II: Preliminary Evidence for a Second Time Dimension Directed from the Future to the Past, and for Unification

Richard Ellis

Corpus Christi College (Alumnus), Oxford OX1 4JF, UK
E-mail: r.ellis@physics.oxon.org

Experiments are presented on the effects of visible light shining on water. To understand these, we note that Landau and others realised General Relativity was incomplete because it does not correct for the Observer's reference frame. When this is done for the general case,the chronometric invariant formalism of General Relativity (CIGR) predicts a second time dimension directed from the future to the past, and new phenomena at low (eV) energies. The initial objective was to test Brittin and Gamow's theory that sunlight lowers the entropy level at the Earth's surface. We detected this effect and found it persists for at least 10 months after exposure to sunlight (17 days after halogen light), *contrary to the second law of thermodynamics*. In a previous paper, the (photo-mirror) hypothesis was made that light can switch the arrow of time into the mirror world of CIGR, via the Brittin and Gamow effect. Experimental evidence is presented that visible photons switch small (0.2 to 1.5 microns) "quantized" regions of water into the mirror world state; and their brightness distributions match the energy spectrum of the halogen light source (χ^2/DF = 1.49 and 0.94 respectively) indicating causality. This is detailed evidence for the Brittin and Gamow effect. Furthermore, these domains persist (for 20 and 27 days respectively), which is evidence for the second time dimension, and there is evidence they are surrounded by the membrane also predicted by CIGR. This is also evidence for the photo-mirror hypothesis, which links Quantum Mechanics and Chronometric Invariant General Relativity, and so is preliminary experimental evidence for unification.

1 Introduction

Following on from Landau's work in the 1930s, Zelmanov developed the mathematical apparatus (chronometric invariants) to correct for the reference frame of the Observer in the general case. This was not published until 1956 [1], and confirmed by Cataneo. Since then Borissova and Rabounski have developed the chronometric invariant formalism of General Relativity (which we refer to as CIGR) further, and shown it predicts a more complex structure for space-time: 5D (3,2) [2]. In a previous paper we have made the (photo mirror) hypothesis that visible light can reverse the direction of the arrow of time into that of mirror space-time (predicted by CIGR), by lowering the entropy level via the Brittin and Gamow effect [3]. This provides the theoretical framework for understanding experiments which show evidence, presented below, for phenomena which violate the second law of thermodynamics.

The following experimental work investigates the photo mirror hypothesis, and finds evidence for this joint quantum mechanical-relativistic effect. which enables the second law of thermodynamics to be reversed, and for the reduced entropy levels to persist. This is made possible by mirror space-time, where time is directed from the future to the past. Murray Gell-Mann has said "I should like to emphasize ... the need to go against certain received ideas. ... Often they have a negative character and they amount to prohibitions of thinking along certain lines... Now and then, however, the only way to make progress is to defy one of these prohibitions that are uncritically accepted without good reason" [4].

One of these prohibitions is the second law of thermodynamics [5, 6]. There are several definitions of the second law. Two early ones by Carnot and Clausius, refer to heat engines [7, 8], which are not the subject of this paper. Furthermore, perpetual motion and similar devices are excluded [9]. Instead we focus on the statistical mechanical approach due to Boltzmann in 1877.

Briefly, in Maxwell's kinetic theory of an ideal gas, heat is due to the motion of the molecules. Each molecule can be in a number of different energy states ϵ_i, but can only be in one state at a time, so many states are empty. In a system of many molecules N, of which g_i could be in the state ϵ_i, but only some of them, N_i, are occupied, where $g_i \gg N_i$ and $N = \Sigma_i N_i$. In this degenerate system, there are several different configurations which all possess the same total energy and correspond to approximately the same temperature ($N_i \propto e^{-\epsilon_i/k_B T}$). The number of ways N_i indistinguishable molecules can be distributed amongst g_i energy states is $g_i^{N_i}/N_i!$. The number of ways a particular macrostate can be achieved is $\Omega = (g_1^{N_1}/N_1!) \times (g_2^{N_2}/N_2!) \ldots$, which increases rapidly with the degeneracy. Boltzmann showed that the entropy $S = k_B \ln \Omega$ where k_B is the Boltzmann constant, and the thermodynamic probability Ω is at its maximum at equilibrium [10]. Therefore the entropy is maximum at equilibrium, and is interpreted as a measure of statistical disorder of the system.

