

## **Water's Quantum Jazz, the Living State & Energy Medicine**

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### **On first encountering water's quantum jazz**

I fell in love with water and became a hydrophiliac 18 years ago, soon after I saw the little fruit fly larva emerge from the egg under the polarised light microscope, rearing and swaying its head, crawling about in all the colours of the rainbow dancing before my eyes. *And no one else in the world had seen that before.*

I soon figured out that all the molecules in the cells and tissues of its body must be moving coherently together for the little larva to put on that psychedelic liquid crystalline display. More importantly, the cell and tissue water too, must be as an intrinsic part of the polarised liquid crystalline phase; the water is forming dynamically coherent units with the macromolecules embedded and immersed in it.

What that implied is a high degree of coherence in the organism. In the book named after the fruit fly larva [1], [The Rainbow and the Worm, The Physics of Organisms](#), first published in 1993 and now in its 3<sup>rd</sup> enlarged 2008 edition, I presented theoretical arguments and empirical evidence to support the idea that the organism is quantum coherent; and water plays the lead role in creating and maintaining the quantum coherence of organisms [1, 2] (see [Quantum Jazz Biology](#), *SiS* 47).

“Quantum jazz” is what I call the dynamic quantum coherence of organisms, which works by perfect intercommunication, and it is water's quantum jazz through and through. I am going to review some key evidence that has emerged especially within the past several years to support the idea that water's quantum jazz is the basis of life. And, then go on to explore what that means for energy medicine, especially homeopathy.

Conventional physics and chemistry have lots to offer in making sense of energy medicine in powerful techniques and a rigorous conceptual framework; but it needs our imagination and the courage to take on new idea.

Much of what I shall talk about is described in more detail in my series on water and on homeopathy, to appear in the next issue of our magazine *Science in Society* ([3] [Water's Quantum Jazz](#) series and [4] [Organic Medicine](#) series, *SiS* 48), which will be available in the next couple of weeks, accompanied by fantastic artworks.

I shall present evidence demonstrating that

- liquid water is quantum coherent at ambient conditions
- liquid water determines the activities of ions; hydration water and macromolecules form one coherent dynamic unit
- hydration water energizes and electrifies DNA
- water keeps almost all of the constituents of the cell dancing coherently most of the time. It keeps the quantum jazz going, day and night, to keep us alive and well.

## Cooperative and coherent water through hydrogen bonding

First, some basics (see [5] [Cooperative and Coherent Water](#), *SiS* 48): the water molecule is a dipole with separated positive and negative charges. It also has the capacity to accept two hydrogen bonds and donate two hydrogen bonds, these hydrogen bonds being usually directed to corners of a tetrahedron, as in ordinary ice.

Decades of research has resulted in a near-consensus that water at ambient temperatures and pressures exists as a dynamic network of supramolecular clusters where a proportion of the molecules are linked together by ‘flickering’ hydrogen bonds, similar to those in ordinary ice. It is also widely acknowledged that the hydrogen-bonded network of liquid water accounts for most, if not all its anomalous properties. Beyond that, there is no agreement over the exact proportion of molecules linked by tetrahedral ice-like bonds, the precise structure and size of the clusters, how freely the molecules can move around, and especially whether interactions are strictly local with nearest neighbour, or much more global in extent.

Within the past decade, substantial evidence has emerged indicating that cooperative interactions between molecules results in remarkably long-range coherence in liquid water under ambient conditions.

First of all water has an unusually high dielectric constant of  $\sim 78$  at room temperature, making it the most important polar solvent in chemistry and biology, it also means that water is easily polarised by an electric field. The dielectric constant, or relative static permittivity, is a measure of the extent to which it concentrates electrostatic lines of flux relative to a vacuum. Researchers led by Manu Sharma at Princeton University, New Jersey, USA, have shown by molecular dynamics simulations from first principles that the high dielectric constant of water is due to two effects of the hydrogen bonding. It serves to align the dipoles and at the same time, pull away positive and negative charges within a molecule, enhancing the average molecular dipole moment.

Quantum chemist Roger A. Klein at Bonn University in Germany has demonstrated from electronic and quantum chemical computations that cooperativity is involved in the formation of hydrogen-bonded supramolecular clusters. He commented that while 6-member rings are common in ice, gas clathrates, such as those enclosing methane at the bottom of the Arctic Ocean typically have 5-member rings.

