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The following is an abbreviated version of a presentation made to the members of the British Acupuncture Society, 2 October, 1999, by Dr. Mae-Wan Ho.

*Dr. Ho has more than 300 publications and a dozen books spanning several disciplines, including *The Rainbow and the Worm - The Physics of Organisms* (1993, 1998), *Genetic Engineering Dream or Nightmare?* (1998, 1999), and *Living with the Fluid Genome* (2003). She also edits the radical science magazine, *Science in Society*.*

Dr. Ho, a long-time critic of neo-Darwinism and genetic engineering and pioneer of a "physics of organisms," is one of the most influential and widely sought-after speakers in the new paradigm of organic science. As Director and co-founder of the Institute of Science in Society and scientific advisor to the Third World Network, she has had plenty of opportunity to put her science into action.

COHERENT ENERGY, LIQUID CRYSTALLINITY AND HEALTH

I have been involved, since 1985, in trying to understand living organisation from the perspective of contemporary physics, especially of non-equilibrium thermodynamics and quantum theory. At the same time, I was developing and using new experimental approaches to investigate organisms non-destructively, as they are living and developing.

I have outlined a tentative theory of the organism in the second edition of my book, *The Rainbow and The Worm - The Physics of Organisms* (Ho, 1998). Let me briefly describe it and then show how it may link up with the meridian theory.

Many physicists have puzzled over how organisms seem able to resist the second law of thermodynamics which says all systems tend to evolve towards thermodynamic equilibrium - a state of maximum disorder in which all useful energy has degraded into a random, useless form referred to as entropy. Instead, organisms can summon energy at will in a perfectly coordinated way, and to maintain and reproduce its exquisite organisation. Everyone knows that because the organism is an open system, it does not actually *violate* the second law, because the environment provides raw materials and useful energy and becomes more disordered as organisation is built up and maintained in the system, and entropy exported out of it. But how does the organism actually do it?

It turns out that the key to living organisation is not so much energy flow as energy storage under energy flow. Furthermore, the organism has somehow managed to close the loop of energy storage to become a self-maintaining, self-reproducing life-cycle.

The organism is thus a system in which energy is *stored* in a *coherent* form, the energy remaining coherent as it is mobilized throughout the system. Notice that I have substituted 'coherent energy' for the usual concept of 'free energy'. Coherent energy, as I shall explain presently, is stored in a range of space-times in which it remains coherent, and is tied to the characteristic space-times of natural processes. I say 'characteristic space-time' instead of the usual 'characteristic time' because in the new physics since Einstein's relativity theory, space and time are no longer separable.

Coherent energy is energy that comes and goes together so it can do work, as opposed to incoherent energy which cancels itself out. Anyone ever hit by a wave on the seashore will know what coherent energy is as opposed to the random motion of say, molecules of air in this room. Coherent energy is mobilised within the organism with minimum dissipation, which means it generates minimum entropy. This depends on a *symmetrical coupling* of energy yielding and energy requiring processes within the living system. Symmetrical coupling involves a complete reciprocity, so that the effects of one process on the other are the same, and furthermore, they can reverse roles so the giver of energy becomes the receiver and *vice versa*. How is that achieved?

Practically all living processes are organised in cycles. The organism is thick with biological rhythms ranging from periods of split seconds for electrical activities of brain cells to seconds such as the heart-beat and respiration, to periods which are circadian and circannual. But no one has ever been able to explain why that should be. The answer is provided by thermodynamics. It turns out that symmetrically coupled cycles are the key to *both* the conservation of coherent energy and compensation (or cancelling out) of entropy within the system so that living organisation is maintained. The way to think about it is that as one cycle of activity is running down, it is charging up a second cycle, so that the role can be reversed later. Similarly, as disorder is created in some part of the system, a kind of superorder appears in elsewhere, which can restore order to the first part.

Each cycle of activity has a characteristic space-time and together, they span all space-times from the very fast to the very slow, the global to the local. Each cycle is hence a domain in which coherent energy is stored, as said earlier. Of course, neither the conservation of coherent energy nor the compensation of entropy is perfect, otherwise, no one would ever need to eat, nor would ever age. But such a dynamic structure of the system is the key to maximising the storage of coherent energy and the speed and efficiency with which coherent energy can be mobilised (see Ho, 1995). Thermodynamically, then, the organism is a dynamically closed system of minimally dissipative coupled cycles feeding off the one-way energy flow, so that the unavoidable dissipation is exported to the environment.

The special energy relationship in the organism, therefore, is what enables it to mobilize energy at will, whenever and wherever required and in a perfectly coordinated way. In the ideal, the organism can be conceived as a quantum superposition of coherent activities, with instantaneous (nonlocal) noiseless intercommunication throughout the system.

Let us look more closely at the mobilisation of coherent energy. Coherent energy is stored everywhere within the system over the entire range of space-times. Consequently any subtle influence arising anywhere within the system will propagate over the entire system and get amplified to global effects. In other words, the system, by virtue of being full of coherent energy everywhere, will be ultrasensitive to very weak signals. This may be the basis of all forms of subtle energy medicine.

Today, mainstream scientists including physicist Roger Penrose (1995) have begun to invoke quantum coherence to account for the macroscopic, phase-correlated electrical activities observed by neurophysiologists in widely separated parts of the brain (see Freeman, 1995; Ho, 1997).