Thus the second law was formulated in the 19th century, is considered absolute, and is widely thought to lead to the "heat death" of the Universe. This is in effect a classical physics "Theory of Everything". It is true that (superficially) there is considerable evidence that entropy (of baryonic matter) tends to increase with time. However, baryonic matter makes up only about 4% of the Universe. The other 96% consists of dark matter and dark energy; and we do not know what these are, *nor what laws they obey*. So it is illogical to assume that the second law applies to them — it may or it may not. Therefore it is perfectly rational to look for processes which create order out of chaos. If an effect is found, then the problem is to understand the results theoretically, so as to facilitate more probing experiments.

This is not a general paper on the violation of the second law of thermodynamics. Our starting point is a little-known theory due to Brittin and Gamow (see equation (1) below). This predicts that sunlight shining on the Earth, pumps entropy out into space, thereby allowing negentropy (i.e. order) to accumulate on the Earth's surface. This appears to be the beginning of the food chain proposed by Schrödinger [11,12].

This paper is divided into three sections. In this first section, we present an exploratory experiment which provides evidence that visible light reverses the second law of thermodynamics by producing ordered states in an inanimate closed system (i.e. pure water), *which persist*. This persistence should not occur. Before we could investigate this in more detail experimentally, we needed a theoretical explanation for this persistence to guide the experimental work. This explanation comes from the little-known (chronometric invariant) extension of General Relativity (CIGR) mentioned above, which predicts a more complex structure for space-time. In particular it predicts a second time dimension directed from the future to the past and fundamental new phenomena at low energies. Details of this new theoretical approach, are presented in a previous paper and the references cited there [3].

Section II presents results of experiments to test this theoretical explanation. Section III presents conclusions, discussion, and predictions. We start by presenting the small exploratory experiment to test the Brittin and Gamow effect, which we did before this theoretical framework was developed.

1.1 Brittin and Gamow's Theory

Photons from the Sun's surface ($T_s \simeq 5,900°$ K) come to the Earth ($T_e \simeq 300°$ K), where they interact. Brittin and Gamow use the quantum theory of radiation to show that the net entropy change on the Earth's surface is [13]:

$$\Delta S = \Delta S_s - \Delta S_e = \frac{4}{3}\,\Delta Q\left(\frac{1}{T_s} - \frac{1}{T_e}\right), \qquad (1)$$

which is negative because $T_s > T_e$. They reason that this is not contrary to the second law of thermodynamics because it is simply due to the temperature gradient $T_s > T_e > T_{space}$. (NB A similar temperature gradient applies to light from a halogen lamp: $T_h > T_e > T_{space}$ since $T_h \simeq 3,000°$ K.)

This quantum effect enables negative entropy to build up on the Earth's surface, *provided it can be stored* [14]. However, in the absence of a storage mechanism, any reduction in the entropy levels should dissipate as the (closed) system returns to equilibrium. Nevertheless, Brittin an Gamow calculate that photosynthesis has an efficiency of about 10% for capturing this negative entropy. So this is apparently not a purely physical theory because it relies upon plants (and hence biochemistry) to capture the negentropy. Does this mean that biochemistry alone enables plants to violate the second law? Or is there some underlying physical mechanism for storing the negative entropy, produced by visible light?

The focus of this paper is to test the above theory in inanimate systems, specifically in water, by looking for reductions of entropy levels which persist.

1.2 Theory of Exploratory Experiment

In order to investigate this, we have done the following simple experiment to test whether there is an *underlying physical storage mechanism.* 60% of the Earth's surface is covered by water, life is water-based, and plants are 70% water. So if there is a physical mechanism (i.e. not based on biochemistry) for storing this negative entropy, the most likely place to find it would be in water exposed to sunlight.