It turns out that cooperativity greatly stabilizes 5 and 6 member rings, which is why they are common structures. The hydrogen bonds in 5 and 6 member rings are far lower in energy than those between two molecules (dimers), and the electron density at the bond critical point is higher because the hydrogen bonds are shortened. These stabilized structures enhance the formation of three-dimensional hydrogen-bonded networks in liquid water. The 3-dimensional networks facilitate rapid resonant energy transfer, with time constant of about 80 fs (femtosecond,  $10^{-15}$ s), much shorter than the average hydrogen bond life time of about 1 ps (picosecond,  $10^{-12}$ s); as researchers discovered using ultrafast 2-dimensional infrared photon-echo spectroscopy.

Are these 3-dimensional hydrogen bonded network of clusters random, or do they have an organised structure?

There are those who believe that the properties of water are best explained if liquid water at ambient temperatures actually existed in two states, light density water with tetrahedral, ice-like hydrogen bonds, and high density water in which the hydrogen bonds are more distorted. Martin Chaplin at South Bank University in the UK has even proposed that

the predominant cluster is a 280 molecule icosahedron that exists in an expanded state corresponding to low density water with tetrahedral ice-like bonds, and a collapsed state corresponding to high density water.

Recently, researchers at Stanford University in California, USA, provided fresh evidence that liquid water is indeed inhomogeneous over a length scale of about 1 nm. They used small angle x-ray scattering to work out the size of supramolecular structures, and x-ray emission and x-ray raman scattering, which give information on hydrogen bonding; and were able to show that water at ordinary temperatures exists in two distinct states of low density water and high density water. Density fluctuations occur over the length scale of ~1.2 nm.

The length scale of ~1.2 nm encompasses about 70 molecules of water. It is tempting to equate that with the inner core of Martin Chaplin's icosahedron, which is composed of 20 identical units of 14 hydrogen-bonded molecules, five of which are in the inner core.

At 24 °C, the proportion of light water with ice-like tetrahedral bonds is about 28.6 percent, and only disappears completely at boiling point.

### **Quantum coherent water**

More and more researchers are coming around to the view that quantum effects need to be taken into account in molecular dynamic simulations of water in order to reproduce and interpret a range of experimental results. In particular, not only electrons, but also protons need a quantum mechanical description. This is most evident in nuclear quantum effects when hydrogen is substituted by its heavier isotopes, deuterium and tritium, which leads to many anomalies that cannot be explained by classical chemistry.

There is even evidence that water at ambient temperatures may be quantum coherent. This has come from unexpected observations in nuclear magnetic resonance experiments over the past twenty years. Warren Warren and colleagues at Princeton University, New Jersey, have discovered intermolecular multiple quantum coherence signals. These signals are generated by the collective effects of the dipole coupling of the spin of each molecule with that of every other in the sample, up to 1 millimetre apart. The observations imply that all the spins of the molecules in the sample are correlated, and driven by the same (electromagnetic) field to oscillate *in phase*.

These remarkable findings have resulted in significant contrast enhancement in magnetic resonance imaging, functional imaging, and many other applications. But their fundamental significance – that water is quantum coherent to a high degree – has remained unappreciated by the general scientific community.

***The possibility that naturally occurring water may be quantum coherent should be considered in the light of the ambient magnetic field of the earth to which the water is constantly exposed.*** At the strength of the earth's field, nuclei including protons would resonate at audio frequencies. This is exploited in Earth's field NMR spectrometers and other instruments that are portable and inexpensive, often used for teaching or field work.

Could it be that these natural nuclear magnetic resonances have vital biological consequences? I have suggested that this may have relevance for homeopathic signals from DNA of bacteria and HIV recently discovered by Luc Montagnier and his colleagues ([6, 7] ['Homeopathic' Signals from DNA](#), [Electromagnetic Signals from HIV](#), *SiS* 48). I shall come back to this later.

For me, the most convincing evidence of water's coherence has come from an extraordinary and brilliant French artist Michel Kappeli, who wrested the hidden structural

symphonies made by water flowing in his local river ([8] [Water - Uncharted Spaces – the Body of the Transitory](#), *SiS* 48). His method was simple, to allow water to speak directly, unmediated and unobstructed by opaque instrumentation.

For more, do come to our special celebrating ISIS event next March, where you can also hear from Peter Fisher, the Queen's Homeopath, and Jim Oschman pioneer and author of Energy Medicine. Details are in the current and next issue of *Science in Society*, the trend setting magazine we publish.

### **Dancing with ions**

The interaction of water with ions has been studied for over a century, but much remains to be understood. In general, ions are classified into 'kosmotropes' and 'chaotropes' according as to whether they induce order or disorder in water (see [9] [Dancing with Ions](#), *SiS* 48). Kosmotropes bind strongly to water and have small diameters, so the charge density is high. Chaotropes bind weakly to water, they have large diameters, so the charge density is low.

