Water theory is watertight, researchers say

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There may be tiny bubbles in the wine, but not at the interface between water and a waxy coating on glass, a new study shows.

The behavior of water when placed in contact with hydrophobic (water-repellent) surfaces, such as raincoats and freshly waxed cars, has puzzled scientists for a long time. According to a controversial theoretical prediction, water near a hydrophobic surface will pull away and leave a thin layer of depleted water at the surface – that is, water molecules at the interface will pack less tightly than usual.

Now, a team of researchers at the University of Illinois at Urbana-Champaign and Argonne National Laboratory has resolved the controversy. Using near-perfect hydrophobic surfaces and synchrotron X-ray measurement techniques, the researchers found the theoretical prediction to be correct. They report their findings in the Dec. 31 issue of the journal *Physical Review Letters*.

"Previous experiments have been interpreted sometimes in favor of a depletion layer, sometimes against, and sometimes as indicating intimate solid-water contact in places and 'nanobubbles' in others," said Steve Granick, a professor of materials science and engineering, chemistry and physics at Illinois.

"Part of our study was to help understand why there was so much disagreement in the scientific literature," said Granick, who also is a researcher at the Frederick Seitz Materials Research Laboratory on campus and at the university's Beckman Institute for Advanced Science

and Technology.

To study the nature of hydrophobicity, the researchers first prepared a nearly ideal hydrophobic surface – a self-assembled methyl-terminated octadecylsilane monolayer. Then they made synchrotron X-ray measurements of the interface between water and monolayer.

The measurements revealed a depletion layer, about one water molecule in thickness. The depletion layer was present with and without air dissolved in the water. Because no nanobubbles were seen, bubbles must not play a significant role in hydrophobicity, the researchers conclude.

The synchrotron X-ray data "unambiguously confirm the theoretical expectation that water, when it meets a planar hydrophobic surface, forms a depletion layer," the researchers write.

"We found that in a real system – more complicated that the theory assumes – the theory does capture the essence," Granick said. "The next time I see water beading on a raincoat, my vision of how the water molecules experience that raincoat is going to be different."

Source: University of Illinois at Urbana-Champaign