PERMANENT CHANGES IN THE PHYSICO-CHEMICAL PROPERTIES OF WATER FOLLOWING EXPOSURE TO RESONANT CIRCUITS

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Summary

The aim of this study is to present the results of three years experimental work on the interaction of water samples with passive resonant circuits. We shall finally attempt a physical justification for the changes that are produced in the water sample.

Permanent changes in the physico-chemical properties of a water sample were obtained by exposing it to a very simple device based on an RCL passive resonator. We detected these changes by means of a microcalorimetric (heat of mixing) procedure that had previously been applied to homeopathic solutions. Most experiments (60 samples) showed an exothermic heat excess relative to the reference water. All the microcalorimetric titration curves from these measurements on the treated water samples looked alike from a qualitative point of view and all of them displayed a break point at the same test solution concentration. We performed pH measurements during about half the total number of tests and observed an increase of the pH value (i.e. toward basic) in all but three of the exposed samples.

Introduction

Hardly any experimental procedure is available for detecting the physico-chemical changes that homeopathic succussion or other similar techniques can produce in water. Recently, a thermodynamic procedure was developed and has proven effective in characterizing homeopathic remedies [1], [2]. It consists in the comparison of the heat-of-mixing reaction of acids or bases in various concentrations respectively with extremely diluted solutions and with bi-distilled water as the control. In 100% of the cases, the homeopathically treated solutions showed a heat excess with respect to the control water.

Early observations on the effects of ultra-low electromagnetic. fields [3] were mainly based on the 'Sensitive Crystallization Method' and on biological tests. Incidentally, these hinted at the existence of a possible relationship between homeopathy and ultra-low electromagnetic fields. The biological effects of weak electromagnetic fields have been investigated by C. W. Smith since 1974 [4]. Recently, he established an equivalence between specific electromagnetic frequencies and homeopathic remedies and acupuncture meridians [5,*].

Material & Methods

The Apparatus. We standardized on a common experimental procedure and used the same exposure device in all the tests we performed. Three different resonant circuits were used with this device for exposing the water samples.

The Exposure Device. This couples the electromagnetic field from the resonator to the water sample so that the water only comes into physical contact with a glass beaker and never with the device itself. The device is composed of two elements: an external brass ring (Ø = 24 mm, 10 mm high, 1 mm thick) and an internal concentric copper dish (Ø = 12 mm) with curvature corresponding to one third of a 10 mm radius sphere. An insulating plastic ring is interposed between the two above elements. Thus, they are kept electrically separated from each other while independently connected to the resonator through insulated copper wires connected in turn to EXT1 and EXT2 as shown in the Figures 1,2,3.

The passive RLC circuits. The first resonator circuit we used to irradiate water samples was a modified Callegari Radionic Circuit [6] and its diagram is shown in Fig. 1.
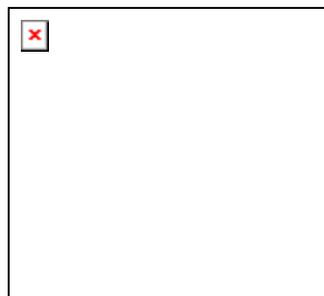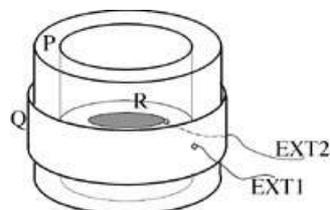

Fig. 1
(Modified Callegari Radionic Circuit)

