MEASUREMENTS OF THE ELECTRO-MAGNETIC FIELDS GENERATED BY BIOLOGICAL SYSTEMS

*Cyril W. Smith**

Abstract: Biological systems make use of coherent frequencies of non-ionizing radiation from the sub- Hertz of circadian rhythms to at least the ultraviolet of bio-photons for purposes of bio- communication and control. The various techniques available for the detection and measurement of electromagnetic fields and their coherent frequencies as generated by biological systems will be reviewed with specific reference to the patterns of frequencies observed, and the relevence of the Fröhlich coherent states. The possibility of coherent frequencies of alternating magnetic vector potential fields (scalar fields), affecting biological systems will also be discussed in terms of biological coherence. The available and possible techniques for measuring the frequencies of magnetic vector potentials in biological systems and frequencies imprinted into water, both technically and by biological systems, will be described and discussed.

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1. Introduction

This paper deals with the continuation of the work described in "Coherence in Living Biological Systems" [1] which covered the clinical effects of coherence with particular reference to electrically hypersensitive patients, the "memory" properties of water imprinted with a frequency by an alternating magnetic field or by persons holding and succussing a tube of water, and the relationship of 'water memory' to homoeopathic remedies. It referred to measurements of coherent frequencies in the radio-frequency region from living cells which have been replicated by Hölzel and Lamprecht, [2] and to the properties of waves of coherence (Wüst Waves). It also covers various techniques available for the detection and measurement of electromagnetic fields and their coherent frequencies as involved in biological systems and water with particular reference to the relevence of the Fröhlich coherent states. Coherent frequencies of alternating magnetic vector potential fields, (sometimes called 'scalar fields') may also affect biological systems and give rise to particular problems of measurement.

*Cyril W. Smith
Department of Electronic and Electrical Engineering, University of Salford, Salford M5 4WT, England

2. Coherence of Biological Frequencies

The cell division cycle of the typical adult human cell takes 18-24 hours, the higher plants have a 10-30 hour cycle, embryonic cells and bacteria may have cycles between 25-70 minutes. There are techniques for synchronizing cell division to facitilate experimentation. The triggering events that initiate DNA synthesis are not known, they may be electrical [3]. What is clear is that there are "windows" [4] during the biological cycle in which the system is particularly sensitive to its electrical environment and frequencies involved in these activities.

Alternating magnetic fields can affect the lac operon system of E. coli [5] and this involves the DNA through the synthesis of beta-galactosidase. The core of DNA is high in protons, so any disturbance such as the deposition of energy selectively into protons might lead to a measurable reproduction rate change. The results of satisfying the highly coherent proton nuclear magnetic resonance conditions during the growth of bacterial cells were unexpected and spectacular. They resulted in the same total cell mass but, with almost twice as many cells of half the size [6].

Oscillatory chemical reactions may occur if the reaction rate is limited by concentration and diffusion of a reaction product. External magnetic fields might affect these through a singlet-to- triplet transition [7] or, electromagnetic radiation through cooperative interactions with strongly excited polar molecular states [8]. Any sort of oscillator must involve a process of positive feedback, i.e. a stimulatory signal from the output reaching the input. In the absence of external stimulation. Positive feedback will give amplification which may result in oscillations triggered by the noise inherent in any system [9]. Weak external signals can synchronise an oscillator, whereas stronger signals will saturate the system. If a coherent oscillation is involved, then a sine wave is the appropriate stimulus, if magnetic flux quanta are involved, then a square waveform is appropriate.

A wide range of biological cells show general oscillatory phenomena [10]. Ross Adey has presented evidence of the sensitivity of a wide range of biomolecular systems to weak environmental electromagnetic fields either in the low frequency region or, with radiofrequency fields modulated by low frequencies [4]. Breithaupt [11] has considered the bio-information transfer properties of biological rhythms and their function in temporal morphology. Wever [12] carried out a 25-year program of research into human circadian rhythms which imply a high degree of coherence. This involved persons living for prolonged periods in underground dwellings shielded from environmental fields. Unexpectedly, the deep body temperature and the sleep-wake cycles had a remarkable sensitivity to weak 10 Hz fields which were able to entrain free-running body rhythms and even force a 23-hour daily cycle.

