



Science Journal: The structure of water isn't certain after all

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By Sharon Begley, The Wall Street Journal

With electrons whizzing around at nearly the speed of light and throwing off infrared radiation and X-rays as though there's no tomorrow, the cutting-edge Synchrotron Radiation Laboratory at Stanford University seems to have little in common with new-age drinks or alternative medicine.

But that was before plain old water -- the most abundant substance on Earth, the basis of life, a compound whose structure was probed during Queen Victoria's reign -- turned out to have fooled a long line of scientists.

"It's such a basic question, the structure of water," says chemical physicist Anders Nilsson of Stanford. "It's amazing we don't really understand it."

Dr. Nilsson made a splash, so to speak, when he and colleagues took a page from director Michelangelo Antonioni. They planned to use X-rays generated by the synchrotron, a kind of particle accelerator, to study chemical bonds in molecules in water. But just as the photographer in Antonioni's 1966 existential classic, "Blow-Up," found that the lovers' tryst he had shot was less interesting than the background (which contained a man with a gun), so the scientists found the background water to be where the action was.

Liquid water, they concluded from the X-ray data, has a structure totally at odds with what textbooks say and what scientists have believed for more than a century. Rather than being a sea of tetrahedrons -- little pyramids with triangular bases, formed when each water molecule connects to four others -- it seems to be an ocean of rings and chains, with most molecules hooking up with only two others via strong bonds.

As often happens when the conventional wisdom starts to collapse, on closer inspection there wasn't much holding it up in the first place. The notion that water molecules form pyramids actually had little empirical support, Dr. Nilsson says: "Experimental findings have been so sparse that theoretical work has dominated the field," and the theory is so inexact "that you can get almost any result you want just by tweaking" a few numbers.

Not everyone is sold on the rings and chain idea. Just months after the Stanford team concluded that the pyramid model was all wet, and in response to it, scientists at the University of California, Berkeley, announced that water is too a bunch of tiny pyramids. That brought a testy response from the Stanford researchers, who disparaged their rivals' experiment as full of "fundamental shortcomings" and beset by a "lack of reproducibility."

Although the Berkeley team is sticking to its pyramids, many scientists are persuaded by the rings and chain. Overturning the pyramid notion is "an incredibly big deal," says chemist Giulia Galli of UC Davis, who wasn't involved in the experiment. She is using a

supercomputer to crank through trillions of quantum calculations to determine what structure water should have according to basic principles.

This may seem like an esoteric question, "but different structures (of water) should behave differently," says Prof. Galli. Because life runs on water, fathoming its true structure could overturn key ideas in biology.

That is years away, but marketers are already exploiting the upheaval in the science of water. Last month, H2Om LLC of Los Angeles unveiled what it calls "the world's first 'vibrationally charged' bottled water."

Although H2Om (pronounced H-two-Om, as in the mantra) starts with conventional spring water, exposure to words on the bottle's label alters it, says the company: "Love" and "Perfect Health," the first varieties, each transmits a "vibrational frequency" that the water absorbs. Each bottle is supposedly also infused through music (in the storage room after bottling) and thoughts (from the person drinking it). The precise science by which the water retains its desirable new structure even as the delivery van passes billboards about HIV and graffiti filled with hate words remains to be worked out.

Fans of homeopathy are also hitching their star to the water revolution. This largely discredited form of alternative medicine is based on the belief that vanishingly small amounts of substances change the structure of water in a way that makes it therapeutic.

In a new paper, William Tiller, former chairman of materials science at Stanford, and colleagues argue that "water can indeed have its properties and hence its structure changed rather easily." From their review of more than 100 studies, they conclude that water is "a 'zoo' of mixed sizes of molecules," suggesting "a potential relevance to homeopathy."

"People have ignored the possibility that liquid water can have multiple structures," says Rustum Roy, a materials scientist at Pennsylvania State University and co-author of the paper in *Materials Research Innovations*. "But there is good evidence for nanostructures." As Prof. Galli suggests, "In a tube measuring one to two nanometers, holding 60 to 80 water molecules, interactions with the wall of the tube might change water's structure."

Few serious scientists are betting on homeopathy, let alone love-infused water. But as Dr. Nilsson says, "It's amazing we are so uncertain about the most abundant substance on Earth. I have a feeling that, with water, there will be more surprises."

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