1.3 Entropy and Brownian Motion

We decided to expose a bowl of pure water to sunlight and later measure the Brownian motion of particles therein, to determine if there is any persistent entropy change. Brownian motion is a random walk which covers the whole of phase space. As is well known, the probability $\rho(x,t)$ of a suspended particle moving a distance x along the x-axis in time t is [15,16]

$$\rho(x,t) = \frac{e^{-x^2/4Dt}}{2\sqrt{\pi D t}}\,, \qquad (2)$$

where D is the diffusion constant. Diffusion takes place when a molecule moves to an unoccupied state, so that the more unoccupied states, the greater the diffusion. Entropy also increases when there are more unoccupied states, so that an increase in the diffusion constant implies an increase in entropy and vice versa. From the Fokker-Planck equation, the Boltzmann-Gibbs entropy $S = -k_{\mathrm{B}} \int_{-\infty}^{+\infty} \rho(x,t) \ln \rho(x,t)\, dx$ where $\rho(x,t)$ is given by equation (2) above. Hence $S = -k_{\mathrm{B}} (\ln(1/\sqrt{4\pi D t}) - 0.5)$ so that as the diffusion constant increases, so does the entropy. Conversely, if the entropy has been reduced then the probability $\rho(x,t)$ will become narrower.

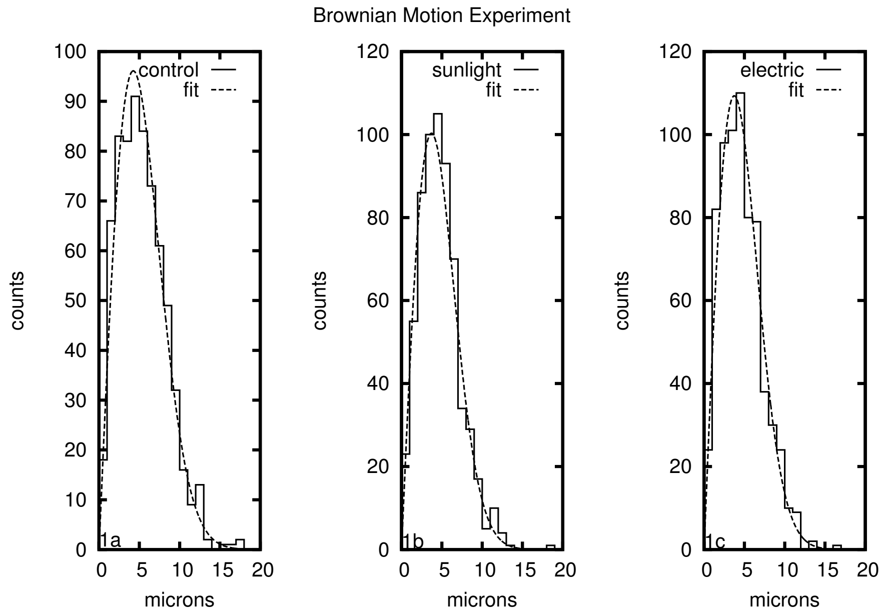

Fig. 1: Distribution of particle displacements every 10 seconds for a) non-irradiated distilled water = control; b) water measured 10 months after exposure to sunlight = signal 1; c) water measured 17 days after exposure to light from an halogen lamp = electric (i.e. signal 2). The dashed curves show the fits — see Table 1 for details. Both the sunlight and electric light samples are narrower than the non-irradiated control by 21% FWHM.

1.4 Details of Exploratory Experiment

Distilled water was exposed to sunlight for 8 days in August in the UK. Another sample was exposed to an halogen lamp ($T_h \simeq 3,000^\circ$ K) so as to receive a similar level of illumination. Both samples were bottled and stored in a box away from direct light, at room temperature which varied by a few °C at most. A third sample was taken directly from the amber Winchester supply bottle without any deliberate exposure to light and used as the control.

After storing the exposed samples, the Brownian motion measurements were made 10 months and 17 days later respectively, as follows. A few drops of the sample were placed on a microscope slide, 1 micron diamond particles were added, it was covered and viewed under a microscope (magnification ×1000), with a video attachment. The Brownian motion of the diamond particles was readily visible and recorded at room temperature.