It was known to the ancient Chinese that the acupuncture meridians in the human body have regular periods of activity (Yin), and passivity (Yang) over the 24-hour period. The effects of the solar and lunar tides and environmental low-frequency fields on circadian rhythms have been summarized by Smith and Best [13]. Plants respond electrically to the variations in the geomagnetic field which preceed day-break at ground level, or to an artificial field having the same rate of change [13]. Dubrov [14] has described a very wide range of effects of the geomagnetic fieldS on biological rhythms and circadian rhythms. Semm, Schneide and Vollrath [15] broadened their investigations of the pineal involvement in cir-

cadian rhythms and its reactions to light and darkness to consider the effects of magnetic field changes comparable to the strength of the geomagnetic field (0.5 G, 50 μT). Reiter [16] has written extensively on the pineal, and on melatonin as the chemical expression of darkness. Power supply fields (which are highly coherent) have also been found to affect the melatonin rhythm [17] and the writer has detected resonances at both 50 Hz and 60 Hz in a sample of pineal extract, which in turn suggests that the worst possible frequencies were chosen for the world's power supply systems since, melatonin is also an anti-cancer agent.

3. Electromagnetic Fields in Biological Systems

In general, routine clinical equipment for measuring the electrical signals from the body (ECG, EEG, EMG), is restricted in its frequency coverage and analysis capabilities. The heart-beat is a prime example of a highly coherent oscillation in a living system and small variations in the periodicity have been used diagnostically by Rein and co-workers [18,19]. Living systems have cyclical patterns of frequency variation over a wide range of frequencies and these can be altered by external electromagnetic fields at levels typical of those in the environment.

Work with electromagnetically hypersensitive patients [20] has led the writer to the investigation of endogenous body frequencies and the development of therapies involving the stimulation of patient specific frequencies by applied electromagnetic fields or potentised water and, because of the extreme sensitivity of some patients has led to the development of frequency measurement techniques based on radiesthesia.

Quboa [21] developed an a.c. electric field strength and magnetic flux density meter for environmental measurements. The (f.s.d.) measuring range was 0.1–1000 V/m and 100 nT–100 μT in steps of 5 Hz from 10–95 Hz; 50 Hz from 100–950 Hz; 500 Hz from 1000–19000 Hz. This was applied clinically to the measurement of the homes and work-places of electrically hypersensitive patients and the field and frequency distributions of electrical apparatus such as fluorescent lighting, televisions and computers, to determine the fields that could trigger reactions in these patients. Attempts to measure any fields and frequencies in the vicinity of reacting patients with this apparatus were not successful. From clinical case records, it is clear that certain patients have emitted significant radiation when reacting, enough to be incompatible with electronic apparatus.

In the absence of any convincing theoretical explanation for the effects of weak electromagnetic fields on biological systems, it is difficult even to try to determine the thresholds for observed effects. Since any electric field must be generated across a capacitance, the displacement current will produce magnetic effects. Magnetic fields are generated by currents in coils and in the direction of the current there is a magnetic vector potenetial. A high alternating electric field produced at a sharp point would not potentise water even on succussion so, it is unlikely that the $E = -dA/dt$ term is involved. The writer is of the opinion [1] that bio-information is carried on the alternating magnetic vector potential while the magnetic field performs a formatting function but, if true this has profound implications. It is clear that the "window" of frequency is the most important, the intensity "window" has a lower threshold which may correspond to the magnetic field at which a single

quantum of magnetic flux links the cross-sectional area of the biological cell and the phase of the biological cycle [6]. The upper threshold is probably that field which is sufficient to break the coherence of the system. The only other way a magnetic vector potential can affect water or a biological system is through its involvement in the wave equation or order parameter of what must be regarded as a quantum system.

When biologists get round to using the magnetic vector potenetial from a toroidal coil instead of the magnetic field of a Helmholtz coil to investigate a living system they may find the results surprising. Dr. Mae-Wan Ho writes, "The results with the toroidal coil are quite tantalizing. Despite the fact that the magnetic field is negligible, significant increases in abnormalities (in Drosophila embryos) are found over matched controls, and both when the embryos are in place before or after the power supply is switched on" [22].

