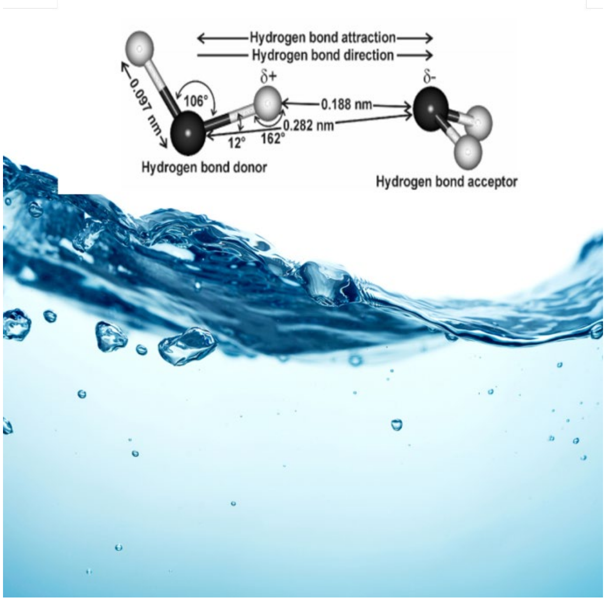
Scientists Finally Measure the Strength of the Bonds That Hold Together Water



Water has some remarkable properties. It has almost the highest specific heat capacity of any substance, meaning that it can absorb a lot of heat-energy when its environment is hot, and release a lot of heat-energy when its environment is cold -- making it the primary regulator of surface temperature on Earth. It becomes less dense as it solidifies, so that water habitats in cold regions will remain partially liquid as solid ice floats to the top of the water column and forms a protective layer -- allowing aquatic inhabitants to survive frigid winters. When water molecules form they adopt a tetrahedral geometry, one of the consequences of which is formation of a partial electric dipole -- making water an important solvent. In fact, water is called the 'universal solvent", because it dissolves more substances than any other liquid.

The source of many of water's remarkable attributes is due to its molecular geometry –

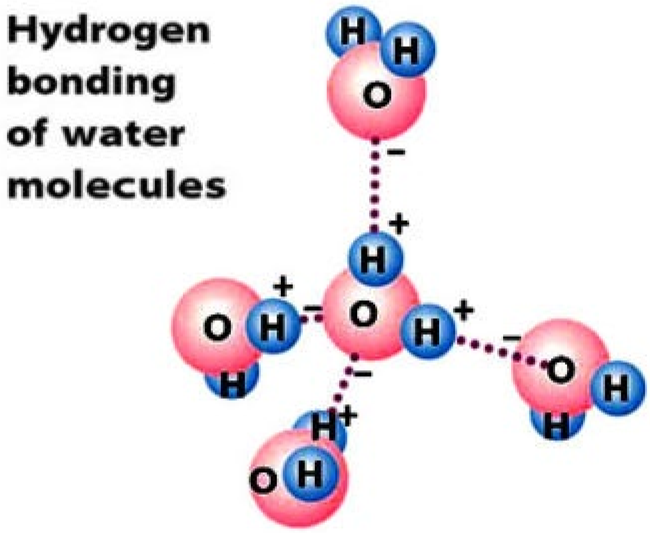
the partial electric dipole formed by its two hydrogen moieties and one oxygen atom.

Such that the oxygen atom is slightly electro-negative at one pole, and the covalently bonded hydrogen atoms are slightly positively charged at

the other pole. This causes water to form tetrahedral-oriented weak bonds with adjacent water molecules. It is

for this reason that water molecules are strongly attracted to each other, meaning that it takes a good amount of energy to get them to separate, such as in evaporation or the increased distance associated with freezing.

This weak bonding between hydrogen atoms and electro-negative elements is called hydrogen bonding, which gives water its amazing qualities but is also involved in many other molecular interactions -- such as holding DNA strands together to form the double helix, coordinating protein folding to enable nearly every function of the cell, and causing stable membranes to form due to hydrophobic--hydrophilic interactions. It is such an important interaction that if the strength of hydrogen bonding were even slightly different in water then life as we know it would not be possible.



"...if the hydrogen bond strength was slightly different from its natural value then there may be considerable consequences for life. At the extremes water would not be liquid on the surface of Earth at its average temperature if the hydrogen bonds were 7% stronger or 29% weaker. The temperature of maximum density naturally occurring at about 4°C would disappear if the hydrogen bonds were just 2% weaker. Major consequences for life are found if the hydrogen bonds did not have their natural strength. Even very slight strengthening of the hydrogen bonds may have substantial effects on normal metabolism. Water ionization becomes much less evident if the hydrogen bonds are just a few percent stronger but pure water contains considerably more H+ ions if they are few percent weaker. The important alkali metal ions Na + and K + lose their distinctive properties if the hydrogen bonds are 11% stronger or 11% weaker respectively. Hydration of proteins and nucleic acids depends importantly on the relative strength of the biomolecule--water interactions as compared with the water--water hydrogen bond interactions. Stronger water hydrogen bonding leads to water molecules

clustering together and so not being available for biomolecular hydration. Generally the extended denatured forms of proteins become more soluble in water if the hydrogen bonds become substantially stronger or weaker. If the changes in this bonding are sufficient, present natural globular proteins cannot exist in liquid water. The overall conclusion of this investigation is that water's hydrogen bond strength is poised centrally within a narrow window of its suitability for life." ---Water's Hydrogen Bond Strength

This places hydrogen bond strength, particularly of water, in the "fine-tuning category" with several other constants and force interactions of nature that, if they were to be even slightly different from their given values, would prohibit the formation of a universe with even nominal degrees of complexity.

All considered, the exact strength of hydrogen bonding is an important value to know. Which is why the latest news of the precise and direct quantitative measurement of hydrogen bond strength by atomic force microscopy is so exciting. With this technique, scientists can now directly measure the strength of hydrogen bonds as well as image hydrogen atoms, something that was previously only inferred given that hydrogen is the smallest element and its position in a molecule is difficult to determine using standard techniques.

"With just a single electron and a single proton, hydrogen is the smallest atom, yet its generation in the early stages of the universe makes it the most abundant element, constituting 75% of all baryonic mass. The extremely high reactivity of hydrogen means it easily forms covalent compounds with nearly all non-metallic elements, famously, oxygen and carbon. Hence, identifying and understanding the role of such a ubiquitous element have long been key scientific challenges. In particular, hydrocarbons are one of the most varied and functionalized products at the heart of engineering, chemistry, and life, and hydrogen is often critical in their function." -- precise and direct quantitative measurement of hydrogen bond strength by atomic force microscopy

Scientists are able to measure the importance of PHOTONIC WAVES by simply detecting the reduction of ORP in PHOTONIC WATER.

Visual detection is also simple by noticing that the Vital wave water is brighter.

Molecular chains are also visible when using cooking oil combined with water as shown opposite.