

# Investigating how droplets move around on a surface shows us why it is important to set boundary conditions

November 18 2015

---



The motion of liquid droplets on a solid surface can now be robustly described using a first-principles hydrodynamic model. Credit: Comstock Images/Stockbyte/Thinkstock

Not everyone ponders sets of partial differential equations when watching droplets slide down a window on a rainy day, but, thanks to new research from A\*STAR, those who are so inclined now have what they need to construct a robust physical and mathematical explanation of what they see.

A 'contact line' is formed when a fluid meets a solid wall. "Contact lines are ubiquitous in nature," explains Weiqing Ren of A\*STAR's Institute

of High Performance Computing. Everyday life is replete with them, from the condensation on the outside of a frosty glass on a hot day through to the milk split on the kitchen table. We engage daily with what physicists call the 'moving contact line problem' without even realizing.

Explaining how a droplet spreads out on a surface seems like it should be simple, yet the moving contact line problem has been contentious. This debate is largely about how 'slip', or the movement of the contact line, should be treated in the mathematical models.

The classical hydrodynamic model assumes that fluids do not slip on a solid surface. This assumption is an example of a restriction placed on the solutions of [differential equations](#) at the edge of a given domain or area, known as a 'boundary condition'.

As the 'no-slip condition' leads to unrealistic, or 'unphysical' behavior at the contact line, theoreticians have proposed a number of modifications to overcome this issue. Ren notes, however, that "most of these models are phenomenological in nature and it is not clear whether they correctly describe the real physics near the moving contact line."

Ren and colleagues combined mathematical and computational methods—including continuum theory, molecular dynamics and multiscale techniques—with two sets of boundary conditions: one for the macroscopic regime where the droplet's motion can be safely described using the no-slip condition, and another for the microscopic regime around the contact line where slip plays an important role. These components were drawn together to form a sophisticated 'first-principle' hydrodynamic model that describes exactly how a liquid drop moves on a surface.

Aside from explaining common occurrences—such as a detergent's ability to remove an oil drop from [solid surface](#) or the interaction of an

ink drop with paper during ink-jet printing—the team's model also provides insights to support device design in developing fields such as microfluidics. "This model helps us to examine many important physical phenomena using analytic and computational tools," says Ren.

**More information:** Weiqing Ren et al. Continuum models for the contact line problem, *Physics of Fluids* (2010). [DOI: 10.1063/1.3501317](https://doi.org/10.1063/1.3501317)

Weiqing Ren et al. On the distinguished limits of the Navier slip model of the moving contact line problem, *Journal of Fluid Mechanics* (2015). [DOI: 10.1017/jfm.2015.173](https://doi.org/10.1017/jfm.2015.173)

Provided by Agency for Science, Technology and Research (A\*STAR), Singapore

Citation: Investigating how droplets move around on a surface shows us why it is important to set boundary conditions (2015, November 18) retrieved 21 June 2024 from <https://phys.org/news/2015-11-droplets-surface-important-boundary-conditions.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.