A strong kosmotrope could have up to 5 or 6 water molecules in its hydration shell. A strong chaotrope, on the other hand, could bind a single water molecule, or none at all, as it approaches the limit of a nonpolar solute, where the surrounding water molecules only form hydrogen bonds with other water molecules, enclosing the solute in a cage-like clathrate structure (see [5]).

The solvation shell around ions is by no means rigid. Recent evidence shows that water molecules in the first solvation shell immediately next to the ion can rotate rapidly through a large angle in of some 60° or 70° to change partners, from binding the ion to binding another water molecule and entering the second hydration shell.

Actually, changing partners involves the water molecule doing a swivel dance in two steps: a really fast swivel of 40° in about 50 fs (femtosecond,  $10^{-15}$ s), followed by a slower rotation of 27° in 1 about ps. Researchers led by KJ Gaffney at Stanford University California in the USA and Stockholm University in Sweden devised a variant of two-dimensional infrared spectroscopy that used polarised light probes to detect the angle of the swivel.

Now, and this is interesting. What happens when different combinations of positively charged cations and negatively charged anions are present in solution, as is often the case? Won't they interfere with each other? Well, certain ion pairs can collaborate and engage a far greater number of water molecules than each individually, which also explains why different measurement techniques can give conflicting results.

When water is dancing with two oppositely charge ions, both of which are kosmotropes, in that they bind strongly to water, then many more water molecules are 'bound' than the sum of the two kosmotrope ions individually, basically because the water molecules are then 'pinned' by both the dipole interactions (of positively charged cations) and the hydrogen-bond interactions of negatively charged anions. This is another example of cooperativity. In the fs-IR measurements, which measures the OH bond response to the hydrogen bond,  $\text{MgSO}_4$  has a much larger fraction of slowly reorienting water molecules corresponding to a hydration number  $N_{\mu} = 32$ , because while the  $\text{SO}_4^{2-}$  ion engages in strong hydrogen bonding with water molecules, the  $\text{Mg}^{2+}$  simultaneously binds the oxygen of water through dipole interactions.  $\text{Mg}(\text{ClO}_4)_2$  and  $\text{Cs}_2\text{SO}_4$  have much smaller hydration numbers  $N_{\mu}$  of 4 and 9 respectively, basically because the water molecules pinned by  $\text{Mg}^{2+}$  through dipole interaction are not measured by the IR technique, which only detects only the smaller

numbers of water molecules hydrogen-bonded  $\text{ClO}_4^-$ . Similarly,  $\text{Cs}^-$  is a chaotrope that doesn't bind much water, so only those bound to  $\text{SO}_4^{2-}$  are detected.

### **Dancing with macromolecules**

Organisms have an enormous repertoire of chemical reactions that enables them to transform energy and materials for growth, development, and to do all that's required of being alive. Perhaps most remarkably, these chemical reactions are catalyzed by specific enzyme proteins that accelerate the reaction rates by a factor of  $10^{10} - 10^{23}$ . But the question of how enzymes work remains unanswered to this day.

This is where water enters the big picture (see [10] [Dancing with Macromolecules](#), *SiS* 48). It is well known that enzymes and other macromolecules, DNA and RNA, need a minimum amount of water in order to work at all, and much more to work efficiently. That is why cells are loaded with water, some 70 percent by weight. In terms of number of molecules, water far outnumbers all other chemical species - ions, small organic molecules and macromolecules – added together.

Water is needed for macromolecules to become flexible, so they can dance freely to water's quantum jazz, in order to accomplish their otherwise impossible tasks of making sluggish chemical reactions happen spontaneously and effortlessly, as I have indicated in my book [1]. Recent evidence from molecular dynamic simulations and experiments indicate that water gives flexibility to proteins, reduces the energy barrier between reactants and products and increases probability of quantum tunnelling by a transient compression of the energy barrier.

The protein hydration shell, as is generally regarded, is a single layer covering the surface of the protein, about 0.2g water per g protein, which enables it to function. The water is non-freezing, but undergoes a glass transition (a solid with no crystalline order) at about 170K, and is often compared to supercooled confined water.

At about 225K, the protein undergoes a dynamic transition that some people believe, it is a transition from a fluid high, density liquid to a less fluid, low density liquid, or supercooled water.

Most of all, protein and hydration shell behave as one dynamically coherent unit from femto seconds to nanoseconds and beyond.

These results have been obtained with a combination of the most sophisticated techniques including x-ray absorption and emission, neutron scattering, dielectric spectroscopy, ultrafast infrared spectroscopy, combined with molecular dynamic simulations

Recently, Martina Havenith and colleagues at Ruhr University Bochum, Germany, have been using a new 'table-top' Terahertz absorption technology to make a number of water scientists rethink protein hydration.