4. Frequencies in Biological Systems

Work with a single cell system became possible during a visit to the laboratory of Dr. F-A Popp, (Technology Centre, Kaiserslautern, Germany). Here measurements were made at low frequencies and radio-frequencies on a single (10 cm long) filamentary cell of Acetabularia. The frequencies were observed to jump discontinuously by a small amount at reasonably regular intervals of a few minutes; the pattern repeated after about 25 minutes provided that the oscillator was only switched on while measurements were actually being made. When the oscillator was left on and tracked continuously on a 'stimulatory frequency', the periodicity became about 2 minutes. While the oscillator was left on a 'depressing frequency' between measurements no frequency jumping took place at all, even over several hours.

This frequency jumping phenomenon applies equally to the human subject. Again, a depressing frequency stops all frequency jumping, while tracking the stimulating frequency speeds the frequency jumping from about a 2 hour cycle to a 6 minute cycle.

The empirical rule evolved for the therapy of electromagnetic hypersensitivity is to use an oscillator set to the highest stimulatory frequency or to imprint some, or all, of the stimulating frequencies into water. Thus, it seems that the therapy involves stimulating lethargic autonomic systems in the patient. The persistant presence of a depressing frequency (clockwise rotation) in the environment can paralyse the natural frequency jumping of a living system. From personal experience, this is most unpleasant, and soon leads to a strong urge to get-away from it.

The frequencies of resonances in water, homoeopathic potencies and biological systems can be measured using the the experimenter's autonomic nervous system as a highly sensitive detector. The sample needs to be excited with an alternating field (magnetic or magnetic vector potential) from a solenoid or toroid respectively. The sample, which might be a tube containing potentised water, and the toroid need to be orientated on a North-South axis with an accuracy of $\pm 45^0$ at fields well above the threshold of detection, although a tolerance of $\pm 5^0$ is required at the threshold field for detection. This orientation may be required to avoid interference from

the vector potential of the geo-magnetic field which is in the East-West direction and which seems to provide a reference for biological coherence effects. The hands (or arms) of the experimenter need to be on the North-South axis, one on each side of the sample being measured. One hand holds a pendulum which gives a clear indication when a resonance is reached; the other hand is free to tune the oscillator feeding the toroid or solenoid. The resonant frequency of the pendulum is such that it matches a natural 2 Hz resonance in the autonomic nervous system when the fields on a resonant specimen produce an left-right unbalance in the experimenter [30]. The (left-handed) writer gets a counterclockwise rotation of the pendulum at resonance when facing West. A water resonance giving this rotation corresponds clinically to a therapeutic frequency while, that giving the opposite rotation produces stressful reactions.

If the experimenter changes from facing West to facing East, the sense of the responses is reversed. Most substances and potencies show alternate counter-clockwise and clockwise rotations at successive resonances beginning at the lowest resonance frequency and ending at the highest with a counter-clockwise rotation.

Each successive homoeopathic dilution and succussion adds one more clockwise and one more counter-clockwise resonance to those found in the previous potency [23] but, all the materials and biological systems so far measured have given harmonics which are not the usual octave apart but, are spaced according to a high-order power-law for which the only reasonable model is a fractal equation [24]. There are some exceptions to the above:

(a) Water held and potentised by a healer contained a sequence of only therapeutic frequencies, starting at the heart frequency and appearing as a continuum at high frequencies.

(b) Dilutions of hydrogen peroxide contained only therapeutic frequencies which, if succussed became a continuum. With hydrogen peroxide, there was no potentisation if diluted with air-free water.

(c) Dilutions of formaldehyde contained only stressful frequencies which, if succussed became a continuum.

(d) Deuterium oxide would not potentise when succussed in an alternating magnetic field or magnetic vector potential until diluted with water $> 5\%$, $< 10\%$ (by volume).

(e) Electrotherapy apparatus can potentise water with all frequencies being therapeutic, or all stressful, depending upon the amplifier parameters selected.