1.5 Results of Exploratory Experiment

Diamond particles with a diameter of about 0.7 microns were selected for measurement. The distance $r = \sqrt{x^2 + y^2}$ moved in 10 seconds was measured. A number of particles were tracked for each sample, with a total of order 700 data points per sample. The distributions for the three samples are shown in Figure 1. There is little or no background and no long tails. Fits to the two-dimensional form of Einstein's theory are very good, as shown by the curves in the Figures, and the chi-squares per degree of freedom, shown in Table 1, are all close to 1. *So we have observed Brownian motion.*

The distributions of the solar and halogen (electric) samples, are *both narrower* than the non-irradiated control. The fits show that sunlight and halogen light have reduced the diffusion constant by about 23% and 22% respectively. (The difference $\delta = -0.01 \pm .029$ between these two signals is not statistically significant.) This translates into a reduction in the entropy by $4.7 \pm 0.7\%$ for water exposed to sunlight and $4.4 \pm 0.7\%$ for halogen light. These correspond to 6.5 and 6.2 standard deviations respectively, so this reduction in entropy is statistically significant. Therefore this is evidence for the Brittin and Gamow effect.

However, this reduction in entropy has *persisted*, despite the samples being closed systems in thermal equilibrium with their surroundings, for 10 months and 17 days respectively, which is far longer than the few hours to reach thermal equilibrium. *So there appears to be a physical mechanism for storing the negentropy.* What is this?

1.6 Discussion and Second Law

In the above experiments, most visible photons pass through the water because it is transparent. A few interact dynamically with water molecules, which can lower the entropy level locally by the Brittin and Gamow effect (see equation (3) below). Then according to the second law, as the water returns to thermal equilibrium, the entropy should return to the maximum. Pippard said that the second law is not violated under any circumstances [5]. Thus the fleeting kinematic effects of photons could not produce a persistant effect unless

Table 1: Exploratory experiment: Determination of Diffusion Constants and Entropy for water exposed to sunlight and halogen light.

Sample type or difference	χ^2/DF	Diffusion constant μm^2/sec	Entropy S $k_{\mathrm{B}} = 1$	ΔS (signal — control)	$\Delta S/\sigma$ (No. of std. devn.)
Signal 1 = solarized water	1.13	$0.691^{+.019}_{-.021}$	$2.732^{+.014}_{-.015}$	$-4.7 \pm 0.7\%$	6.5
Control = non-irradiated water	0.91	$0.903^{+.023}_{-.026}$	$2.866^{+.013}_{-.015}$	—	—
Signal 2 = halogen light water	1.15	$0.701^{+.020}_{-.022}$	$2.739^{+.014}_{-.016}$	$-4.4 \pm 0.7\%$	6.2
δ = (signal 1 — signal 2)		$\delta = -0.01 \pm .029$			

there is some agency which causes or facilitates this persistence. Without such a mechanism, this persistence violates the second law.

In both experiments above (sunlight and halogen), it is just photons in and photons out. Photons are massless and travel at the speed of light, and cannot combine chemically with water. Therefore we rule out the so-called "memory of water" — see Appendix A for details. The interaction of photons with water is purely dynamical. Assuming that the water molecules move at random, one would expect the reductions in entropy to dissipate as the water returns to equilibrium. But this does not happen in the above experiment. There are two possible types of explanation for this. Either this effect is a property of water (e.g. due to its structure), or it is due to some external agency. It is generally accepted that water has some peculiar properties, some of which may be explained by its structure. Theories of the structure of water are summarised in Appendix B, where it is shown that *they do not explain the phenomena observed.* Therefore these isothermal entropy reductions must persist because there is some external agency which causes them too.

For example, when a magnetic field is applied to a perfect spin gas, the spins become aligned and the entropy decreases. This can occur at constant temperature, in which case both the energy levels and their populations change to correspond to the same Boltzmann distribution for that temperature [17]. In general an isothermal entropy change requires *both* the energy levels and their populations to change. However the above results, whilst they show an isothermal entropy decrease, cannot be so explained because there is no external field to entrain the water molecules. The Earth's gravity and magnetic fields would not do this, nor did they affect the control. Furthermore we present evidence below and in Appendix B, that the structure of water did not cause this persistence. So we need to find an alternative explanation.