They found that dissolving proteins in an excess of water led to a steep increase in absorption of Terahertz radiation, with the maximum absorption between 0.5 and 1 mM, when the protein molecules occupy an estimated 1 percent of the volume. Thereafter, the absorption dropped sharply and remained almost flat as protein concentration increased further. With the help of molecular simulations, they worked out that the protein's hydration shell extended 3-4 shells out from the protein surface, and when the average distance between proteins decreased to less than that as protein concentration increased, the Terhertz absorption also dropped.

David leBard and Dmitry Matyushov at Arizona State University, Tempe, USA, said that to explain those observations requires a very large “effective dipole moment of the protein and its hydration shell, much exceeding the dipole moment of the protein itself.” They confirmed, by means of numerical simulations, that the protein hydration waters are polarized into a ferroelectric shell some 3-5 water molecules thick, with very large dipole moment and large amplitude fluctuations, much bigger than those in bulk water, in contradiction to the usual linear response theory. This was also demonstrated in real measurements.

There is even evidence of quantum coherence in the dynamics of the hydration shell and protein. All these recent findings are just what you would expect from observations I described at the beginning of my lecture: proteins and water form one dynamically coherent liquid crystalline continuum [1].

Very similar findings have been made for the hydration of DNA.

Hydration water governs the molecular dynamics of DNA with coherent vibrations from femtoseconds to nanoseconds that decay in a power law fashion, suggesting a high degree of correlation over all time scales.

Amazingly, the electrical conductance of DNA increases exponentially with hydration up to a million fold, due to both electron and proton jump conduction, and the conductivity of hydrated DNA is sensitive to magnetic fields, with potential applications in spintronics, using spin to control the flow of electricity.

We can expect very exciting things concerning the real function of DNA, other than coding for amino acid sequence of proteins.

### **The rainbow ensemble**

We are now ready to venture inside the cell and see how everything, all the ions, macromolecules and other molecules, which I shall call the rainbow ensemble, can do water’s quantum jazz together (see [11] [The Rainbow Ensemble](#), *SiS* 48).

As you recall, there are kosmotropes and chaotropes. Kosmotropes bind strongly to water, so they end up with more bound water in their solvation shell, chaotropes bind weakly to water, and have very few if any water molecules bound.

But ions in water also affect proteins in solution. Frank Hofmeister, a Czech scientist in the late 19<sup>th</sup> century, found that some salts helped egg white proteins to dissolve in water, while others caused the proteins to precipitate out, and there were those that had effects in between. He ranked the ions according to their ability to “salt-out” and “salt-in”, which resulted in the Hofmeister series. The Hofmeister series is correlated with other properties, but until quite recently, there has never been a satisfactory explanation.

Kim Collins at University of Maryland Medical School, Baltimore, USA, may have found the answer, and it is related to the ions’ affinity for water.

When pairs of oppositely charged ions have similar affinities for water, something special happens: they come out of their solvation shells, join up and neutralize each other. That’s because they can just as easily form intimate partners with each other as with water molecules; exchanging water molecules for the counter-ion does not cost anything in energetic terms. This ‘Law of Matching Water Affinities’ appears to explain why certain salts are less soluble than others, and why some salts precipitate proteins out of solution while others help them dissolve. The answer is that only neutral molecules precipitate (or crystallize) out of solution; neutral molecules have much lower solubility.



More specifically, a radius of 1.06 Å separates small monovalent cations from large ones, and a radius of 1.78 Å separates small monovalent anions from large ones. Small monovalent ions are strongly hydrated, while large monovalent ions are weakly hydrated. For example, LiF contains small monovalent ions that readily come out of their hydration shells to pair up as ‘contact ion pairs’, it has a solubility of only 0.1 M. In contrast, CsF has a large cation and a small anion, and do not pair up in solution; it has a solubility of 24.2 M.

The same principle applies to ions carrying two or more charges. For polyatomic ions, water affinity is determined by the surface charge density of the specific atom that water interacts with. This simple hypothesis seems to account well for the salting in and salting out of proteins.

Most of all, Collin’s theory shows that the intracellular concentrations of ions – which are opposite of those in extracellular fluids – are optimised for keeping proteins and other macromolecules in solution. Intracellular fluid has high concentrations of potassium and magnesium cations and phosphate and sulphate anions, and very low concentrations of sodium and chloride; the converse is true of extracellular fluid: low in potassium, magnesium, phosphate and sulphate, and high in sodium and chloride. While there appears to be not much difference between extracellular and intracellular calcium, most of the intracellular calcium is bound, with only  $10^{-7}$ M free  $\text{Ca}^{2+}$  most of the time, except for very transient, local increases associated with signal transduction.