If a sample of imprinted water is placed on the left of the toroid and a sample of 'clean' water is placed equidistant to the right and succussed, the latter acquires a phase inverted imprint of that in the water on the left. A practical application for this is for allergy therapy as it provides a way of inverting high frequency components of allergens outside the bandwidth of electrotherapy apparatus.

With the above method it is also possible to detect proton NMR in a water sample (2.13 kHz in a 50 μT geomagnetic field); this resonance can be tuned through by moving a small magnet in the vicinity of the water.

For the writer to be able to detect a 1 kHz resonance in water, a magnetic vector potential of $A > 17$ nWb/m (calculated rms value) is required at the sample. The detection threshold increases linearly with distance from the toroid between 0.3 m and at least 4 m [24]. It is also possible to use this method to detect resonances in series or parallel resonant inductance-capacitance (LC) circuits. The LC circuits **do** have octave spaced harmonics with the fundamental and all the other odd harmonics giving (the writer) a counter-clockwise pendulum rotation while all the even harmonics give a clockwise rotation.

The objective detection of resonances in water has been achieved and repeated on rare occasions using a technique whereby a pair of gold wire electrodes is dipped into a cuvette containing the sample of potentised water, these are connected to a suitable low-noise, high- gain, narrow-band amplifier. Similar results have been obtained at Wekroma AG, Switzerland, using a Fourier Transform Spectrometer with signal averaging over a large number of measurements [21]. The frequencies measured in this way were the same as those originally imprinted into the water and the same as measured on the sample by the above subjective method.

We now know much more about how to erase the 'water memory' albeit as the result of trying to measure erased samples. Heating water above 70^0C will erase its memory, as will an amplifier off-set current greater than about a microamp, or even the tube being handled by the 'wrong' person. But, most importantly, placing the water in a hypomagnetic container (e.g. a closed mu- metal box) erases not only 'water memory', but also tablets and liquid preparations of homoeopathic potencies and is very useful for producing "controls" by erasing a specimen after it has been measured. The threshold steady magnetic field necessary for the maintenance of 'water memory' is about 400 nT. At this field, the mean separation between magnetic flux quanta ($2.07 \times 10 - 15$ Wb) is 71 μm. A strong magnetic field > 250 μT will suppress 'water memory' although in this case, the imprint is recoverable by succussion.

5. Coherence or Wüst Waves

Specimens of potentised water seem to be well protected by wrapping the glass container in aluminium foil. The reason for this probably lies in the small critical angle for coherence waves passing from aluminium into water as shown in Tab. 1. It is theoretically possible to make lenses to focus coherence or Wüst waves. The critical angle did not alter measurably from 1 Hz to 100 kHz, also there did not seem to be appreciable dispersion when the velocities of coherence waves were measured by by Fizeau's method [1], nor in the case of stationary coherence waves on Lecher's wires. Therefore, coherence wave dispersion spectroscopy may not be available although, interference methods of spectroscopy remain a possibility. The imprint of potentised water will be picked up by a light beam shone through it and can be imprinted into water or metal on which it falls by succussion.

Material	Critical Angle (Measured relative to water)	Critical Angle (Calculated from coherence wave velocities [1])
Galvanized iron	85^0	
Formica-type	35^0	
Roofing tile	30^0	
Wood	21^0	
Limestone	18^0	
Window glass	16^0	
Sandstone	9.2^0	
Pyrex glass	8.3^0	9.2^0
Aluminium (foil)	4.6^0	5.5^0 (Al wire)
Quartz (rock)	3.7^0	
Air	1.5^0	1.1^0

Tab. 1. *Critical angles for total reflection of coherence waves at a material to water interface.*

If an insulated wire is arranged to conduct a coherence wave as described previously [1] and is then passed through a hypomagnetic enclosure, it is found that is a critical magnetic field > 740 nT for propagation beyond the enclosure. At this field, the mean separation between magnetic flux quanta is 52 μm. A coherence wave will propagate through a 10A fuse wire (calculated diam. 322 μm), It will not propagate through a 3A fuse wire (calculated diam. 140 μm), there is what is probably a 1-D coherence in a 5A fuse wire (calculated diam. 200 μm), Coherence waves can be conducted through water in tube diameters > 2.5 mm, but not in tubes < 2 mm.