There are two additional possibilities: either this simple experiment *and the others below*, are wrong, or there is something we don't know about the second law. In order to avoid theoretical bias, we decided to accept the experimental results at their face value and investigate an alternative (theoretical) solution.

One way to understand the above experiment is in terms of the arrow of time. Eddington noted that entropy tends to increase with time [6]. What happens when photons lower the entropy level, as observed above? Does the Brittin and Gamow effect reverse the arrow of time? There are three possibilities:

1. It does not affect the flow of time, in opposition to Eddington's hypothesis. Therefore the reduction in entropy would dissipate as the system returned to thermal equilibrium, contrary to the observations.

2. The direction of time is reversed momentarily, probably locally where the photon interacts, but returns to normal after the entropy has been reduced. However, the entropy would then increase as the system returned to equilibrium, contrary to the observations.

3. The direction of time is reversed locally *and this persists*. One possibility is that when a photon interacts, it switches the direction of the flow of time into another space-time, where time flows from the future to the past, if such a space-time exists. In this way, this effect would not violate the second law nor the arrow of time. Furthermore, this second type of space-time could provide the external agency required for this phenomenon to persist.

There is a version of General Relativity which predicts another space *where time flows from the future to the past*. We have discussed this in more detail in the theory paper referred to above [3]. However we give a brief summary here.

1.7 Chronometric Invariant General Relativity

In the 1930s, Landau pointed out that General Relativity is not complete because it does not allow for the Observer's reference frame [18]. Zelmanov correctly introduced the Observer using chronometric invariants [19, 20]. Borissova and Rabounski have shown that Chronometric Invariant General Relativity (CIGR) requires the existence of a second sector (mirror world) with a second time dimension directed from the future to the past [2, 21, 22]. The mirror world is separated from normal space-time by a membrane with three layers, but shares the same space as normal space-time. We make the following deductions from this theory:

1. This second time dimension is a macroscopic one.
2. This second time dimension enables entropy levels to decrease with respect to our time, and therefore makes the second law of thermodynamics dual.
3. The membrane between the two worlds consists of 3 layers, 2 layers of photons (1 positive energy on the outside, the other negative on the inside) and a middle layer which is purely spacial with no time dimension, so photons cannot traverse is. It is thus opaque to photons and will reflect or scatter them.
4. We make the hypothesis that light, under certain circumstances, can switch space-time into the mirror world state, by means of the Brittin and Gamow effect, in which *light reduces the entropy level and so reverses the direction of time*. We call this the photo-mirror hypothesis [3].

The persistent decrease in the entropy of water exposed to sunlight and of that exposed to halogen light observed above, are preliminary evidence for the photo-mirror hypothesis.

1.8 Conclusions for Section I: Brownian Motion Experiment

1. Brownian motion has been observed in the above experiments.
2. Sunlight and halogen light both reduced the entropy levels in water by approximately the same amount within the errors. This reduction persisted (for at least 10 months and 17 days respectively), so there appears to be a physical mechanism for storing negentropy in water.
3. Theories of the structure of water do not explain this persistence. Therefore it must be due to some external agency.
4. We deduce that the external agency is probably a second space-time. For example, Chronometric Invariant General Relativity has a second macroscopic time dimension, which is directed from the future to the past.
5. We make the hypothesis that visible light can switch, via the Brittin and Gamow effect (when it lowers the entropy level), the direction of time into mirror space-time. We call this the photo-mirror hypothesis. The rest of this paper is directed to finding more specific evidence for this.

2 Light and Water

Light shining on pure water is a physical system. We decided to look for additional evidence for the Brittin and Gamow effect, for this hypothetical second time dimension and for the photo mirror hypothesis. To do this we exposed HPLC grade water to a 400 watt halogen lamp (1100 lux at surface of the water) and took regular samples for up to 6 days.