Fig. 2
Water Exposure Device

Figure 2 shows the essential features of the Water Exposure Device (Cu indicates the internal copper disk, B the external brass ring and P the plastic ring).
We later developed and used two other circuits that were quite similar to each other. Their conception and design are substantially different from the first Device (Fig. 1) as the diagram in Fig. 3 clearly shows. Although the component elements and the electrical parameters are the same as those in the previous diagram, a ferrite bar has been added. The set-up and the electrical parameters are fully described in the previous references [*], but for the sake of clarity we briefly repeat them here. The aerial **A**, is a brass sphere $\emptyset = 5.5$ mm having a capacitance $C = 900$ pF, **C1** is a variable 30-300 pF capacitor, the inductance of $L = 0.02$ μH. **EXT1** and **EXT2** refer to the plugs on the resonator in Fig. 1 and the corresponding sockets in Fig. 2 on the exposure device. Finally, **Ac** is an unused plug serving as an elementary aerial compensating device.
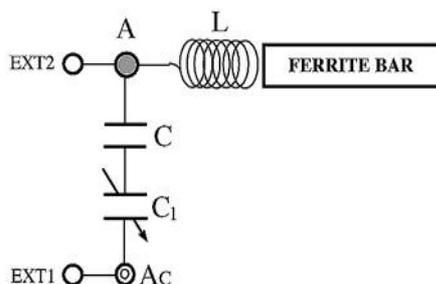

Fig. 3
The 'ferrite circuit'

Methods for Using the Apparatus. We exposed the bi-distilled water samples contained in glass vials or beakers by placing them under the exposure device. The resonator was connected to the above-mentioned exposure device. In all the circuits, one of the plugs is always located at the end opposite to the inductance (EXT2) and in line with the aerial (terminal **Ac**). It is important to note that the whole apparatus has no connection with any external or internal electric supply, nor a generator, nor any source of energy or oscillations. It is completely passive. The inductance axis in the operating condition must lie parallel to the local geomagnetic/geographical E-W direction.

E.M. Characterization of the Circuits. For quite a long time, it seemed almost impossible to have an electromagnetic footprint of the circuits. This proved to be a much more difficult task than having clear evidence of effects on the bi-distilled water samples.

After three years of fruitless trials, finally Dr. Clarbruno Vedruccio provided a completely satisfactory characterization of the circuits by means of a spectrum analyzer (Tektronik 492) linked to a tracking generator (Tektronik TR 504). The tracking generator was operated on the frequency band in the range 0-2 GHz with the signal amplitude set to 0 dB/mW (decibels per milliwatt) [i].

The results of that procedure are displayed in the following pictures taken from the spectrum analyser (Figs. 4 and 5) when the absorption spectra of the circuits were being displayed. Fig 4 refers to the circuit shown in the diagram in Fig. 1, while Fig. 5 refers to the circuit shown in Fig 3.
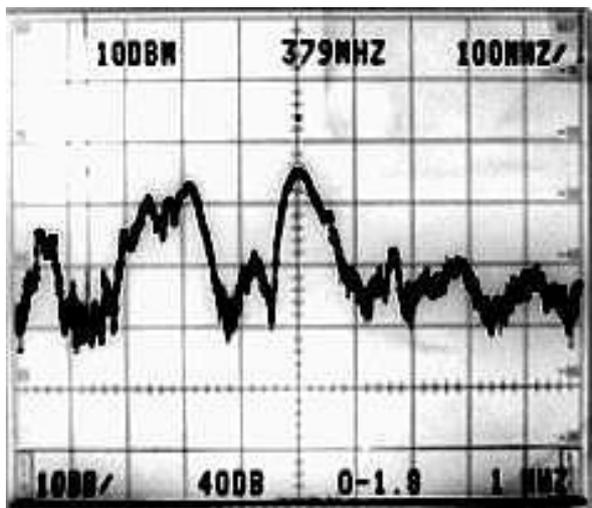

Fig. 4
Resonance spectrum of the circuit
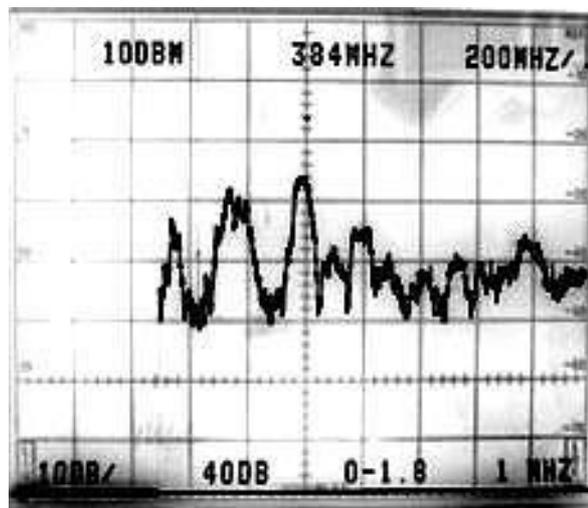shown in Fig. 1.