I must emphasise that the theory of the organism just presented is firmly based on empirical experimental findings from our own laboratory as well as from established laboratories around the world. Many of the findings are published in scientific journals, but there is little or no satisfactory explanation for them within conventional mainstream biology. I won't have time to describe all the experimental results which have built up a picture of coherence in the organism (see Ho, 1998). Perhaps the most suggestive evidence is our discovery in 1992 that all organisms are liquid crystalline.

What we actually discovered was a novel noninvasive optical imaging technique based on the polarised light microscopy (Ho and Lawrence, 1993; Newton *et al*, 1995; Ross *et al*, 1997). This imaging technique is telling us that the living organism is coherent beyond our wildest dreams, with dynamic order that extends from the molecular to the macroscopic.

There is a dynamic, liquid crystalline continuum of connective tissues and extracellular matrix linking directly into the equally liquid crystalline cytoplasm in the interior of every single cell in the body (see Ho, 1997; Ho, 1998; Ho and Knight, 1998, and references therein). Liquid crystallinity gives organisms their characteristic flexibility, exquisite sensitivity and responsiveness, thus optimizing the rapid, noiseless intercommunication that enables the organism to function as a coherent, coordinated whole. In addition, the liquid crystalline continuum provides subtle electrical interconnections which are sensitive to changes in pressure, pH and other physicochemical conditions; in other words, it is also able to register 'tissue memory'. Thus, the liquid crystalline

continuum possesses all the qualities of a 'body consciousness' that may indeed be sensitive to all forms of subtle energy medicines including acupuncture.

The connective tissues of our body include the skin, bones, tendons, ligaments, cartilage, various membranes covering major organs and linings of internal spaces. We tend to see them as serving purely mechanical functions to keep the body in shape, or to act as packing material. Actually, connective tissues may also be largely responsible for the rapid intercommunication that enables our body to function effectively as a *coherent* whole, and are therefore central to our health and well-being.

The clue to the intercommunication function of connective tissues lies in the properties of *collagen*, which makes up 70% or more of all the proteins of the connective tissues. Connective tissues, in turn form the bulk of the body of most multicellular animals. Collagen is therefore the most abundant protein in the animal kingdom.

But collagens are not just mechanical fibres and composites. Instead, they have dielectric and electrical conductive properties that make them very sensitive to mechanical pressures, pH, and ionic composition and to electromagnetic fields (reviewed in Ho, 1998; Ho and Knight, 1998; in particular, Zhou, 1999). The electrical properties depend, to a large extent, on the bound water molecules in and around the collagen triple-helix.

This biological water is integral to the liquid crystallinity of collagens (Zhou *et al*, 1999) and other composites such as the extracellular matrix, the cell membrane and the 'cytoplasm'.

The existence of the ordered network of water molecules, connected by hydrogen bonds, and interspersed within the protein fibrillar matrix of the collagens is especially significant, as it is expected to support rapid jump conduction of protons, ie, hydrogen atoms without its electron, which constitute positive electric charges. This jump conduction is a kind of semi-conduction and is much faster than ordinary electrical conduction or conduction through nerve fibres. That is because it does not actually require any net movement of the charged particle itself. It is passed rapidly down a line of relatively static, hydrogen-bonded water molecules.

Jump conduction of protons in collagen has been confirmed by dielectric measurements.

The hydrogen-bonded water network of the connective tissues is actually linked to ordered hydrogen-bonded water in the ion-channels of the cell membrane that allow inorganic ions to pass in and out of the cell. There is thus a direct electrical link between distant signals and the intracellular matrix of every single cell in the body, leading to physiological changes inside the cells, including all nerve cells. This electrical channel of intercommunication is in addition to and coupled with the mechanical tensegrity interactions between the connective tissues and the intracellular matrix of every single cell, a continuum that always changes as a whole. Any mechanical deformations of the protein-bound water network will automatically result in electrical disturbances and conversely, electrical disturbances will result in mechanical effects.

As mentioned earlier, proton jump-conduction is a form of semi-conduction in condensed matter and much faster than conduction of electrical signals by the nerves. Thus the 'ground substance' of the entire body may provide a much better intercommunication system than the nervous system. Indeed, it is possible that one of the functions of the nervous system is to slow down intercommunication through the ground substance.

I have argued that a body consciousness possessing all the hallmarks of consciousness - sentience, intercommunication and memory - is distributed throughout the entire body. Brain consciousness associated with the nervous system is embedded in body consciousness and is coupled to it (Ho, 1997; 1998).

Under normal, healthy conditions, body and brain consciousness mutually inform and condition each other. The unity of our conscious experience and our state of health depends on the complete coherence of brain and body.

Western medicine has yet no concept of the whole, and is based, at the very outset, on a Cartesian divide between mind and brain, and brain and body. Because there is no concept of the organism as a whole, there is, in effect, no theory of health, only an infinite number of disease models, each based on the supposed defect of a single molecular species. There is an urgent need to develop a theory of health for proper delivery of healthcare in the next millenium.

For the full text version of this article, including references, go to: <http://www.i-is.org.uk/acupunc.php?printing=yes>

Dr Mae-Wan Ho's book, *The Rainbow and the Worm*, can be ordered from the same web-site - www.i-is.org.uk