2.1 Viscometer Experiment

The statistical error in the exploratory experiment above goes as $1/\sqrt{M}$, where M is the number of observations, which makes it labour intensive to increase the precision. So for $M = 700$ the error is about 4%. There is another equation due to Einstein: $D = RT/6\pi N\eta a$ where R is the gas constant, η is the viscosity, a is the radius of the particle, and N is Avogadro's number; which shows that the diffusion constant D is inversely proportional to the viscosity. The advantage is that viscosity can normally be measured with a precision of about 0.1% using a capillary viscometer (in a constant temperature bath), with a stop watch.

The viscometer used gave precise results for the *untreated* (i.e. not deliberately exposed to light) HPLC grade samples, which agreed with the known viscosity of water at 20° C with a precision of about 0.1% or better, as expected. However, results for all the halogen light *treated* samples tended to be less consistent, even if they had been exposed to halogen light for only a few hours. Repeated measurements of the same halogen light treated sample had a much wider spread, up to five times that for the control (i.e. untreated), despite attention to detail, such as cleansing between samples. (More details of the viscometer technique, are given in the following reference [23].) Despite these larger errors, all the viscosity measurements of treated water were significantly greater than that of untreated pure water, *implying that light lowers the diffusion constant and hence the entropy*, as originally observed. However, there was evidence that irradiated samples had two components, with different viscosities.

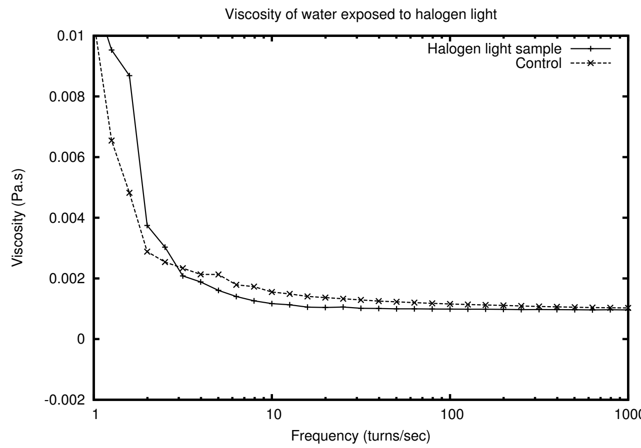

Fig. 2: This rheometer data shows the halogen sample has two components: at low turns per second the viscosity is above the control, and at higher tps it is below the control.

2.2 Rheometer Experiment

To investigate this possibility of two components, a sample was exposed to halogen light for 48 hours. Three days later, it was measured using a cone-and-plate rotation rheometer [24]. Distilled water was used as the control. The results are given in Figure 2. Note, the increase in the viscosity of distilled water below 10 turns per second (tps) is an instrumental effect. Nevertheless, the data shows that the water which has been exposed to halogen light, has two components, one with vis-

Fig. 3: The control sample of distilled water, examined using a novel microscope technique. It looks mainly black because there are no "structures" or domains to reflect the light, apart from a bit of noise (e.g. from ambient lighting).

cosity greater than that of the control at low tps, the other with viscosity less than that of the control at higher tps. So the water exposed to halogen light has two components. What are these?

2.3 Theory of light and water

Whilst Brittin and Gamow's theory (equation 1) is derived from the quantum theory of radiation, it is presented there in terms of the macroscopic energy flow from the Sun to the Earth, and then from the Earth to space. In this experiment, light from a halogen lamp shining onto a bowl of water, consists of individual photons. Water is transparent and so most photons pass straight through, and only occasionally does a photon interact with the water, so that ΔQ is replaced by the energy of that photon $h\nu$:

$$\delta S = \frac{4h\nu}{3}\left(\frac{1}{T_{s/h}} - \frac{1}{T_e}\right). \tag{3}$$

This energy is radiated away by lower energy photons, and there is a small reduction in entropy δS locally in the water. Then by the photo-mirror hypothesis, a small region around this interaction would be switched into the mirror world state. According to CIGR, this will automatically be surrounded by the triple-layer membrane, since the two worlds are separated by this membrane. This enclosed mirror-world region could then persist in the water, because the momenta of molecules in the mirror state are still positive, and so will balance across the membrane. We will refer to these small mirror-world states as "domains", or in the case of images or software detection thereof, as "structures" or "sources".