Fig. 5
Resonance spectrum of the circuit
shown in Fig. 3.

It is a quite remarkable event that albeit the circuit designs are very different from each other, both exhibit very similar shapes. The very close values of the frequencies corresponding to the main absorption peaks are located at 379 MHz and 384 MHz respectively. The left-side secondary absorption peak in Fig. 5 can be reasonably interpreted as the 'footprint' of the exposure device. In fact, that peak does not appear when the irradiating device is not plugged in the circuit. This is confirmed by the following picture Fig. 6, which refers to the same circuit as that analyzed in Fig. 5.

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[i] If the frequency resonances are stored "delocalized", as hologram, it would be necessary to provide a "reference beam" or equivalent to localize the information in space and time. This might have been the function of the tracking oscillator.
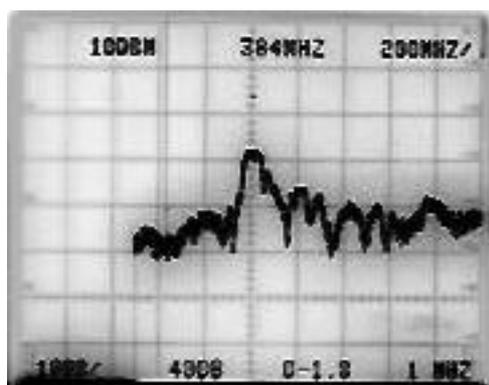
Fig. 6
Resonance spectrum of the circuit as in Fig. 3
but without connection to the Exposure Device.

The Experimental Set-up. The photograph in Fig 7 shows the experimental setup that we adopted in all our tests. We exposed the bi-distilled water samples by just placing the Exposure Device (plugged into the resonator) over the top of the clear glass beaker that served as their container. The Device was held in place above the water surface by a thin cardboard disk acting also as the beaker's cover. The circuit shown in this picture is the same as that schematically represented in Fig. 2.
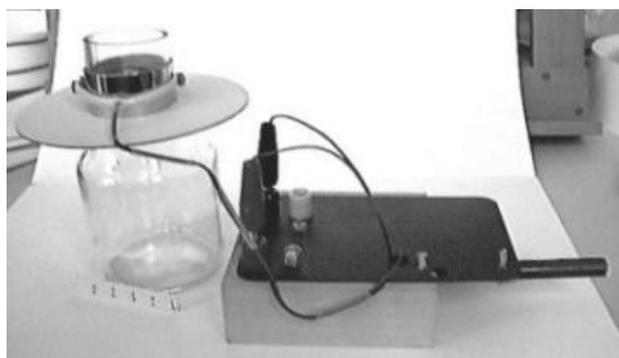

Fig. 7
Exposure device placed over a beaker of bi-distilled
water showing connections to the resonator circuit.

Sample Preparation. We always used fresh bi-distilled water (from Carlo Erba, Italy) which was kept in polyethylene until used. Exposure was always performed over pyrex glass beakers. Several water volumes were used in the experiments: 80 ml, 100 ml, 250 ml, or 400 ml.

Two different irradiation times were tested in general: 6 hours or 24 hours. In two experiments, from an initial 250 ml water sample, 20 ml aliquots were taken after 1, 2, 3, 4, 5 and 6 hours, and then the residual volume was left exposed for up to 24 hrs.

Once the exposure time had elapsed, the samples were always transferred into dark glass bottles. In all experiments, a control comprising the same volume of the same non-exposed bi-distilled water was kept in the same kind of dark glass bottles. The bottles containing the samples were kept far apart from the controls until measured. Both calorimetric and pH-metric measurements were performed. These were carried out at various times after the sample production ranging from a few hours to 14 days in order to determine the stability of the effects over time.

