White Paper XXXIV

Integrating Some Negentropic Processes into Gibb's Thermodynamic Free Energy Function: Some Novel Experiments

By

William A Tiller, Ph.D. and Walter E. Dibble, Jr., Ph.D.

William A Tiller Institute for Psychoenergetic Science, Payson AZ 85541 USA, bill@tiller.org

Introduction

It is historically well known that in nature, entropy is directly connected to the number of possible changes that could occur at any moment in a system as distinct from the probabilities of these changes. Many use the metaphor "disorder" as a way to represent this quality. Perhaps the best formula to represent the quantitative nature of this quality was provided by Max Planck via

$$S_0 = k_B \ell n \; P_0 \quad . \qquad (1)$$

Here, S_0 represents the thermodynamic entropy of a physical system, P_0 is the number of probably elementary complexions, or uniquely distinguishable different states in the system. The constant, k_B, is the Boltzmann Constant, 1.38 x 10^{-16} C.G.S. units for our normal U(1) electromagnetic Gauge symmetry state of distance-time-only reality(1).

As a simple example, suppose we consider a gas in a container. It is composed of myriads of molecules moving about ceaselessly. At a given instant of time, we have no idea of the exact positions, speeds, internal energy states and directions of movement for the individual particles so that the **microscopic** structures of the system are unknown to us. We know only the **macroscopic** values of pressure, volume, temperature and chemical compositions. Fortunately, over time, we have developed specific instruments for measuring the time-average values of these parameters (but not the specific details re the distribution of these molecules in space). It is on these bases that one can compute the number of **complexions** of the system, and its **entropy** via Equation 1 as a function of time.

Every experiment conducted on the system can yield specific information about the system. This can be considered as a type of informational order in an otherwise chaotic system of gas molecules. In Shannon's(2) seminal work on Information Theory, this has been recognized as a type of equivalence between a negentropy change, $-\Delta S$, and a new information increase, $+\Delta I$, as in

$$\Delta I = -\Delta S \quad . \qquad (2)$$

Modern information theory was developed by Claude E. Shannon in the 1940s to mid-1950s to find fundamental limits on signal processing operations such as compressing data and on reliably storing and communicating data. Since its inception, this has been broadened to find applications in many other areas including statistical inference, natural language processing, cryptology, neurobiology, the evolution and function of molecular codes, model selection in ecology, thermal physics, plagiarism detection and other forms of data analysis.

The concept of information (negentropy) cannot be separated from that of thermodynamic free energy. This concept was first formalized by Leon Brillouin(3,4). Brillouin provides a precise definition of "information" in the following fashion.

Let us consider a situation wherein, for P_0, different things might happen and each of these possible outcomes have equal probability apriori. This is an **initial** condition for which we have no special information about the problem so $I_0=0$. However, circumstances may arise wherein we may have some more precise definitions or measurements about a similar problem, and thus obtain a smaller number, P_1, of equally probably outcomes. Thus, one can state that the information created, $I_1=\Delta I$, in this problem can be defined by the formula

$$\Delta I = K\ell n(P_0/P_1) = K\ell n P_0 - K\ell n P_1 \qquad (3a)$$

where K is a constant depending on the units selected.

In problems dealing with telecommunications, Shannon(2) used binary digits called bits and here, one uses

$$K = 1/\ell n 2 \quad . \qquad (3b)$$

However, when one is mainly interested in physical problems, we want to use similar units for information and entropy, so one chooses

$$K = k_B = 1.38\, x\, 10^{-16} \text{ E.G.S. units .} \qquad (3c)$$

This choice of units enables one to compare information directly with entropy and thus thermodynamic free energy, G, as in the modified Gibb's Equation

$$G = PV + E - T\,(S + \Delta I)\ . \qquad (4)$$

Thus, if ΔI is positive in an experiment, via Equation 2, an entropy reduction occurs and G is increased. However, practically, the ratio of Equation 3b to 3c is very close to 10^{+16}, an extremely large number, so it requires an enormous amount of information, measured in bits to yield a significant, or practical spacetime U(1) Gauge state thermodynamic entropy. This fact is not necessarily true for higher Gauge state processes.