Apart from the inorganic ions, there are some 65 mM of proteins present in the cytoplasm, which are rich in carboxylate anions in their side chains. As Collins pointed out, the intracellular ions are optimised for *mismatch* in water affinities, so as to maintain high solubility of the proteins and other constituents of the cytoplasm at all times. That’s why quantum jazz of the rainbow ensemble is possible.

Increasingly, protein-folding disorders are being identified, including Alzheimer’s disease, Parkinson’s disease, transmissible spongiform encephalopathies (mad cow disease), Huntington’s disease, and type II diabetes, which have been linked to ligand binding and hydration. In all likelihood, these diseases represent different failures in keeping almost all the molecular participants in cellular biochemistry dancing with water at any one time, so some of them end up salting out at inappropriate places.

In view of the high affinity of sodium ions for carboxylate (the amino acid side group), intracellular concentration of sodium is kept very low; and it is generally believed, by a  $\text{Na}^+/\text{K}^+$  ATPase that pumps sodium out of the cell in exchange for potassium.

But is that really so?

The secrets of water are being unravelled to an unprecedented extent within the past few years. We now know that water has quantum properties even at room temperature, and may even be quantum coherent. We now know that water does play the lead role in the dynamics of proteins and DNA, and other macromolecules such as RNA that make the quantum jazz of life possible. There is good evidence that water does exist as a mixture of two states, high density water and low density water; and as Philippa Wiggins so brilliantly suggested, the spontaneous inter-conversion of these two forms of water may be what gives life its seemingly boundless ‘free energy’ (see [12] [Water’s Effortless Action at a Distance](#), *SiS* 32).

**The big mystery remains**

But the big mystery remains. How did the cell manage to have just the right combination of ions inside, which is completely the opposite of what's on the outside? How could the cell have evolved before it acquired all the complicated pumps and channels for all the ions? Physiologist Gilbert Ling has stubbornly rejected the idea that it was all due to membrane pumps. Instead, he has maintained for more than half a century that the cytoplasm naturally excludes sodium and binds potassium. His association-induction hypothesis proposes that the major components of living protoplasm – water, proteins, and  $K^+$  - exist in a closely associated, high-energy state at 'rest'. Purified proteins, he said, are not at all what proteins are like in the cell. Instead, within the cell, most if not all proteins are extended so that the peptide bonds along their polypeptide chains are free to interact with multiple layers of polarized water molecules and their carboxylic side chains similarly preferentially bind  $K^+$  over  $Na^+$ . The other reason is the ubiquitous presence of ATP in the living cell.

Living protoplasm is full of ATP, which is bound to proteins at certain 'cardinal sites', according to Ling. These ATP-bound sites then induce changes in the electron density, ultimately of the entire polypeptide chain, including the side chains.

In the absence of ATP, proteins do tend to adopt secondary structures - alpha helix, or a beta pleated sheet - due to hydrogen bonding between peptide bonds in the same chain, which gives them a folded up conformation where they don't interact maximally with water. However, when ATP is bound to the cardinal site, it tends to withdraw electrons away from the protein chain, thereby inducing the hydrogen bonds to open up, unfolding the chain and enabling it to interact with water.

For me, among the most persuasive evidence was the experiments he and his co-workers performed, showing that cells with cell membranes made permeable with detergents, or completely cut off at one end, nevertheless maintained their distinctive ionic compositions over long periods of time.

### **What's the cell really like?**

It is necessary to look at the cell again, not as a membrane bound entity containing various organelles suspended in an otherwise featureless cytoplasm, still widely supposed to consist of proteins in aqueous solution. That view was already strenuously refuted by Joseph Needham who cited extensively evidence in his book, *Order and Life* first published in 1936 in support of meticulous molecular organisation in living *protoplasm*. Living protoplasm differs strikingly in many respects from the same proteins dissolved in water, including the ultraviolet absorption spectra. This book also suggested that living cells are polyphasic liquid crystals, anticipating the discovery in my laboratory by 56 years.

Rickey Welch and James Clegg, lead champions of the view that the cytoplasm is organised; recently published an important review on the history of protoplasm. They recall how Keith Porter used high voltage electron microscopy to show up the 'microtrabecular lattice' (MTL) of the cytoplasm, which provides scaffolds for enzyme and other proteins, as well as numerous micro-environments or nanospaces for specific enzyme reactions to take place independently of one another.