The brass beakers as used to contain samples whose signals are to be introduced into electropuncture apparatus provide a convenient alternative method of coupling a coherence wave in a wire. They are usually provided with more than one socket so that a pair of wires can be lead away each carrying an identical coherence signal. If a beaker contains a sample of water excited at its imprinted frequency by a toroid, and such a pair of wires is passed one either side of the end of an air-cored solenoid resting on the bench (3000 turns/m, 50 mm diam) and through which a small steady current can be passed, then we have the basic arrangement for the Aharanov and Bohm experiment. This arrangement gives a phase variation in the detected pendulum rotation proportional to the current in the solenoid as shown in Fig. 1, for water excited at both the ESR and proton-NMR resonances in the ambient magnetic field. The same curve is obtained for copper at the ESR frequency only. The same result is also obtained if water in a plastic tube passes either side of the solenoid, replacing the wires and the beaker containing the water sample. Simultaneous application of both ESR and NMR frequencies to water produces a phase inversion.

FIG.2

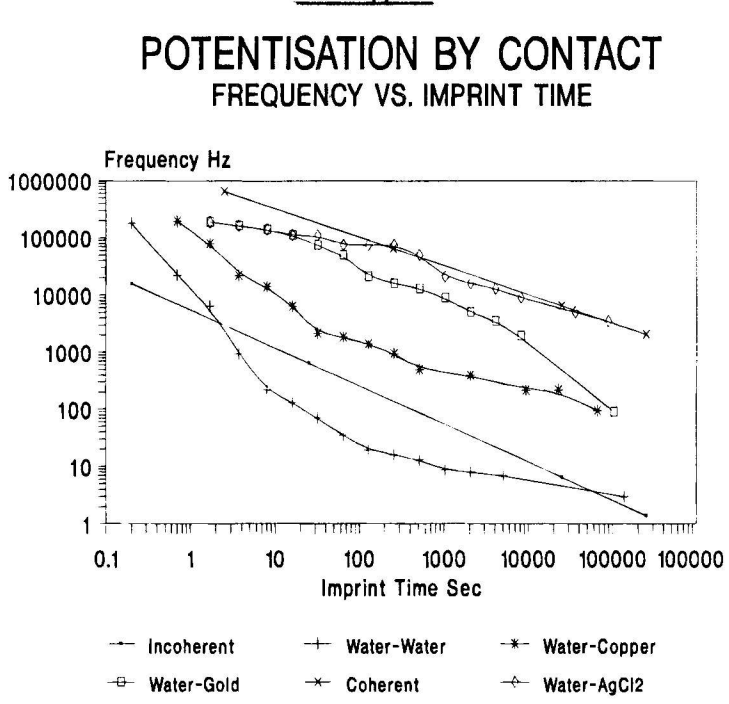

Fig. 1. *The phase shift in half-wavelengths for an Aharanov and Bohm experiment involving coherence waves in water at both its ESR and NMR resonant frequencies in the ambient geomagnetic field, and for copper wires at the ESR frequency only.*

The NMR for Cu_{63} and Cu_{65} were detected, but no effect was produced at these frequencies by varying the current in the solenoid. Likewise, there was no effect at the NMR frequency of deuterium oxide when an ampoule of pure D_2O was placed in the beaker. This must imply an absence of coherence wave phenomena.

6. Potentisation by Contact

As already mentioned, 'water memory' can be imprinted with a frequency using an alternating magnetic field, or with an alternating magnetic vector potential plus either succussion or a magnetic field. However, the information will also slowly imprint by contact. For example, if a glass tube containing 'erased' water is placed in a beaker of water imprinted with a range of frequencies, the frequencies will slowly become imprinted, the higher frequencies imprint more quickly than the lower frequencies as shown in Fig. 2. This suggests that imprinting does not need energy other than thermal excitation, and that the imprinting awaits the random arrival of the correct frequency component in the thermal noise to provide a bifurcation. The (random) theoretical curve, close to the water-water curve, is

based on the uncertainty relations for the number of randomly arriving quanta within the coherence time which are sufficient to give an energy equal to thermal energy (kT) [25]. The imprinting times for copper and gold immersed in water are also shown. Chlorided-silver wire, has no potential barrier with water at low frequencies and imprints the frequencies in times given by assuming the equivalent statistics for coherent quanta [25]. As Fröhlich often remarked, onset time delay is a hall-mark of coherence.