In 1953, Brillouin derived a general equation stating that any changing of an information bit value requires at least a ΔG change of $K\ell n 2$. Rolf Landauer, also from IBM, generated a physical principle pertaining to the **lowest** theoretical limit of ΔG consumption required for a computation. The Landauer principle holds that "*any logically irreversible manipulation of information, such as the erasure of a bit or the merging of two computation paths must be accompanied by a corresponding entropy increase in non-information bearing degrees of freedom of the information processing apparatus or its environment*" (Bennett, 2003)(5).

Landauer's principle asserts that there is a minimum possible amount of ΔG required to change one bit of information, known as the Landauer limit of $k_B T \ell n 2$. At room temperature, 25°C or 298.15°K, the Landauer limit represents a ΔG of approximately 0.0178 eV or 2.85 joules.

Theoretically, room temperature computer memory operating at the Landauer limit, could be changed at a rate of one billion bits per second with only 2.85 trillionth of a watt of power being expended in the memory medium. Modern computers use millions of times this level of power. If no information is erased, computation may, in principle, be achieved which is thermodynamically reversible, and requires no release of heat. Recent experiments (Moore, 2012; Bèrut, 2012)(6,7) provide further evidence that Landauer's prediction is indeed true.

Before closing this section and proceeding to the main experimental work of this paper, four pieces of historical background need to be introduced. The first deals with the "conditioning" of an experimental space via the application of human intention of magnitude, ΔI^*, from a source with consciousness, C^*. Our working hypothesis is that "any act of **intention** is an act of **creation** which provides new information in nature and thus negentropy production". This, in turn, leads to the second important consideration that must be considered which is a departure of the electromagnetic Gauge symmetry state of the experimental space from our normal U(1) Gauge symmetry state. These two new and significant experimental variables, I^* and C^*, will be very important in future scientific studies.

To be brief, over the past 15 years we have learned how to imprint a specific human intention into a simple electrical device which we label an IHD (intention host device) which can create significant metastable thermodynamic changes in materials: Inorganic and organic, non-living and living.
Reimprinting the IHD at 3 months to 6 month levels allow these material changes to become semi-permanent. This process, in turn, appears to change the EM Gauge symmetry state of the experimental space from the U(1) state to the SU(2) state. In the next section, we will briefly show (A) how this Gauge state change process occurs in the pH-measurements of water via an IHD and (B) how such pH-change measurements can be experimentally used to detect negentropy effects in water.

In today's orthodox physics, an SU(n) Gauge reaction involves $n^2 - 1$ interacting elements. Thus, the quantum electrodynamics (QED) example of the neutron-proton exchange reaction is SU(2) because the neutrino is also an active and essential ingredient of the reaction because $2^2 – 1 = 3$ (neutron, neutrino, proton). For n = 3, we have $3^2 – 1 = 8$ independent players leading to Murray Gellman's "eightfold way" of quantum chromodynamics (QCD) involving eight different quark-quark interactions. This should be sufficient for the reader to realize that the Gauge symmetry state change is akin to a thermodynamic phase change but on at least a sub-atomic particle level.

Our third working hypothesis is that, in the intention work, we are most probably dealing with "subtle energies" rather than with electromagnetic energy. One of us defined subtle energies(8) as "all those energies functioning in nature beyond those involved in the four fundamental forces discovered to date by today's orthodox physics".

The fourth working hypothesis is that the nucleated regions of what we label as "coupled state" material in Figure 2 vs. "uncoupled state" material involves a unique coupling agent described at length in Reference 9. Now, let us proceed with Section A.

A. pH Changes During U(1) to Mixed U(1)/SU(2) States

We start with the definition of pH in the U(1) Gauge symmetry state as

$$pH = -log_{10}(a_{H^+}) \qquad (5)$$

where $a_{H^+}$is the thermodynamic activity of the hydrogen ion, H^+. Figure 1 provides a schematic setup of apparatus used in all of our test site measurements$^{(10)}$, with the medium of investigation being some type of aqueous solution and a sensor probe involving a pH-electrode and water temperature sensors are utilized as the H^+ ion redistributes itself in the sensor probe to produce thermodynamic equilibrium throughout the system . An electric voltage, V_E develops across the membrane/space charge interface of the probe.

