SPACE & PHYSICS

Can somebody finally settle this question: Does water flowing down a drain spin in different directions depending on which hemisphere you're in? And if so, why?

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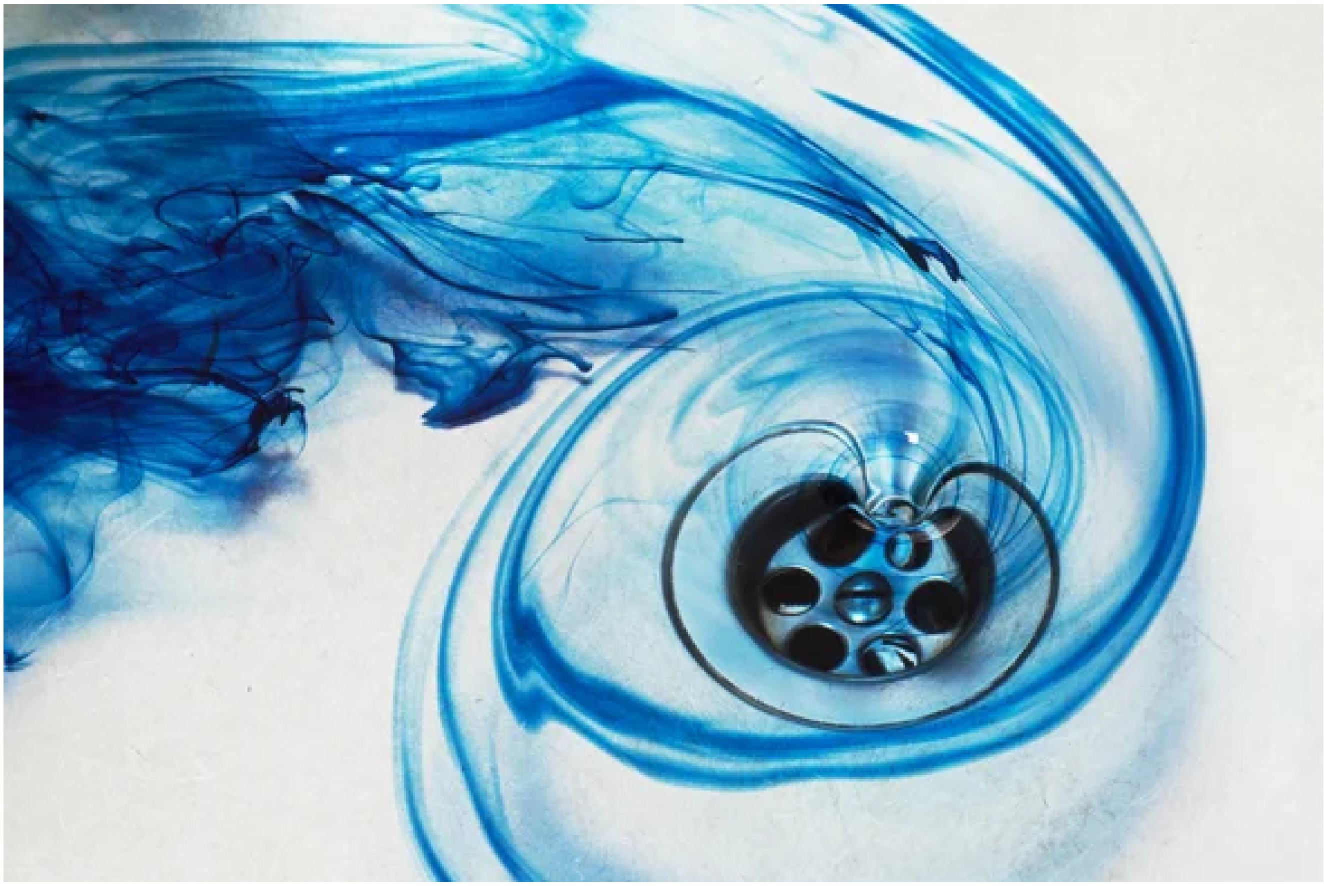

Credit: James Stevenson *Getty Images*

This question would seem to be one of simple physics, and yet it continues to engender sharp disagreements. The main problem here is the division between theory and practice: whereas in principle the earth's rotation could affect the direction of draining water, in the real world that effect is probably swamped by other, less uniform influences.

