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The Fourth Phase of Water: A role in fascia?

How can a Jesus Christ lizard walk on water? Why do pollen grains jitterbug in a puddle? Why do fair weather clouds form such lovely puffy white shapes? And why can you "feel" the movement of fascial water?

Answering those questions requires an understanding of water. Given water's pervasiveness and simplicity, we presume that water must be completely understood, but in fact precious little is known about how water molecules line up — until recently.

We learn that water has three phases: solid, liquid and vapor. But there is something more. In our laboratory at the University of Washington we have uncovered a fourth phase. This phase occurs next to water loving (hydrophilic) surfaces. It is surprisingly extensive, projecting out from surfaces by up to millions of molecular layers; and it exists almost everywhere.

The evidence for this new phase of water has been described in a recently-released book: *The Fourth Phase of Water: Beyond Solid, Liquid and Vapor* www.ebnerandsons.com. The book documents the finding with ample experimental evidence, and is profusely illustrated with photos and cartoons designed to make the material accessible. It is written in language laymen can understand.

The existence of a fourth phase is not entirely unexpected. One century ago, the physical chemist Sir William Hardy argued for its existence; and, over the years many authors have found evidence for some kind of "ordered" or "structured" phase of water. Fresh experimental evidence not only confirms the existence of that ordered, liquid-crystalline phase, but also details its properties. These properties explain everyday observations and questions ranging from why gelatin desserts hold their water, to why teapots whistle.

The energy for building this structure comes from the sun. Radiant energy converts bulk water into ordered water, building this zone. We found that all wavelengths, from UV through visible, to infrared can build this ordered zone. Near infrared energy is the most capable. Water absorbs the infrared energy freely from the environment; it uses that energy to convert bulk water into liquid crystalline water. Hence, buildup of the fourth phase occurs naturally and spontaneously. Energy input beyond that occurring naturally creates additional liquid crystalline buildup.

Of particular significance is the fourth phase's charge, commonly negative. Absorbed radiant energy splits water molecules; the negative moiety forms the building block of the ordered zone, while the positive moiety binds with bulk water molecules to form free hydronium ions. Adding more light stimulates more charge separation.

This process resembles the first step of photosynthesis. In that process, energy from the sun splits a water molecule. Splitting is catalyzed by a hydrophilic chromophore. The process under consideration appears more generic: any hydrophilic surface may catalyze the splitting, some more effectively than others.

The charges separated by light resemble a battery. That battery can deliver energy in a similar way as the separated charges in plants deliver energy. Plants, of course, comprise mostly water and it is therefore no surprise that similar energy conversion takes place in water itself.

The stored electrical energy in water can drive various kinds of work, including flow. An example is the axial flow through tubes. We found that immersing tubes made of hydrophilic materials into water produces flow through those tubes, similar to blood flow through blood vessels. The energy derives from the radiant energy absorbed and stored in the water. Nothing more. Flow may persist undiminished for hours, sometimes longer. Additional incident light brings faster flow. This is not a perpetual motion machine: incident radiant energy drives the flow — in much the same way that it drives vascular flow in plants.

This energy conversion framework is rich with implication for any system involving water, ranging from biology and chemistry all the way to atmospheric science, engineering, and medicine. The fourth phase can appear nearly everywhere. All that's needed is water, radiant energy, and a hydrophilic surface. The latter can be as large as a slab of polymer or tissue and as small as a dissolved molecule. The liquid crystalline phase inevitably builds — and its presence plays some integral role in the respective system's behavior.

Let me provide a couple of representative examples.

One example is… you. Two thirds of your cells are water — by volume. In terms of the fraction of your cells'

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molecules, that translates to more than 99% because so many of those diminutive molecules are required to build that two-thirds volume fraction. Modern cell biology considers those 99% of your molecules as secondary: they constitute the background carriers of the "important" molecules of life, such as proteins and nucleic acids. Conventional wisdom asserts that 99% of your molecules don't do much.

However, liquid crystalline water envelops every macromolecule in the body, including those of the fascia. Those macromolecules are so tightly packed that the liquid crystalline water pervades your body. In other words most of your water is liquid crystalline water — the kind just described. This water plays a central role in everything we do, as elaborated in my earlier book, *Cells, Gels and the Engines of Life* www.ebnerandsons.com.

