, new Hebrew University of Jerusalem research shows that how things break (fracture) and how things slide (friction) are closely interrelated. The breakthrough study marks an important advance in understanding friction and fracture, with implications for describing the mechanics that drive earthquakes.

Over 500 years ago, da Vinci described how rough blocks slide over one another, providing the basis for our understanding of friction to this day. The phenomenon of fracture was always considered to be something totally different.

But new research by Prof. Jay Fineberg and his graduate student Ilya Svetlizky, at the Hebrew University's Racah Institute of Physics, has demonstrated that these two seemingly disparate processes of fracture and friction are actually intimately intertwined.

Appearing in the journal *Nature*, their findings create a new paradigm that's very different from the da Vinci version, and, according to the researchers, give us a new understanding of how earthquakes actually occur.

Fineberg and Svetlizky produced "laboratory earthquakes" showing that the friction caused by the sliding of two contacting blocks can only occur

when the connections between the surfaces are first ruptured (that is, fractured or broken) in an orderly, "organized" process that takes place at nearly the speed of sound.

How does this happen? Before any motion can occur, the blocks are connected by interlocking rough contacts that define their interface. In order for motion to occur, these connections have to be broken. This physical process of breaking is called a fracture process. This process is described by the theory of crack propagation, say the researchers, meaning that the stresses (or forces) that exist at the front edge of a crack become highly magnified, even if the overall forces being applied are initially quite small.

"The insights gained from our study provide a new paradigm for understanding friction and give us a new, fundamental description of the mechanics and behavior that drive earthquakes, the sliding of two tectonic blocks within natural faults," says Fineberg. "In this way, we can now understand important processes that are generally hidden kilometers beneath the earth's surface."

More information: "Classical shear cracks drive the onset of dry frictional motion." Ilya Svetlizky, Jay Fineberg. *Nature* 509, 205–208 (08 May 2014) DOI: 10.1038/nature13202. Received 18 November 2013 Accepted 25 February 2014 Published online 07 May 2014

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