Microcalorimetric Apparatus. We measured the heats-of-mixing by means of a Thermal Activity Monitor (TAM) from Thermometric (Sweden) with $0.1\mu W$ sensitivity. It is equipped with flow-mixing and a batch titration vessel. In the case of the flow-mixing vessel, two peristaltic pumps convey solutions into the calorimeter through Teflon tubes. The flow rates through the inlet pipes are equal and constant, so that the solution coming out of the calorimeter has a concentration one half of the initial concentration. Our mass flow rate was constant to within 1% and its value $P_W = 3 \cdot 10^{-3} g \ s^{-1}$ remained the same in all the experiments. The following relation defines the enthalpies of mixing ΔH_{mix}:

$$\Delta H_{mix} (m_X^i \rightarrow m_X^f) = -(dQ/dt)/P_W$$

where (dQ/dt) is the heat flux/sec (Watt), P_W is the total mass flow rate of the solvent ($kg \ s^{-1}$) and m_X^i and m_X^f are the initial and final molalities, respectively, of the solution. ΔH_{mix} expressed in J kg^{-1} of solvent.

Calorimetric Measurement Procedures. The authors are indebted to Prof. Vittorio Elia and Dr. Marcella Niccoli of the University of Naples for these microcalorimetric measurements and procedures.

We matched each calorimetric test with a test on the pure bi-distilled water control. For this purpose, we compared every enthalpy measurement obtained by mixing a sample of irradiated water with test solution (an acid or a basic solution) with the measurement obtained by mixing pure water with the same test solution under the same experimental conditions.

Fig. 8 shows the measuring procedure through a typical power-versus-time diagram that results from a single calorimetric measurement. Line A represents the solvent water steady state condition: only pure water enters the calorimeter through both the input tubes. In this case, the heat produced is from the mixing of two solutions having identical concentrations, specifically bi-distilled water mixing with bi-distilled water, is evidently zero. Thus, we take line A as the base line. Bi-distilled water mixing with an acid or with a basic solution at a certain concentration yields line B once the system has reached a steady state. Line C refers to the steady states reached by mixing Device Exposed Water with an acid or a basic solution at the same concentration. There is a value increase as shown, this we read on the ordinate axis between stationary states C and B. It is proportional to the excess heat of mixing for the exposed water relative to the reference water. Finally, line D is again a base line and refers to the same experimental conditions as those yielding line A, i.e. reference water against reference water.

We performed about 150 heat-of-mixing measurements using NaOH or HCl as the test solutions at various concentrations in the 0-0.01 mol/kg range. All the microcalorimetric tests showed the line C ordinate higher than the line B ordinate. Thus, in all cases we observed an excess of exothermic heat of mixing with the Device Exposed Water.

Cardella C, de Magistris L, Florio E and Smith CW. (2001) Permanent Changes in the Physico-Chemical Properties of Water Following Exposure to Resonant Circuits. *Journal of Scientific Exploration* 15(4): 501-518 (2001). Correspondence: 16(2): 256-259 (2002).
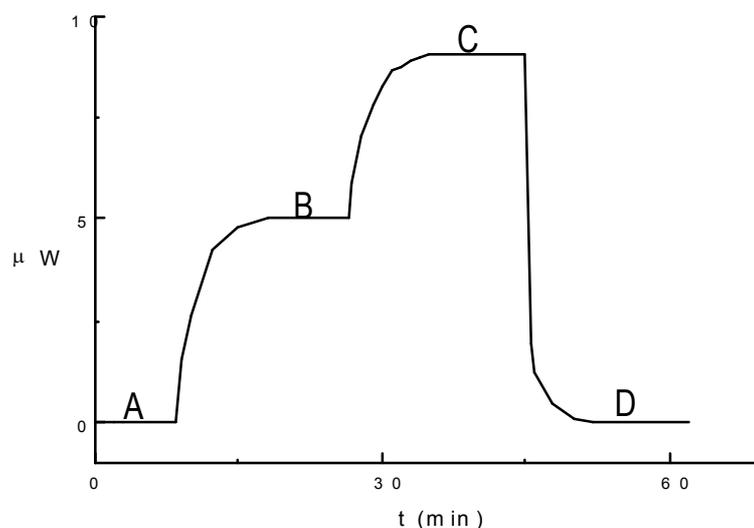
Fig.8- Power vs. time diagram.
A is the solvent water steady state condition.
B is the enthalpy steady state value reached by mixing
bi-distilled water with an acid or a basic solution.
C is the steady state value reached by mixing an exposed ample
with the same acid or base in the same experimental conditions.