Much later, the MTL was rediscovered as the ubiquitous cytoskeleton composed of filaments made of actin and other proteins, a dynamic structure that's constantly breaking down and reforming as the cell changes shape, and transports materials to all parts of the cell. There is at least one journal entirely devoted to the topic of intracellular transport, and it is



full of photographs of cells with cytoskeleton lit up in a fine meshwork of neon fibres stained with fluorescent antibodies for the cytoskeletal proteins.

Martin Chaplin has proposed a scheme whereby ATP and  $K^+$  carboxylate binding are associated with actin polymerization in low density water with ice-like hydrogen bonds and a relatively static (resting, or poised for action) regime, alternates with a more mobile high density water regime of actin depolymerisation, in which hydrogen bonds are distorted or broken and less  $K^+$  carboxylate binding.

These hypotheses can be tested experimentally. For example, as far as I know, no one has yet tested whether proteins do behave differently in solutions of  $K^+$  and Mg-ATP. Or whether proteins enclosed in phospholipid micelles might behave differently and show selectivity for  $K^+$  over  $Na^+$  due to a change in the state of water.

Most of all, we must always bear in mind the hauntingly beautiful intimation of what the living cell is really like when Ludwig Edelman at Saarland University in Hamburg, Germany, took extraordinary care in preserving its fully hydrated living state.

There is little doubt that the dynamic quantum coherence of water, or water's quantum jazz, is the basis of life. I venture to suggest that it is also the basis of all forms of subtle energy medicine.

### **What Luc Montagnier and colleagues found**

Let's see what Luc Montagnier and his team have demonstrated that is so significant. They have demonstrated highly reproducible electromagnetic signals that can be detected from diluted, rigorously shaken solutions associated with a biological function, i.e., bacterial and viral infection [6, 7]. They have tracked down the primary source of the signals to specific pathogenic DNA sequences in the genomes of the bacteria and viruses concerned. Furthermore, these signals (and associated biological function) appear to survive in "nanostructures" even after the DNA solutions are highly diluted, possibly to the point where no molecule of the original DNA is present.

These findings are analogous to observations in greatly diluted homeopathic remedies that claim to be efficacious even after all molecules of the original substance must have been diluted away. But there is one important difference.

For the first time, the putative memory of the water invoked for homeopathic activity, in the form of specific electromagnetic signals, can be clearly and independently detected. This is the major breakthrough that Montagnier and his team achieved.

They used a device previously designed by Benveniste and Coll to detect the signals produced, which they displayed and analysed by Fourier transform so anyone can see the difference. I show you the graphs from their papers. Here on the left is noise from the ambient 60 Hz electromagnetic field. On the right is the signal from a diluted filtered culture medium of cells infected with *Mycoplasma*, that is sterile, has no cells in it, no bacteria, nothing in it bigger than 20 nm, The medium was diluted serially 5 times or more, each time by 10-fold. Fourier transform software identified distinct high frequency components in the signal that are not in the noise, and they are highly reproducible, as shown by the 3-dimensional plot showing the same Fourier transform pattern at successive times. These high frequency components are in the range of 1 000 to 3 000 Hz.

Typically, the signal does not appear in the filtered culture medium, but only after serially diluted at least 5 times, and disappearing only after 13 serial dilutions or higher.

In the HIV blood samples, the signal is only detected in patients that are undergoing retroviral therapy and there is little or no viral load measurable in the blood. The signal is not associated with the RNA virus itself, but in a cryptic form replicating by DNA after having turned itself into complementary DNA.

As in the case of bacteria, the blood plasma has to be filtered and diluted before the signal appears, and once it appears, it remains stable for weeks.

Significantly, the DNA sequences that originate the signals are not the agents that remain to carry the signals in the diluted solutions. Instead, the agents appear to be some “nanostructures” less than 20 nm in diameter.

### **A science of homeopathy?**

Based on these findings, *it should now be possible, in principle, to distinguish homeopathic preparations that are active from those that are not.* This alone would do much for advancing the science of homeopathy, and contribute towards our understanding of water (see above). Obviously, it is necessary to investigate if all homeopathic remedies have specific EM emissions that can be detected by appropriate instrumentation.

The research raised a number of key questions that need to be addressed, the most pressing being: ***What are the emitting nanostructures and why do they emit?***

That DNA should emit electromagnetic signals is not surprising. There is evidence dating back to the 1980s that DNA has molecular vibrations in a wide range of frequencies, from below  $1\text{ cm}^{-1}$  (radiofrequency) to  $4\,000\text{ cm}^{-1}$  (far infrared) [13-15], which can be detected, or stimulated and modified by externally applied electromagnetic fields. These are much higher frequencies than those in the signals detected by Montagnier and colleagues.