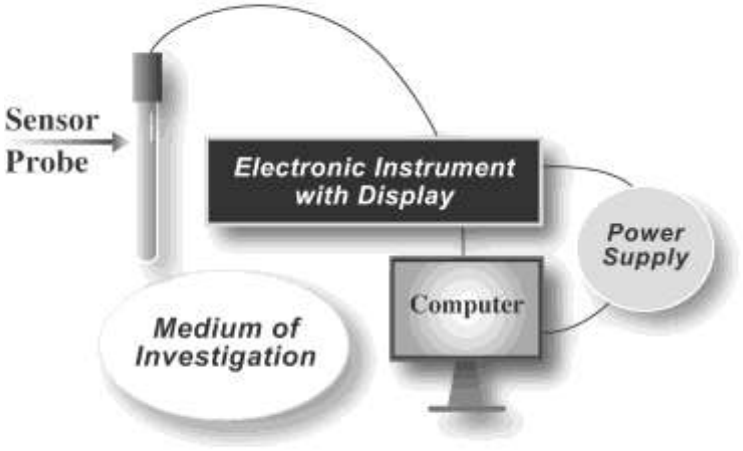

Figure 1. Experimental set-up for testing pH changes.

The general Boltzmann equilibrium equation connecting V_E to $pH_{U(1)}$ can be readily calculated$^{(10)}$ to give, for an ideal system,

$$V_E = V_0 - 59.16\,pH\ (mV) \qquad (5b)$$

where V_E is the standard cell voltage in the sensor of Figure 1. The non-ideal case involving membrane polarization and other factors leads to

$$V_E = S^*(pH_{U(1)} - 7)T_{CORR}\ , where\ T_{CORR} = \left(\frac{T-273.15}{298.15}\right)\ . \qquad (5c)$$

Here, $V_0=7S^*$ where S^* is the electrode slope with respect to pH and voltage determined via calibration. Periodic recalibration of S^* was always used to attain accurate measurements.

Rearranging Equation 5c, we define the “Nernst parameter, N” where

$$N = \frac{S^*}{V_E}\,(pH - 7)T_{CORR}\ \ . \qquad (5d)$$

Of course, N should always be unity for the U(1) Gauge state. However, as one “conditions” an experimental space from the U(1) state to the composite Gauge state of an SU(2) gauge state phase in a matrix of U(1) Gauge state water, (see Figure 2) one finds that N is no longer equal to unity and Equation 5c must be altered because the SU(2) gauge material has a higher thermodynamic free energy per unit volume than its host U(1) Gauge material (the uncoupled phase).

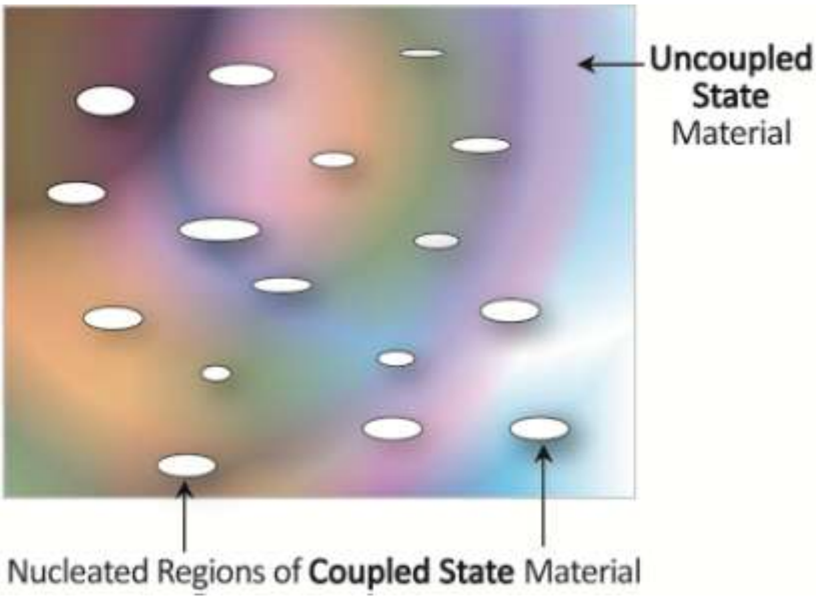

Figure 2. Nucleation and growth of the macroscopic coupled state domains of physical reality.