Fig. 9 shows two typical experimental diagrams that display the excess heat of mixing for a Device Exposed Water sample versus the concentration of two different test solutions. In other words, for the same water sample it shows the two graphs for microcalorimetric titrations against NaOH and HCl respectively. Thus, it provides more complete information about the changes that the exposure procedure induces into the water. Namely, Fig. 9 gives the excess heat of mixing (in J kg^{-1}) resulting from the addition of test solutions with increasing concentration m (in mol kg^{-1}) respectively to Device Exposed and to reference water samples. The test solutions used were NaOH (in graph I) and HCl (in graph II) solutions. The exposed water sample was exposed for about 13 hours by means of the apparatus described above.

Curve I in Fig. 9 shows that any increase in NaOH concentration yields a substantial excess heat increase only up to the "break point" located at $1 \cdot 10^{-3}$ m concentration. Further concentration increases yield only small variations in the excess heat until a constant value is reached.

When instead HCl is used as the test solution, the excess heat is found to be independent of the HCl concentration (graph II).
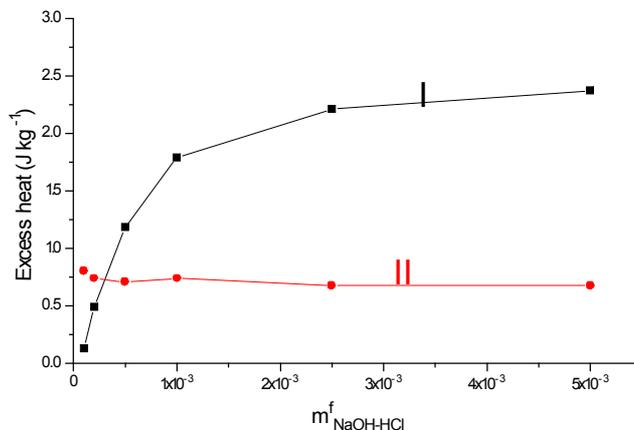
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Fig. 9
- Graph I: calorimetric titration by NaOH
-Graph II: calorimetric titration by HCl

Results

Microcalorimetric Measurements. We exposed 60 water samples by means of the RCL passive circuit. All of them underwent microcalorimetric titration by NaOH test solutions; 10 of them also underwent titration by HCl test solutions. All of them showed an excess (exothermic) heat of mixing in titration both with NaOH and HCl test solutions.

To compare results from the various experiments, each calorimetric measure was expressed as the maximal excess heat obtained by mixing with NaOH, when the control's value of heat of mixing was subtracted. The excess heat is expressed as J kg^{-1} and the maximum values are listed in Table I which summarizes all the experiments.

In 31 of the 60 samples, an excess heat was measured. Its values ranged from 0.19 J kg^{-1} to 6.2 J kg^{-1}; the median value being 1.87 J kg^{-1}. In 18 samples, no significant excess heat was detected, its value being close to that measured in the control samples. In the remaining 11 samples we observed an excess heat value significantly lower than that of the corresponding control, these measured negative values ranging between 0.2 and 2.0 J kg^{-1}. These negative values were most likely produced by an alteration of the geo-magnetic field that actually took place at the time the measurements were performed due to an exceptional solar magnetic activity. This should have changed the Schumann Band radiation in which one resonance is at 7.8 Hz which is the low frequency coherence corresponding to the 384 MHz of the RLC circuits used in these experiments. Since we did not know of this event until recently, we reported these cases in Table 1 under the generic heading of a "negative" value.

It is worth noting that all the NaOH titration curves exhibit a common feature. Namely, that in all cases the excess heat of mixing diagram shows a break point (i.e. it flattens out) at the same NaOH concentration value. This constant value is $1 \cdot 10^{-3}$ *m* regardless of the upper value of the excess heat of mixing that actually ranged between 1 and 4 J kg^{-1}. Conversely, all the HCl titration curves showed a mutually similar behavior in that they had all an approximately constant excess heat of mixing of value 0.64 J kg^{-1}.

