Scientists close in on 'superbrakes' for cars

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A theoretical study of friction between solids that looks at the process just one molecule at a time could soon lead to a more effective way to stop cars in an emergency than simply slamming on the brakes or using ABS.
Scientists and engineers have assimilated an enormous amount of empirical information on the processes taking place when two surfaces rub against each other producing friction. They have even devised numerous physical rules and laws to explain these forces. These laws are adequate for most practical purposes, but according to Peter Reimann and colleagues, our understanding of how friction is traced back to the behaviour of solids at the molecular level where surfaces meet is still far from complete. He and his colleagues hope to improve our fundamental understanding of the microscopic laws governing materials in contact.

This research is reported today in a special Einstein Year issue of the New Journal of Physics published jointly by the Institute of Physics and the German Physical Society (Deutsche Physikalische Gesellschaft).

"In our work, we consider theoretically a somewhat simplified setup," explains Reimann, "This consists of a single, very small point, which is pulled over an atomically flat surface." This, Reimann explains further, is an exceptionally simple and well controlled "minimal'" system that allows he and his team to study the forces between the point and the surface. Experimentalists studying friction use a similar setup to measure the actual forces involved.

Reimann's team begins with a mathematical description of the system

that takes into account the forces between the point and the surface at the microscopic level as the point is drawn across the surface. They found that their model could explain previous experimental findings confirming its validity. However, they have also drawn a surprising conclusion. The model suggests that the frictional force increase as the point begins to move, then reaches a maximum as it speeds up, and then falls if the point continues to be accelerated across the surface.

"We find this prediction quite surprising and experimentalists have already signalled their excitement to test it in their labs," says Reimann. If similar behaviour were seen with the friction between car tires and the road, then there are important implications for road safety. The findings suggest that neither locking the wheels nor the usual ABS-system is the most effective method of stopping a car in the shortest possible stopping distance, explains Reimann. He says that a compromise between the two approaches to braking could be much more effective.

The paper will be published on Monday 31st January 2005 in New Journal of Physics (www.njp.org) as part of a celebratory focus issue on "Brownian Motion and Diffusion in the 21st Century" (stacks.iop.org/1367-2630/7/i=1/a=E01). P Reimann et al. New J. Phys. 7 (2005) 25, direct link stacks.iop.org/1367-2630/7/25.