Montagnier and colleagues invoke “resonance” induced by the ambient electromagnetic noise from the mains to explain the electromagnetic signals, but did not go further. One kind of resonance that could be induced under such circumstances is nuclear magnetic resonance. As I mentioned earlier, it appears that the earth’s magnetic field can substitute for the much stronger static magnetic field used in a nuclear magnetic resonance (NMR) experiment [5]. If that is the case, the ambient field, which appears to be necessary for producing the signals, plays the part of the radiofrequency field in a usual NMR experiment. The resonance frequency would then be shifted correspondingly to lower frequencies, perhaps from microwave to audio frequencies (30 to 20 000 Hz, which matches those ( $\sim 1\,000$ - $3\,000$  Hz) reported by Montagnier and colleagues. In this context, the rigorous mixing after dilution (equivalent to ‘succussion’) may serve also serve as stimulation for these specific vibrations. It is perhaps important to emphasize that the vibrations may not be those of the DNA sequence, but rather, those of DNA sequence modified by the water and other constituents (see later). Crystals (including liquid crystals) and other solid state materials do emit electromagnetic fields when stimulated.

However, it does not tell us how the water can have memory of such specific vibrations, especially when the DNA molecule has been diluted away.

Montagnier and colleagues proposed that the carrier of EM signals are “nanostructures” - retained by filters of pore size of 20 nm and displaying a broad range of densities from 1.15 to 1.25 - presumably created by the specific DNA sequence originally present.

Martin Chaplin, prominent water researcher at South Bank University, London, in the UK, reviewed the memory of water in 2007, and pointed out that if by memory of water, it

means that water retains a history of its past experience, there is plenty of evidence [16]. For example, a well-known memory-effect is associated with the formation of clathrate hydrates, cage-like structures of water around small molecules such as methane gas. A water sample that has been crystallized into a gas clathrate under pressure and then melted will more quickly re-form the clathrate hydrate when mixed with the gas and pressurized, compared with water that did not experience the hydrate state. However, the question is *how* such memory could be formed and retained, even when the original substances have been diluted away.

### **The silica-water epitaxy hypothesis**

There are many hypotheses on how memory of chemical substances could be formed and retained in water. The one which suggest itself (to me) most strongly is what I shall call “the silica-water epitaxy hypothesis”. Epitaxy is a well-known phenomenon in material science. It is the growth of one crystalline material on the surface of another to mimic the structure of the latter. In more general terms, it is the structural imprint of one substance on another. Roy Rustum, Distinguished Prof of Materials at Arizona State University and Professor of the Solid State and of Geochemistry at Pennsylvania State University (who has just passed away) has long drawn attention to the importance of epitaxy in homeopathy [17].

Silica ( $\text{SiO}_2$ ) is the most abundant substance on earth by far. It occurs in sand, and in glass, more specifically in the glassware for making homeopathic remedies; and many have suspected dissolved silica to play a key role in the potency of homeopathic preparations.

David Anick at Harvard Medical School and John Ives at Samuelli Institute for Information Biology, Alexandria, Virginia, in the USA, have clearly articulated “the silica hypothesis of homeopathy” from a physical chemical perspective [18].

I shall restate the hypothesis more generally as the “silica-water epitaxy hypothesis” as follows: ***homeopathy remedies contain dissolves silicates that, in concert with water, retain the structural imprints (and associated electromagnetic signature) of the substances originally dissolved in water.*** I hasten to add that all the evidence for the hypothesis is contained in the paper by Anick and Ives, and I am only renaming it, and connecting with electromagnetic signals to make the mechanisms more explicit.

Silica dissolves in water by joining with two water molecules to form silicic acid  $\text{Si}(\text{OH})_4$ , which has a low solubility in water of around 0.01 percent, though additions of  $\text{Na}_2\text{O}$  or other alkali can dramatically increase solubility.

Silicic acid can polymerise under pressure to form dimers, trimers, and higher oligomers up to about 12 in concentrated solutions. Anick and Ives proposed that succussion against the glass wall of the bottle initially generates a saturated or supersaturated solution of silicic acid, which could polymerize in later successions, due to the momentary high pressures generated, which favour polymer formation. Low concentration of dissolved silicon has been reported in many homeopathic preparations.

The dissolved silicic acid and acid polymers, as well as the water, interact with the substances in the homeopathic ‘mother tincture’ (MT, usually a 1 M solution) through molecular epitaxy, in which both silicic acid and water are imprinted by the MT. In this way, a complex dynamic quasi-crystalline structure can be maintained even when the original MT substance has been diluted away.