In two samples, hourly aliquots were taken and these results are reported in Table II. A significant excess heat appeared only after a 4 hours exposure, it then increased until a maximum value was reached after 24 hrs. Upon comparison of the results obtained respectively with 6 and with 24 hrs exposure time, we can easily see that the longer exposure time does not appear to affect the result significantly (see Table 1). This fact hints at the existence of a saturation exposure time which is reached between 4 and 6 hours. Similarly, the volume of the sample exposed was always at least in the 80-400 ml range, and seems to be independent of the measured heat excess values.

In four cases, we repeated the measurements on the same water samples again after about 20 days and we always observed an increase in the heat excess, this could be up to twice the preceding value. After about a further 20 days, we performed for a second time the previous measurements on the same samples. We obtained titration curves similar to the earlier ones and again the same concentration value of $1 \cdot 10^{-3}$ m at the break point characterized all the NaOH curves. This event was verified in spite of the remarkable fact that the excess heat maximum value had increased up to twice the previous value in all the observed cases.

pH Measurements. We performed pH measurements on 29 out of the 60 samples. The apparatus we used was equipped with an electrode for low molecular force solutions. The values that we measured on irradiated water samples were compared to their corresponding controls and the results were expressed as a ΔpH increase. The generally observed pattern in these measurements was an increase toward basic pH values as shown by the ΔpH changes reported in Table II. The ΔpH values ranged between 0.05 and 2.60 pH units; in 5 cases, the ΔpH change shifted toward acid values and these are indicated in the Table I as negative values. All the negative ΔpH values corresponded to negative or zero excess heats but, there were positive ΔpH changes with negative excess heats.

Conclusion and Discussion

From the above considerations, we feel able to draw the following conclusions:

a) Exposure of bi-distilled water samples to a passive resonant circuit by the above described procedures does affect water samples in a "permanent" way[ii]. At present, this means that the observed changes persist over a relatively long time interval, a month or more.

b) The effects of the changes produced in the water samples in this way can be detected and evaluated by both microcalorimetric and by pH measurements.

c) The experimental results can be repeated and checked over and over again. However, they do not seem to be **exactly** reproducible. This means that although we have clear evidence of the fact that the above effects occur over repeated experiments, we have not yet found an experimental procedure leading to the precisely the same measured values each time.

d) The effects of this exposure on water can be enhanced by mechanical or thermal treatments. For example, water samples that had been previously shocked (successed) mechanically or dynamised (potentized) gave higher values of ΔH_{mix} than ones not so treated. The same applies to thermal treatment. When we measured an irradiated water sample after boiling it for 20 minutes in an oxygen controlled atmosphere, we got higher values of ΔH_{mix}.

e) The 'ferrite circuits' proved to be much more effective than the 'Callegari-like' ones. The measured values from the effects of 'ferrite circuits' ranged from 3 to 5 times higher than those obtained by 'Callegari-like' circuits.

[ii] Water imprinted with frequencies by the methods used by C.W. Smith [11] gave qualitatively similar microcalorimetric results when tested by Prof. Vittorio Elia.

f) There is a definite influence of the inverse time arrow on the irradiated water samples. When the measurements on a same irradiated water sample were repeated after a certain time interval, an increase in the measured values was found. Thus, we feel able to state that such an increase has grown during time subsequent to the irradiation, at least for a certain period which can roughly be evaluated as three or four weeks.

About a possible mechanism of action. There has been a considerable amount of serendipity in the development of this work throughout the past three years. This is a necessary premise to the following considerations since, one may ask how all this study started and where the idea of operating with passive circuits originated. The first input was the lecture on G. B. Callegari's work[7] about his simple experiments with 'radionic' passive circuits. Subsequently, we verified that the circuits he described actually produced observable effects on matter, albeit effects very hard to measure due to their extremely low intensity. The great difficulty in obtaining some experimental evidence with the Callegari circuits led to the development of the first circuit previously described herein, and to the exposure of water using it in the hope of a better chance of getting measurable effects. Finally, the microcalorimetric method of Professor Elia gave us the chance to measure the changes that this produced in water. Evaluation of these effects allowed us to develop a second kind of circuit (Fig. 3) that proved to be much more effective than the first one (Fig. 1).