What's new is the role of radiant energy: powering many of those cellular functions. An example is the blood flowing through your capillaries. That blood suffers high resistance: capillaries are often narrower than the red blood cells that must pass through; those red cells need to scrunch down in order to make their way. Resistance is high. Notwithstanding, the pressure gradient across the capillary bed is negligible. This has seemed paradoxical: without a pressure gradient, what drives the flow through those resistive vessels? If radiant energy helps propel flow through capillaries in the same way that it propels flow through hydrophilic tubes, then the paradox resolves. Radiant energy may constitute an unsuspected source of vascular drive, supplementing cardiac pressure.

Radiant energy may also play a role during massage. Your hand generates radiant energy, and fascia absorbs that energy. That energy builds the liquid crystalline water that is necessary for healthy function. Further, pressure itself does the same: because liquid crystalline water is denser than bulk water, massage pressure converts bulk water into liquid crystalline water. We confirmed that in recent laboratory experiments. In other words, pressure and radiant energy build the liquid crystalline water that is characteristic of healthy tissue and necessary for normal physiological function.

Another example is weather. Common understanding of weather derives from two principal variables: temperature and pressure. That's said to explain virtually everything. However, the atmosphere is full of micrometer-scale aerosol droplets — comprising water. Atmospheric humidity exists in the form of scattered droplets. We found that liquid crystalline water envelops each droplet, while hydronium ions populate the interior. Those hydronium ions create pressure, which pushes against the shell of liquid crystalline water. That provides a novel answer to the question why droplets tend toward roundness.

How do those aerosol droplets condense to form clouds? Droplet shells bear negative charge. Like-charged droplets should repel, precluding any condensation; the aerosol droplets should remain dispersed throughout the atmosphere. However, droplets do sometimes condense into clouds. They condense because of unlike charges that lie in between the droplets. Richard Feynman, the legendary Nobel Prize physicist of the late 20th century understood the principle, opining that: "like-likes-like because of an intermediate of unlikes." The like-charged droplets "like" one another, so they come together. The attractor is the unlike charges lying in between.

The like-likes-like principle has been widely appreciated, but also widely ignored: after all, how could like charges conceivably *attract*? One reason this powerfully simple concept has been ignored is that the source of the required unlike charges has been difficult to identify. We now know that the unlike charges can come from the splitting of water — the negative component building the droplet's shell, the corresponding positive component constituting the unlike attractors. With enough of those unlike attractors, the negatively charged aerosol vesicles may condense into clouds.

Beyond scientific, the discovery of the fourth phase has practical applications. Those applications include electrical energy harvesting, flow production, and even filtration. Regarding the latter, natural filtration emerges because the liquid crystalline fourth phase massively excludes common solutes and particles in much the same way as ice (In fact, this behavior *is* ice-like.). Accordingly, the fourth phase water is largely solute free. Collecting it provides you with solute-free and bacteria-free water. A bench-type prototype confirms this expectation. Such purification requires no physical filter: the fourth phase itself does the separation, and the energy comes from the sun.

Revelation of the fourth phase opens many doors to understanding. Previews of these fresh understandings can be found in various hour-long talks. One of those is an award lecture, conferred annually by the University of Washington: http://www.youtube.com/watch?v=XVBEwn6iWOo. Another was delivered more recently: http://www.youtube.com/watch?v=JnGCMQ8TJ_g.

The full picture of the scientific developments and diverse applications can be found in the aforementioned new book, *The Fourth Phase of Water: Beyond Solid, Liquid, and Vapor*, available at www.ebnerandsons.com. The book considers fundamental phenomena ranging from osmosis and diffusion to Brownian motion and basic chemistry. It offers fresh interpretations of all of them based on these recent discoveries. It goes on to consider everyday phenomena that we may often see but don't really understand: e.g., why your joints don't ordinarily squeak. A Cambridge University colleague opined after reading, that the book resembles an illustrated children's book, but with paradigm shifting content.

That was the author's intent.

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