The remedy would be specific, on account of the specificity of the molecular imprint. Liquid water has an infinitely variable and changing supramolecular structure (crystalline or

quasi-crystalline structures) reflected most of all in the endless variety of snowflakes that can be formed in nature, each unique [5]. Masaru Emoto was inspired by that to document the same uniqueness in the ice crystals that can be obtained from water in different locations, with different histories, and even, on experiencing different feelings [19].

Similarly, the intricately sculpted diverse siliceous shells of diatoms offer us a hint of the immense array of possible structures that silicic acid could adopt in an imprinting setting, as displayed in the variety of siliceous diatoms that impress diatom aficionados, and which are themselves the product of molecular epitaxy on specific polymer matrices in a water medium. I have assembled for display some beautiful scanning electron microscope pictures from sciencercay.com [20].

The silica-water epitaxy hypothesis does not tell us how homeopathic remedies actually work. Montagnier and colleagues' identification of specific EM emissions is significant. I am among those who have long advocated that electric and electromagnetic signals are involved in intercommunication within organisms and between organisms [1]. There is also evidence suggesting that molecules including proteins and DNA interact by resonating to specific frequencies [21] ([The Real Bioinformatics Revolution](#), *SiS* 33). That is why I have included the associated electromagnetic signature produced by the silica-water system in the statement of the hypothesis. The particular signal may have frequencies specific for communicating with other chemical species in the cells and organisms to enable particular functions to be carried out.

The obvious next step is for Montagnier and colleagues to characterize the “nanostructures” responsible for the EM signals, to see if they are indeed dissolved silica structured by the DNA and water in the original supernatant.

A science of homeopathy has the potential to revolutionize biology and put all forms of energy medicine, including radionics on the map.

## References

1. Ho MW. *The Rainbow and the Worm, the Physics of Organisms*, 1993, 1998 (2<sup>nd</sup> ed), 2008 (3<sup>rd</sup> ed), World Scientific, Singapore, London.
2. Riley D, McCraty R and Snyder S. Quantum Jazz Biology, Interview with Mae-Wan Ho, Pioneering work in understanding life. [Science in Society 47](#), 4-9, 2010.
3. Ho MW. Water's quantum jazz. [Science in Society 48](#) (to appear).
4. Ho MW. Organic medicine series. [Science in Society 48](#) (to appear).
5. Ho MW. Cooperative and coherent water. [Science in Society 48](#) (to appear).
6. Ho MW. Homeopathic signals from DNA. [Science in Society 48](#) (to appear).
7. Ho MW. Electromagnetic signals from HIV, prospects for a science of homeopathy. [Science in Society 48](#) (to appear).
8. Kappeli M. Water, uncharted spaces – the body of the transitory. [Science in Society 48](#) (to appear).
9. Ho MW. Dancing with ions. [Science in Society 48](#) (to appear).
10. Ho MW. Dancing with macromolecules. [Science in Society 48](#) (to appear).
11. Ho MW. The Rainbow Ensemble. [Science in Society 48](#) (to appear).
12. Ho MW. Water's effortless action at a distance. [Science in Society 32](#), 21-23.
13. Chou K-C. Low-frequency vibrations of DNA molecules. *Biochem J* 1984, 221, 27-31.

14. Wooland DL, Globus TR, Gelmont BL, Bykhovskaia M, Samuels AC, Cookmeyer D, Hesler JL, Crowe TW, Jensen JO, Jensen JL and Loerop WR. Submillimeter-wave phonon modes in DNA macromolecules. *Phys Rev E* 2002, 65, 051903.
15. Szyc L, Yang M, Nibbering ETJ and Elsaesser T. Ultrafast vibrational dynamics and local interactions of hydrated DNA. *Angew Chem Int Ed* 2010, 49, 3598-610.
16. Chaplin MF. The memory of water: an overview. *Homeopathy* 2007, 96, 143-50.
17. Roy R, Tiller WA, Bell I and Hoover R. The structure of liquid water; novel insights from materials research; potential relevance to homeopathy. *Materials Research Innovation* 2005, 0, 577-608.
18. Anick DJ and Ives JA. The silica hypothesis for homeopathy: physical chemistry. *Homeopathy* 2007, 96, 189-195.
19. Emoto M. *Messages from Water*, Hado Kyoikusha Co., Ltd., Tokyo, 1999, 2001. ISBN 4-939098-00-1.
20. Drelayaraja P. Designs of nature. The architectural marvels of the diatoms showcased by scanning electron microscopy (sem), 23 November 2009, <http://sciencelay.com/biology/designs-of-nature-the-architectural-marvels-of-the-diatoms-showcased-by-scanning-electron-microscopy-sem/>
21. Ho MW. The real bioinformatics revolution, proteins and nucleic acids singing to one another. *Science in Society* 33, 42-45, 2007.

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