2.4 Microscope Experiment

In order to make visible these otherwise hidden domains in water, we have used a novel microscope technique developed by Schweitzer [25]. This technique involves first examining the sample with normal illumination to see if it contains any bacteria, dust particles or other impurities. If the sample is clear (as expected for distilled water), then a drop of the water is allowed to evaporate whilst illuminated from the side, approximately orthogonal to the direction of view. When it is about 0.1 mm thick, hidden structures or domains, if present, become visible, provided that the side illumination and other conditions are correct (see Appendix C for details of this technique).

Quite why domains in bulk water are invisible, yet become visible when the thickness is less than about 0.1 mm, is not clear. Perhaps when the water becomes thin enough, the domain membranes become distorted and start to scatter the side illumination. The theory needs to be worked out in more detail. We just report the experimental facts.

Figure 3 shows the results using this technique, for the

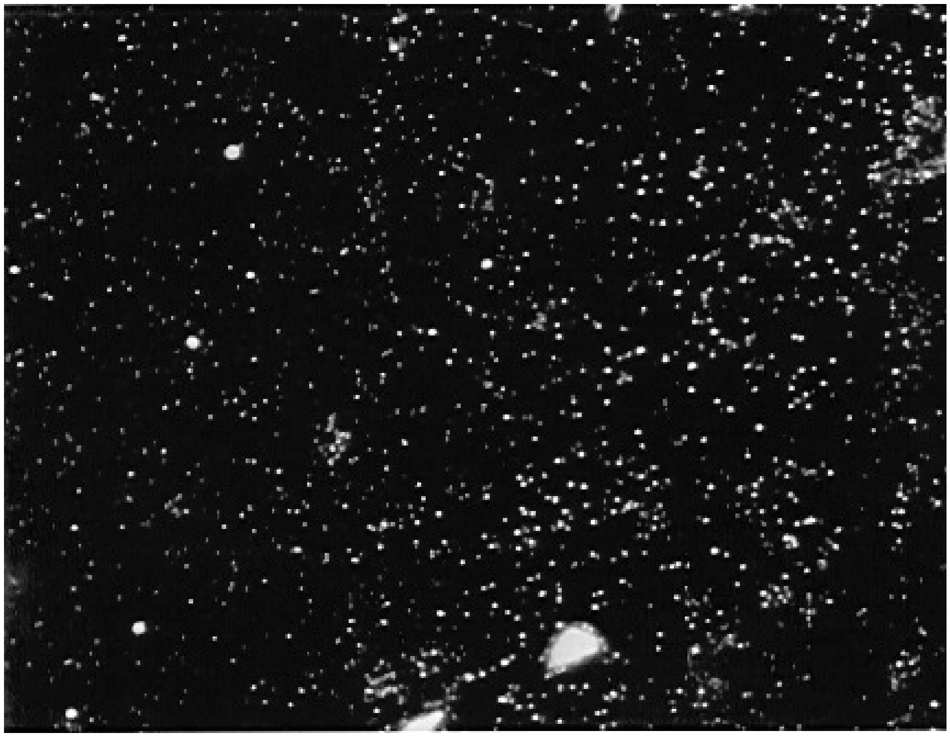

Fig. 4: Hidden domains in water exposed to halogen light for 37.5 hours, revealed by a novel microscope technique using side illumination. These domains are 0.2 to 1.5 microns in size, with a few exceptions.

control sample of distilled water (i.e. not HPLC grade) which has not been deliberately exposed to sunlight nor halogen light (although it may have been exposed to some ambient lighting during the experiment). The process of distillation randomises the water and so breaks up any "structures" or domains, so that this control sample looks mainly black because there are few "structures" or domains to scatter or reflect the light, apart from a bit of "noise".

Figure 4 shows the first sample, which had been exposed to a 500 Watt halogen lamp for 37.5 hours. Figure 5 shows the second sample which had been exposed to halogen light for 79.5 hours. These are the black and white versions of the original colour CCD images, which are also mainly black and white. There are no signs in the originals, of a range of colours, which could come from diffraction. We conclude that these domains are reflecting or scattering light (from the side illumination) into the microscope. The first image (figure 4) was recorded 20 days after exposure to halogen light, and the second (figure 5) 27 days after exposure. So the effect persists.