FIG. 1

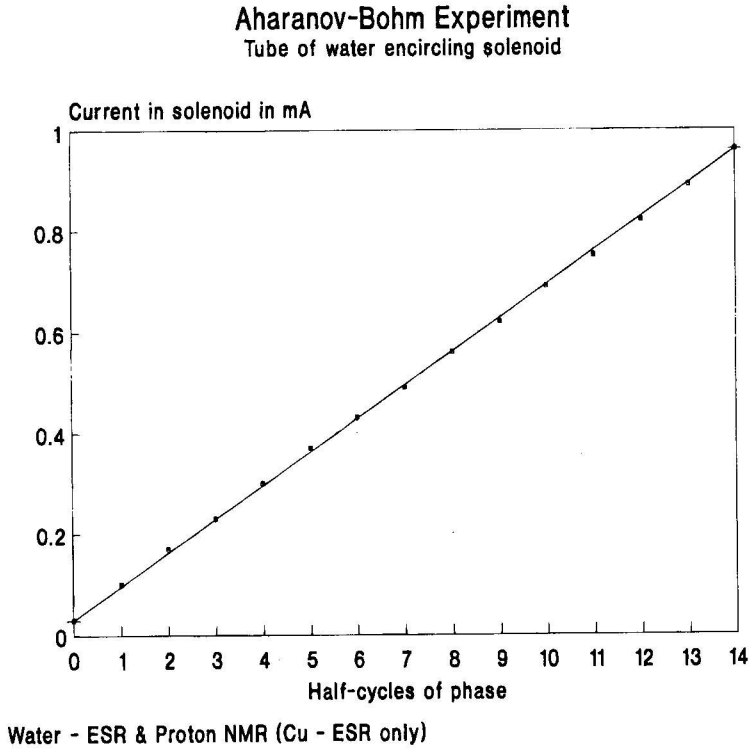

Fig. 2. *The time delay for potentisation by contact as a function of the frequency being imprinted. The time for water in a glass tube immersed in a beaker of water potentised with a sequence of frequencies to become potentised without any succussion follows the trend of the incoherent theoretical curve. The time for chlorided-silver to become potentised is close to the theoretical coherent curve. The other metals investigated come in-between. There was no potentisation by contact for a piece of copper placed in contact with a piece of copper previously potentised with frequencies by succussion. Martin's Press, 1989; Paris.*

7. Discussion

Living systems (single cells to humans) have frequencies associated with their activities, and that these frequencies have natural fluctuations. An applied frequency

which tracks a stimulating frequency can speed up the jumping rate tenfold; while a depressing frequency completely stops this frequency's normal jumping activity. The stimulating frequencies are the same as those which are clinically therapeutic for the electromagnetically hypersensitive patient. The depressing frequencies are the same as those which provoke reactions. The frequencies can be applied to the living system through alternating electric or magnetic fields, or an alternating magnetic vector potential, or through coherence waves. The magnetic vector potential must become involved through the order parameter of a quantum system since an alternating electric field does not potentise water. In this context, it should be remembered that chemistry and biochemistry do not exist in "classical" physics.

The present and previous paper [1] describe investigations aimed at determining the physical parameters likely to be involved in biological coherence and 'water memory'. It appears that in water both the electrons and the protons (which are just quantum particles) may be involved in coherence activities. In metals it seems to be only the electrons which contribute to the coherence and frequency 'memory' phenomenon. Deuterium oxide does not seem to exhibit coherence effects so, memory in water may require both proton and electron coherence, whereas in a metal the lattice of metal atoms is already spatially coherent and memory seems to be achieved by electron coherence alone.

8. Conclusions

The basic conclusion must be that Fröhlich was right! There is a whole sub-bioculture of coherence phenomena quietly going about its business of organising long-range order in water and the structure and function of biological systems and is waiting to be investigated. Special instrumentation is needed for this.

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