Figure 3 illustrates a proposed example of the δG^{*}_{H+} change in the electrode-pH relationship for such a case.

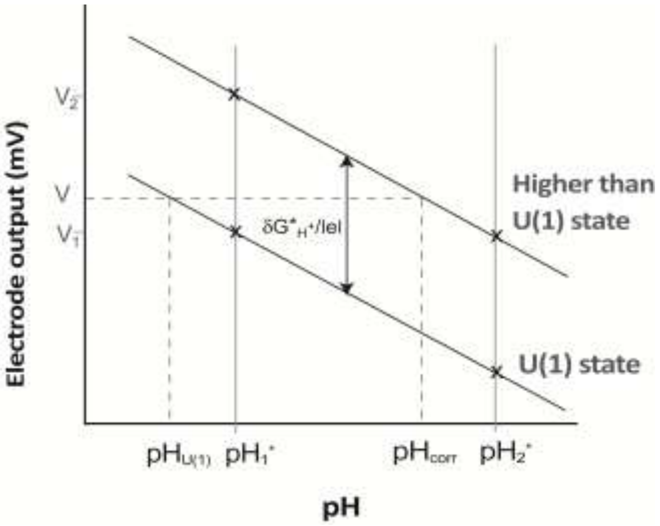

Figure 3. The electrode electrical output vs. pH plots for both the U(1) state ($\delta G^*=0$) and a higher than U(1) EM gauge symmetry state.

For an IHD imprinted to increase the pH of purified water by ΔpH units with no chemical additions, Figure 4 illustrates the typical exponential pH vs. time response curve with pH_0 being the U(1) Gauge state theoretical value and β is a constant determined by the experimental space.

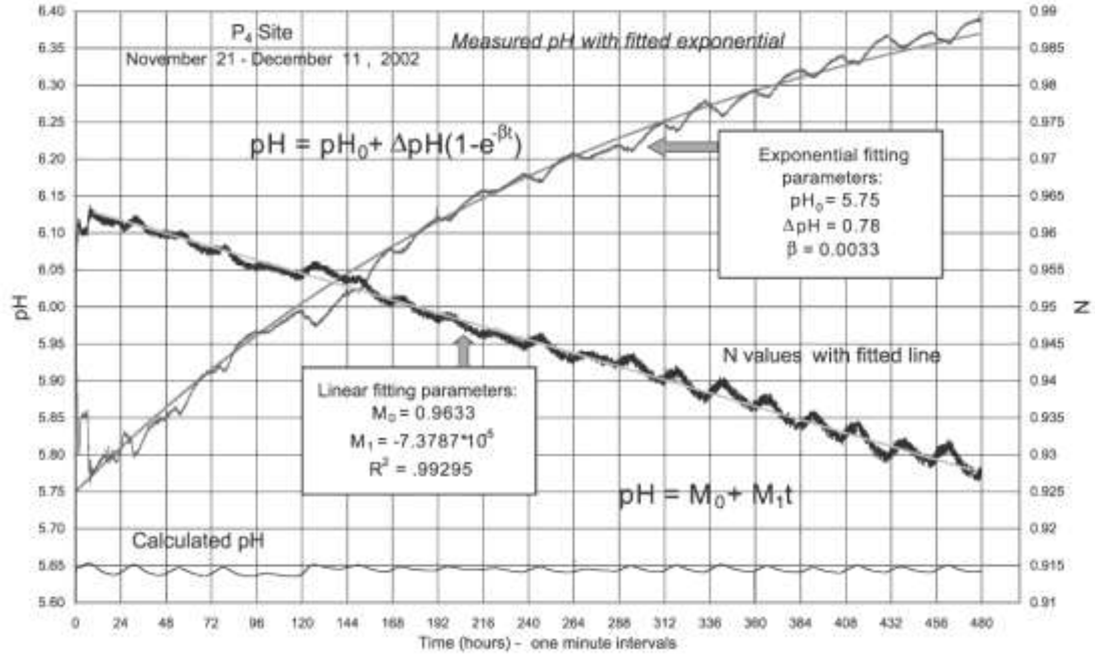

Figure 4. Showing the time-average exponential variation of pH and N after fresh purified water was introduced into the measurement cell on 11/21/02.