Brad Hanson, a staff geologist with the Louisiana Geological Survey, presents the argument of why--in theory--water going down the drain would indeed spin in different directions depending on which hemisphere you're in:

"The direction of motion is caused by the Coriolis effect. This can be visualized if you imagine putting a pan of water on a turntable and then spinning the turntable in a counterclockwise direction, the direction in which the earth rotates as seen from above the north pole. The water on the bottom of the pan will be dragged counterclockwise direction slightly faster than the water at the surface, giving the water an apparent clockwise spin in the pan. But if you were to look at the water in the pan from below, corresponding to seeing it from the south pole, it would appear to be spinning in a counterclockwise direction. Likewise, the rotation of the earth gives rise to an effect that tends to accelerate draining water in a clockwise direction in the Northern hemisphere and counterclockwise in the Southern."

Fred W. Decker, professor emeritus of oceanic and atmospheric science at Oregon State University notes, however, that the Coriolis effect may actually have little to do with the behavior of real-world sinks and tubs:

"Really, I doubt that the direction of the draining water represents anything more than an accidental twist given by the starting flow. The local irregularities of motion are so dominant that the Coriolis effect is not likely to be revealed. An empirical test could help."

Robert Ehrlich, a physicist at George Mason University, expands on these ideas:

"Do bathtubs drain in different directions in the two hemispheres? If you had a specially prepared bathtub, the answer would be yes. For any normal bathtub you are likely to encounter in the home, however, the answer is no.

"The tendency of a circulation in a fluid to develop in a clockwise direction in the Northern Hemisphere and a counterclockwise direction in the Southern Hemisphere can be traced to the earth's rotation. Imagine a cannon fired southward from any latitude above the equator. Its initial eastward motion is the same as that at a point on the spinning earth. This initial eastward velocity is less than that at a point later in its trajectory, because points closer to the equator travel in a bigger circle as the earth rotates. Therefore, the cannon shell is deflected westward (to the right), from the perspective of a person standing on the earth. A gunner firing a cannon northward would find that the shell is also deflected toward the right. These sideways deflections are attributed to the Coriolis force, although there really is no force involved--it is just an effect of being in a rotating reference frame.

"The Coriolis force accounts for why cyclones are counterclockwise-rotating storms in the Northern Hemisphere, but rotate clockwise in the Southern Hemisphere. The circulation directions result from interactions between moving masses of air and air masses moving with the rotating earth. The effects of the rotation of the earth are, of course, much more pronounced when the circulation covers a larger area than would occur inside your bathtub.

"In your tub, such factors as any small asymmetry of the shape of the drain will determine which direction the circulation occurs. Even in a tub having a perfectly symmetric drain, the circulation direction will be primarily influenced by any residual currents in the bathtub left over from the time when it was filled. It can take more than a day for such residual currents to subside completely. If all extraneous influences (including air currents) can be reduced below a certain level, one apparently can observe that drains do consistently drain in different directions in the two hemispheres."

Finally, Thomas Humphrey, a senior scientist at the San Francisco Exploratorium, discusses in more detail the reasons why we do not see the Coriolis effect at work in the bathroom:

"There is an African country near the equator where entrepreneurs have set up two toilets, one just north of the equator, the other just south of it. For a fee, they will allegedly demonstrate that the toilets flush in opposite directions. It is only for show, however; there is no real effect. Yes, there is such a thing as the Coriolis effect, but it is not enough to dominate the flushing of a toilet--and the effect is weakest at the equator.

"The telling comparison is between the magnitude of the Coriolis effect and the initial amount of angular momentum in the water--that is, how much is it spinning anyway, regardless of the earth's rotation. Coriolis acceleration at mid-latitudes is about one ten-millionth the acceleration of gravity. Because it is a very small acceleration, it needs a very long distance for it to produce an appreciable curvature--and hence directionality--to the motion. A toilet or sink is just not large enough. The Coriolis effect influences because wind velocities may be hundreds of times greater than the motions in a sink and because the distances involved are far larger than the tiny draining diameter in a sink or toilet.

"It is impossible to find a cup full of water that does not have some average net motion; it will always be going one way or the other, and that little amount of angular motion is enough to swamp the Coriolis effect. The net motion in the water becomes much more pronounced as the water is forced to move in toward the center of evacuation, causing the normally invisible flows in the water to become visible as the water nears the drain. The ultimate direction of that flow is random--it can go one way one time, the other way the next.

"If you run an experiment in your sink--fill the sink, then pull out the stopper--the water will almost always go down the same way, making you wonder if this is really a random effect. But you will find that the faucet is almost always off center or that there is some other asymmetry in the sink. As a result, filling the sink consistently gives it some net rotation in the same direction, which you see as the normal direction of evacuation. Toilets will always drain and fill the same way, for the same reason.