In conclusion, the progress of this study was rather empirical and was powered by sheer curiosity. That is to say, it was impossible for us to find an adequate theoretical explanation for these findings. Nonetheless, some attempts in that direction seemed justified hence this paper.

It is undeniable that the effects of water irradiation by the passive circuits are measurable by an objective physical method whereas, their physical cause is hardly detectable. In fact, while there is a measurable energy output, no energy input can be traced, only information has been supplied to the water.

As a first viable hypothesis, we considered that the RLC resonant circuits could act as amplifiers of some very low intensity electromagnetic field frequencies that occur in the water or, as a second hypothesis, that they were very specific frequency converters and amplifiers of the local geo-magnetic field fluctuations.

It may be worth while to focus attention on the last feature (f) mentioned in the previous section, as this is quite difficult to explain by any physico-chemical approach. Namely, the time behavior of the irradiated water sample seems to resemble more that of a living organism than that of so-called inorganic matter. The problem here is very much like that presented by certain viruses. It is well known that some viruses can be crystallized like inorganic molecules and that they can actually comprise just a single molecule about the size of a sucrose molecule. If now we attempted to interpret the behavior of these viruses based on their chemical formulae, their vital behavior would become mysterious or even incomprehensible.

The mystery of life coincides with the mystery of consciousness. They both overlap the mystery of creation as the birth of a real shape whether in chemical or in biological morphogenesis.

Alternatively, we could interpret that behavior as an interaction by resonance in conjugated states. This approach would apply to the behavior of the Device Exposed Water samples as well. In so doing, the physical mystery of the formation of non-local and non-observable bonds becomes coincident with the biological mystery of the molecule itself. We can infer the formation of that kind of bond from the effects, mainly on the time behavior of the "living" molecule. As G. Bachelard pointed out (*Le materialisme rationnel*), the molecule can be seen as a base where an energy exchange takes place; where the energy finds a structure and where finally, a structural state "is chosen" from an essential multiplicity of possible states. On the other hand, Schrödinger [8] regarded genetic mutations consequent to an atomic explosion as being very similar to the transmutation of uranium into barium or into lead.

It is the time aspect of the chemical bond activity at any level, and not just the geometrical aspect that prepares the "history" of spatial molecular structures. They seem to be able to pass from a virtual to an actual state through some kind of reproductive behavior. Is it possible to define, for instance, a new kind of molecular bond for a time dependent active structuring? In other words, H. Blum's [9] remark still applies about the possible existence of some kind of chemical bond that implies a systemic unity. That is to say, only particular lattices of these specific bonds could give a molecule the capacity of asserting itself over the other surrounding molecules sufficiently to impose on them its own energy patterns.

Spatial shape is always a secondary outcome of an activity. In every occasion the shape considered under its spatial aspect is the product of an activity or, more precisely the product of the shape of its rhythm or its melody (i.e. a frequency). Shape in a subtler sense is an internal activity, the theme of the active structuring work.

Resonator coupled to water: possible mechanism. The equations for an RCL resonant circuit can be written with the magnetic vector potential replacing the current and give the same conditions of resonance. The frequency information imprinted into water by a magnetic field is the frequency of the magnetic vector potential component $\underline{A}$[10]. The $\underline{B}$ component merely enables this imprinting.

Thermal agitation induces random currents in a RCL circuit and hence random $\underline{A}$ fluctuations. Within resonance, these are magnified by the "Q" factor of the circuit, possibly above the threshold necessary to imprint the water. To test this, a CL circuit was tuned to the 384 MHz as used above, a tube of water was placed inside the coil. After about 130 seconds, this frequency had become imprinted into the water. To determine the threshold "Q" factor, series resistors were added in sequence until the water failed to take up that frequency. This occurred with 3 ohms whereas, with 2.5 ohms there was still a frequency imprint. Thus, the threshold "Q" for imprinting water was <470 but >392. Thermal electrons have an energy of 1/40 eV. Across a resistance of 2.5 ohms this would represent a random current of 10 mA. At resonance, the interchange of thermally excited volt-amps-reactive between L and C would pass through the 2.5 ohms in a coherent manner and be multiplied by the "Q" factor. As a consequence of coherence in this resonant circuit, when there is a voltage across the resistance there is no current through it and *vice-versa*. Otherwise, there would be power dissipation which clearly is not happening. This current would be 4.7 A and give rise to a magnetic field in the coil of B = 634 µT, also about the threshold needed for imprinting the frequency of the $\underline{A}$ component into water [ibid.]