Superimposed on this plot is the corresponding variation of N with time via Equation 5d. Table 1 shows a range of N-values at eight different experimental sites (gathered in 2003).

Table 1

Values of N for all of the various sites operating in our overall experimental system.

Site	Recent N-values	% departure from 1.00
P_1	.89	-11
P_2	1.14	14
P_3	.98	-2
P_4	.87	-13
M_1	1.3	30
K_1	.98	-2
B_2	1.23	23
B_1	1.04	4

In this Table, P=Payson, K=Kansas, M=Missouri, B_A=Baltimore and B_B=Bethesda and the subscript numbers stand for particular measurement stations located at these geographic sites (see Reference 1) as of ~January 25, 2003.

This is a very straightforward way for an experimenter to realize that his/her experiment has become partially “conditioned” and that the Gauge symmetry state is beginning to change to a mixed Gauge state composite pattern, perhaps somewhat like that illustrated in Figure 2. The reader can peruse much more detail concerning this study by reading Reference 10.

B. Discovering Negentropy Effects in IHD "Conditioned" Water

Our working hypothesis for this section is that an IHD-conditioned space holds an information content in excess of that found in a conventional U(1) Gauge state thermodynamic system. Via methods we have developed over the past 15 years, we may have found a way to measure negentropic effects during Reconnection Healing Workshops held between the 2007-2009 time period. The goal of this work was to find experimental data to test the efficacy of **Reconnective Healing workshops** for developing healers. In particular, our goal was to experimentally measure "subtle energy/information changes" that occur in the actual workshop room at various stages of either the lecturing portion of the workshop or the hands-on practice of the students.

Figure 5 illustrates the equipment setup in a typical workshop.

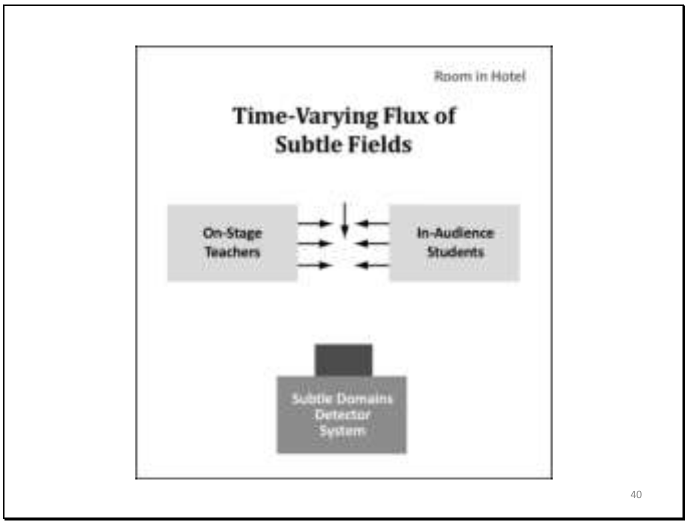

Figure 5. The general methodology is illustrated here.

Our experimental probes were (1) the continuous measurement of acid/alkaline balance (pH) for a vessel of highly purified water in the workshop room and (2) in the same vessel, the continuous measurement of water temperature, T_W, and, nearby this vessel, plus in other parts of the workshop room, the air temperature, T_A. From these measurements (pH, T_W and T_A) plus the pH-electrode voltage, V_E, a theoretical procedure has been developed for calculating the excess thermodynamic free energy per unit volume change, $\delta G^*_{H^+}$, for the aqueous H^+-ion in the room, relative to a normal U(1) Gauge symmetry state space where ($\delta G^*_{H^+} = 0$).

