The Physics Of A Bump In A Rug

October 20 2009, By Mike Lucibella

Image credit: ISNS

Scientists often have to make sacrifices for their work. Physicist Dominic Vella chopped his bathroom rug into strips, and L. Mahadevan's coauthor ran off with his bookshelf. With these sacrifices, these two teams were able to glean enough information to revolutionize the world's understanding about the physics of lumpy carpets.

Their results, set to be published in two separate papers in the latest issue of Physical Review Letters, describe everything about wrinkles in rugs--known also as rucks -- including how they form, how they move, and what happens when they interact.

“We were motivated by an old analogy that uses the ruck in a rug to explain how certain defects in a crystal move,” said Mahadevan from

Harvard University in Cambridge, Mass. “The phenomenon itself had not been very well studied, and so we decided to spend some time on it.”

The way a bump in a rug travels across a floor has been compared with the way tectonic plates move, cell membranes slide and inchworms crawl. Friction makes it difficult to drag a big piece of carpet, but when there's a wrinkle in the material, the wrinkle can easily roll down the length of the carpet, moving the carpet along in the process.

"It's always used as an analogy for lots of things in physics," said Vella, at the University of Cambridge in the UK, adding that in order to know for sure if these analogies are accurate, "you have to first understand the physics of the ruck in the rug."

Vella’s team studied the form that bumps take, how well they hold that shape and how fast they move across a flat surface. First, Vella and his team tested rubber mats of different thicknesses on a variety of flat surfaces. After observing how a wrinkle in the rubber mat developed on wood, sandpaper and metal, the team compared it to the behavior of Vella's own bathroom rug on the same surfaces. To see how these wrinkles move, the team used a high-speed camera to film the mats while a team member waved one end up and down.

They found that larger wrinkles have an easier time supporting themselves no matter what kind of surface the rug sits on. Smaller bumps smooth out quickly unless there's a lot of friction holding them up from the surface below. For most types of carpet Vella tested, moving bumps travel at around one meter per second, though smaller ones tend to move faster than larger ones. When two wrinkles collide, they combine to form a bigger one that moves even faster.

Mahadevan's team looked at how gravity pulls a bump down a ramp. He placed a wrinkled rubber sheet on the bookshelf borrowed from his

office and tilted it until the wrinkle started rolling on its own. He describes in detail the bump's speed, shape, and angles at which different sizes started rolling.

Both teams plan to further explore the new field of carpet mechanics.

Based on the results so far, they confirm, physicists can still use wrinkled rugs for their analogies.