

Physicists make ripples with their 'magic carpet'

Tiny rug gets off to a flying start.

Philip Ball

Perfectly timed for pantomime season, a team of scientists has come up with instructions for how to make a flying carpet.

The magical device may owe more to Walt Disney than to *The Arabian Nights*, but it is not pure fantasy, according to Lakshminarayanan Mahadevan of Harvard University in Cambridge, Massachusetts, and his co-workers. The researchers have studied¹ the aerodynamics of a flexible, rippling sheet moving through a fluid, and find that it should be possible to make one that will stay aloft in air.

No such carpet is going to ferry people around, though. The researchers say that to stay afloat in air, a sheet measuring about 10 centimetres long and 0.1 millimetres thick would need to vibrate at about 10 hertz with an amplitude of about 0.25 millimetres. Making a heavier carpet 'fly' is not forbidden by the laws of physics. But the researchers say that their "computations and scaling laws suggest it will remain in the magical, mystical and virtual realm", as the engine driving the necessary vibrations would need to be so powerful.

The key to a magic carpet is to create uplift by making ripples that push against fluids such as air or water. If it is close to a horizontal surface, like a piece of foil settling down onto the floor, such rippling movements create a high pressure in the gap between the sheet and the floor. "As waves propagate along a flexible foil, they generate a fluid flow that leads to a pressure that lifts the foil, roughly balancing its weight," Mahadevan explains.

But as well as lifting it, the ripples can drive the foil forward — a trait required by any respectable magic carpet. "If the waves propagate from one edge," says Mahadevan, "this causes the foil to tilt ever so slightly and then move in one direction towards the edge that is slightly higher. Fluid is then squeezed from this end to the other, causing the sheet to progress like a submarine ray."

Speed bumps

To travel at speed, the carpet would have to undulate in big ripples, comparable to the size of the carpet. This would make the ride very bumpy. "If you want a smooth ride, you can generate a lot of small ripples," says Mahadevan. "But you'll be slower."

"It's cute, it's charming," says physicist Tom Witten at the University of Chicago in Illinois, who is intrigued that the researchers thought to study such an unusual engineering feat.

So could tiny flying carpets really be made? Spontaneous undulating motions have been demonstrated in 'smart' polymers suspended in fluids — the polymers can be made to swell or shrink in response to external signals. In September, another team at Harvard University described flexible polymer sheets coated with cultured rat muscle cells that flex in response to electrical signals and are able to swim².

"In air, it should be possible to make moving sheets — a kind of micro hovercraft — with very light materials, or with very powerful engines," Mahadevan says.



State Art Museum, Nizhny Novgorod, Russia/Bridgeman Art Library

References

1. Argentina, M., Skotheim, J. & Mahadevan, L. *Phys. Rev. Lett.* 99, 224503 (2007). | [Article](#) | [ChemPort](#) |
2. Feinberg, A. W., *et al.* *Science* 317, 1366-1370 (2007). | [Article](#) | [PubMed](#) | [ISI](#) | [ChemPort](#) |

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