From other experiments, it has been found that the experimentally measured value of $\delta G^*_{H^+}$, labeled $\delta G^*_{H^+}(M)$, consists of two different contributions (1) an electrode portion, $\delta G^*_{H^+}(E)$, and (2) a portion associated with **actual** changes in the vacuum level of the experimental space itself, $\delta G^*_{H^+}(S)$, so that

$$\delta G^*_{H^+}(M) = \delta G^*_{H^+}(E) + \delta G^*_{H^+}(S) . \qquad (6)$$

The pH-electrode portion, $\delta G^*_{H^+}(E)$, depends upon the total use-history of the particular electrode so that **each** pH-electrode has its own "personality", so to speak thus, when, multiple pH-probes are used to measure a room's state of "conditioning", each will provide a different value of $\delta G^*_{H^+}(M)$. Thus, $\delta G^*_{H^+}(M)$ by itself gives only a **relative value** for the space "conditioning" developed in the room during a healing workshop. Fortunately, we have also discovered procedures for measuring a particular electrode's value of $\delta G^*_{H^+}(E)$, which usually changes very slowly$^{(11)}$. For calculation simplicity, we subtract $\delta G^*_{H^+}(E)$ from $\delta G^*_{H^+}(M)$ so that the **reported** $\delta G^*_{H^+}$-values are actually $\delta G^*_{H^+}(S)$ for the space itself.

The value of $\delta G^*_{H^+}(M)$ in Equation 6 comes from our pH-measurements while values of $\delta G^*_{H^+}$ are calculated$^{(11)}$ from Equation 7

$$\frac{\delta G^*_{H^+}}{|e|} = \frac{\{T_{CORR}(pH_{U(1)}-7)S\}-V_E}{1+T_{CORR}} . \tag{7}$$

In Equation 7, |e| is the absolute magnitude of the electron (proton) charge. The other quantities were all defined in Section A. the quantity $pH_{U(1)}$ represents the pH of the aqueous sample determined independently of measurement. For purified water in equilibrium with air, the value of $pH_{U(1)}$ can be calculated from thermodynamic data lone as a function of temperature. The $pH_{U(1)}$ of pure water in equilibrium with air of normal CO_2 concentration at 25°C is approximately 5.60. This value represents a kind of internal standard against which one can compare measured experimental values.

Another important pH-variable that we calculate is $\Delta pH = pH_{CPU}-pH_{U(1)}$, where pH_{CPU} is the value of pH recorded by the pH-measuring equipment. For all of these various pH-parameters, one can create charts to show how these parameters change with time during a particular experiment.

The two basic assumptions we use for applying this methodology are:

(1) The value of $\delta G^*_{H^+}(S)$ in Equation 6 represents the excess thermodynamic free energy for the "conditioned" space and
(2) The air temperature represents the value of the "conditioned" space temperature.

For U(1) Gauge state thermodynamics, the macroscopic Gibb's free energy function, G, is given by

$$G = H - TS \; and \; H = PV + E \tag{8a}$$

with

$$(\delta G/\delta T)_P = -S \; and \; \left[\frac{\delta G/T}{\delta 1/T}\right]_P = H . \tag{8b}$$

Here, H=enthalpy, S=entropy, P=pressure, V=volume and T=temperature. Thus, from Equations 8, a **simultaneous** measurement of both G(t) and T(t), to yield $(\delta G/\delta T)_P$ and $(\delta T/\delta t)_P$, allows both S and H to be determined as a function of time. Any time-domain regions that yield negative segments for S are indicators that positive information production events have occurred.

A slight expansion of the thermodynamics of Equation 8 to include both positive and negative entropy production requires a small modification of the Gibb's Equation to the form

$$G = PV + E - T\left(S_0 + \int_{t_1}^{t_2}\left(\delta S(t) + \delta I(t)\right)dt\right) \tag{9a}$$

differentiating G with respect to T_A leads to

$$\frac{dG}{dT} \approx -\left[S_0 + \int_{t_1}^{t_2}\big(\delta S(t) + \delta I(t)\big)dt\right], \qquad (9b)$$

$$\approx d\big(\delta G^*_{H^+}/dt\big)/(dT/dt)\,. \qquad (9c)$$

In the Reconnective Healing workshops, when a speaker/trainer stepped onto the stage and drew the focused attention of the audience, the **magnitude** of δG^*_{H+} increased in a nearly linear fashion (see Figure 6 – bottom plot), although the direction of change is usually in the negative direction.