Final remarks. Our experiments have proved that exposing water to passive RCL circuits can permanently alter some of the physico-chemical properties. Moreover, the water sample after exposure has acquired a "biological-like" behavior that lasts for a significant period of time. We can reasonably assume that such a behavior will somehow affect any chemical and/or bio-chemical reactions in which the exposed water may become involved.

It is important to realize that one is not accustomed to discussing the physics of water used as a solvent. In other words, most of the time the experimenter is concerned only with checking the chemical purity of the water needed. Now, we know that some message could have already been "written" into the water sample without altering its chemical purity in any way. That "hidden message" could be the cause of a constructive or a destructive interference with any "new message" the water sample may be about to receive.

The chemical message may of course be much more "powerful" than the physical one at least at short ranges of the order of the chemical bond length, and thus be little affected by it. Suppose we

are working at a level where low intensity actions possibly at long range are significant, such as for instance at the homeopathic level where such changes could make a great difference. That is to say, until now we have overlooked the importance of the solvent in homeopathic preparation. The effectiveness of homeopathic remedies might largely depend on the physical treatment the solvent water has undergone before its use for homeopathic preparation. Further studies on this subject are in progress.

Table 1

SAMPLE NUMBER	VOLUME ML	IRRADIATION TIME (HRS)	MAX EXCESS HEAT J.KG-1	ΔPH
A	100	8 Rome 2/6/97	0.42	
B	100	8 Rome 1/6/97	1.87	
0	100	8 Rome 13/6/97	3.6	
1	100	15	1.95	
1b	100	15	4.5	
2	100	15	1.8	
3	100	15	1.73	
4	100	15	1.25	
5	100	72	1.12	
6	100	15	0.71	
7	100	72	1.6	
8	100	15	4.4	
9	100	15	1	
10	100	15	1.54	
11	100	15	1.4	
12	100	15	0.8	
13	100	6 Rome 26/6/97	1.6	
14	100	6 Rome 6/7/97	0.96	
15	100	6 Rome 7/7/97	0.35	
16	100	6	0	
17	250	1-24	5.5	
18	250	1-24	6.2	
19	400	24	5	
20	400	24	0	
21	400	24	0	0.01
22	80	6	2.7	1.4
23	80	6	3.6	2.6
24	80	6	0.3	0.3
25	80	24	0.3	0.2
26	80	6	0	0.3
27	80	25	0.05	2.5
28	80	24	3.4	1.2
29	80	24	0	
30	80	24	0	
31	80	22	0.3	0.3
32	80	24	0.7	0.45
33	80	24	negative	0.01
34	80	24	negative	0.2
35	80	24	negative	0.2

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36	110	24	negative	0.025
37	110	24	negative	0.075
38	110	6	negative	-0.4
39	110	24	negative	-0.2
40	110	24	0	-0.3
41	110	24	0	0.1
42	110	24 phys. saline	Ind.	0.01
43	110	24 phys. saline	Ind.	0.005
44	110	24	negative	0.1
45	110	24	negative	0.1
46	250	24	0	0.09
47	250	24	0.19	0.2
48	250	24	0	0.3
49	250	Ref.	0	
50	250	24	0	0.2
51	250	24	0	0.5
52	250	Ref.	4.1	
53	250	24	-0.2	-0.1
54	250	24	-0.6	-1

Table 2: Experiments where hourly quotas were taken (excess heat expressed as J.kg-1)

SAMPLE NUMBER	1 HR	2 HR	3 HR	4 HR	5 HR	6 HR	24 HRS
1 ΔH_{mix}	0	0	0	0	0.5	0	5.5
2 ΔH_{mix}	0	0	0	0	0.45	0.45	6.2

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