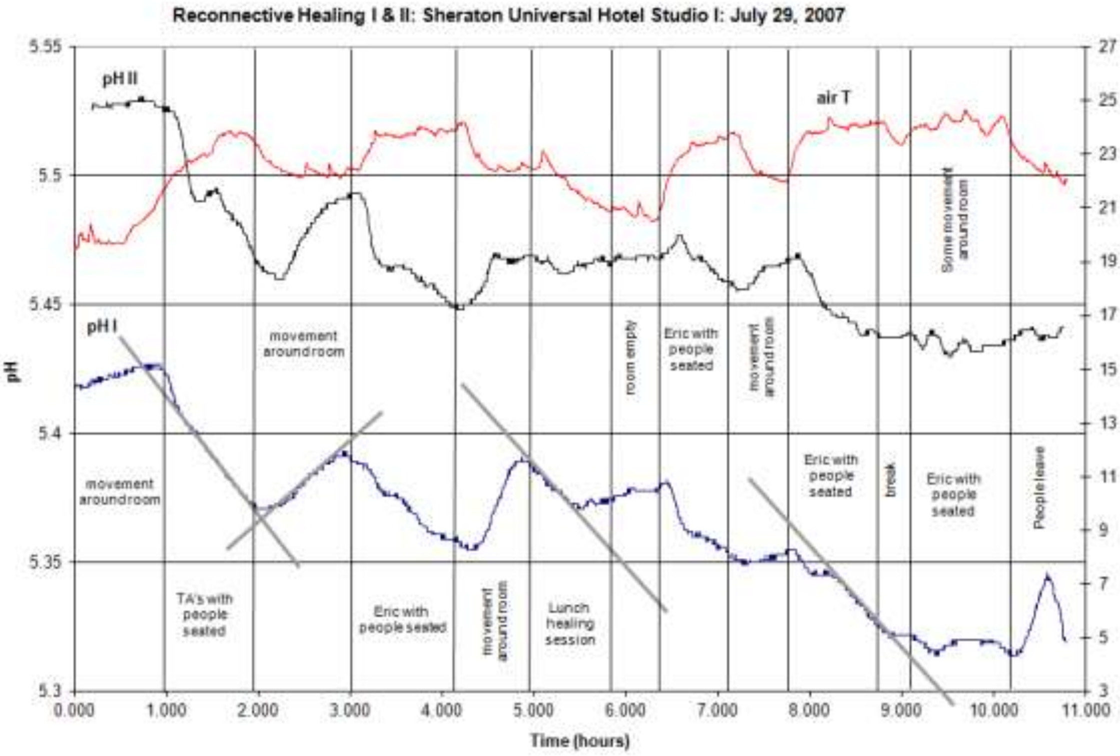

Figure 6. pH (or $\delta G^*_{H^+}$) and air temperature vs. time.

Conversely, when such sessions were over, and people's attention was drawn away from the stage, the change in δG^*_{H+} was always in the opposite direction. Since the $\delta G^*_{H+}(t)$ data comes from the pH(t) experimental data, Equations 9 can be solved allowing one to evaluate the R.H.S. of Equation 9b. Figure 7 provides us with a sum of both the positive and negative entropy contributions.

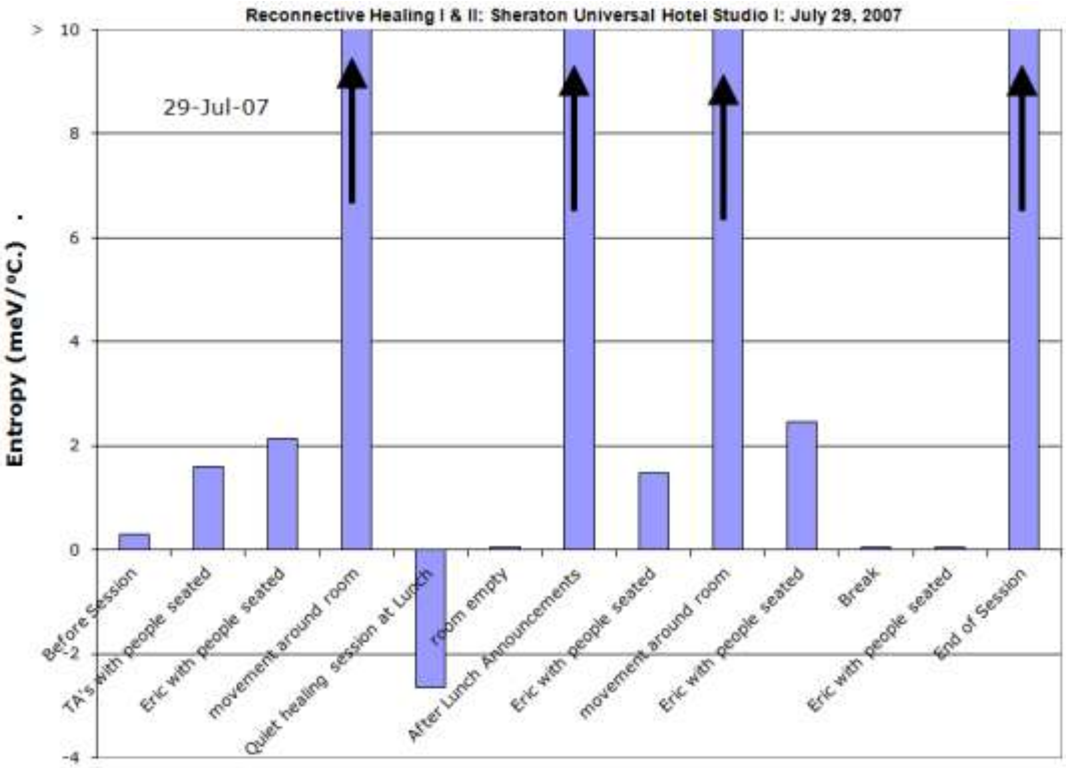

Figure 7. Total entropy production vs. time.

In Figure 7, one observes that (a) the greatest positive entropy production occurs when there is significant human movement around the room both during and at the end of the individual sessions, (b) the **maximum** negative entropy production period was during lunch time when the room was used for private healing sessions and (c) four periods of negative entropy production large enough in magnitude to reduce the total entropy production magnitude to almost zero occurred.

Discussion

We consider these two examples as test cases for the use of our methodology. Obviously, for anything so new and unusual, much more work needs to be done to verify the efficacy of the procedures used here. That being said, it is gratifying to note that the Figure 7 result is fully consistent with our general understanding of conventional thermodynamics. As to the future, in principle, what is labeled as structured water might be examined by these procedures (if the actual structure was known) and the information equivalent in bits could then be roughly determined.

References

1. K. Moriyasu, An Elementary Primer for Gauge Theory (World Scientific Publishing Co, Pte. Ltd. Singapore, 1983).
2. C.E. Shannon, "A mathematical theory of communication", The Bell System Technical Journal, 27, 379-423 (July) and 623-656 (October).
3. L. Brillouin, Science and Information Theory; Second Edition, (Academic Press: New York, NY, 1962), Chapter 12.
4. L. Brillouin, Scientific Uncertainty, and Information (Academic Press: New York, NY, 1964) Chapter 1.
5. C.H. Bennett, "Studies in history and philosophy of modern physics", 34, 501-510 (2003).
6. S.K. Moore, "Landauer limit demonstrated. Scientists show that a 50-year-old principle limiting future CMOS computing is real: Erasing information gives rise to heat", online document, Spectrum.ieee.org. Posted 7 Mar 2012.
7. A. Bèrut, A. Arakelyan, A. Petrosyan, S. Ciliberto, R. Dillenschneider and E. Lutz, "Experimental verification of Landauer's principle linking information and thermodynamics", Nature, 483, 187-189.
8. W.A. Tiller, "What are subtle energies?", J. Scientific Exploration 7, (1993) 293.
9. W.A. Tiller and W.E. Dibble, Jr, online document, www.tiller.org, White Paper VIII.
10. W.A. Tiller and W.E. Dibble, Jr, "Towards general experimentation and discovery in conditioned and CAM spaces, Part V: Data on 10 different sites using a new type of subtle energy detector, Journal of Alternative and Complementary Medicine, 13, 133-149 (2007).
11. W.A. Tiller and W.E. Dibble, Jr, online document, www.tiller.org, White Paper XI.