2.5 Analysis of Results of Microscope Experiment

In both images there are hundreds of white "sources" which are 0.2 to 1.5 microns across (apart from a few which have started to merge together), *independent of exposure time*. The existence of these 0.2 to 1.5 micron zones in the water suggest that halogen photons have interacted with the water according to equation (3). If these sources are so produced, then there should be some correlation between their size distribution and the energy spectrum of the photons which produced them. We investigate this and their persistence in more detail below.

These domains look like stars in the night sky, even though they are being observed with a microscope instead of a telescope. The appearance is so similar that we decided to use astronomy software to do pattern recognition on these images [26]. The software was run with the default parameters and found 1288 "sources" in the shorter exposure (figure 4) and 935 in the longer one (figure 5), which is a bit less because of the black regions in that image. The program calculates the isophotal flux which is defined as the sum of the pixel counts above backround of all the pixels in a particular "source" ($\sum_{i\in S} p_i$).

The histograms of the isophotal flux, or brightness, for the sources detected in the two images are shown in Figures 6 and 7 respectively, by solid lines. The selection criteria in the software for distinct sources affected the first two bins, so they are excluded. We have also plotted the spectrum of light from the halogen lamp, which has been converted from wavelengths to electron volts [27]. The halogen spectrum (broken line) falls away from the main peak quite quickly down to the secondary peak, and then decreases more slowly after that, matching the two measured brightness distributions well. This suggests the halogen photons have caused these sources. Furthermore, the brightness is independent of the exposure time, being depen-

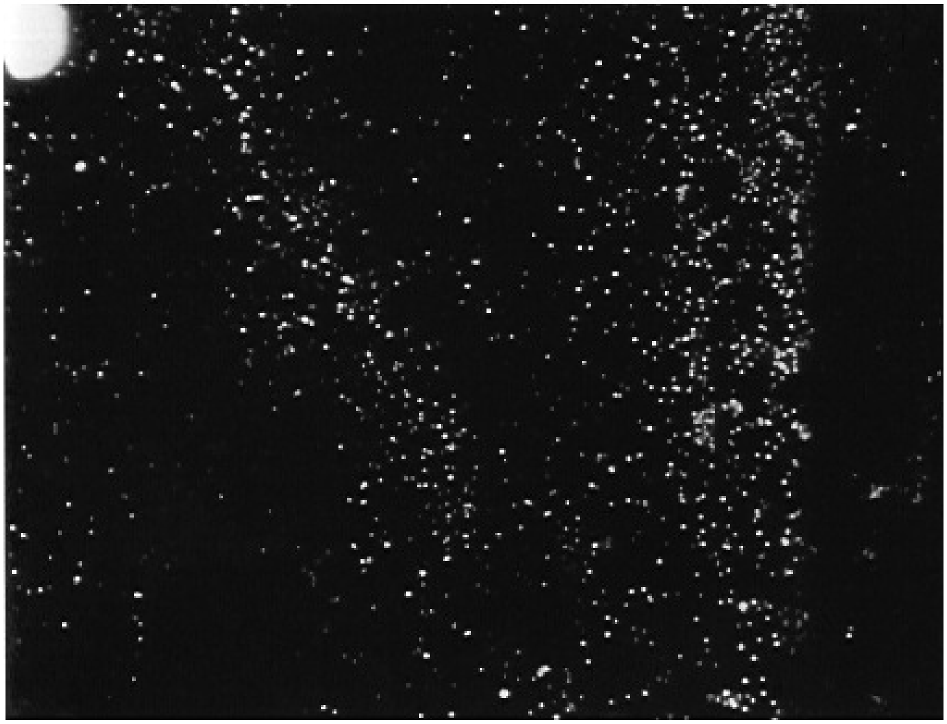

Fig. 5: Hidden domains in water exposed to halogen light for 79.5 hours, revealed by a novel microscope technique using side illumination. These are 0.2 to 1.5 microns in size.

dent on the photon energy, as predicted by equation 3.

We then fitted this spectrum to the data using just three parameters for the least squares fit: an x-axis offset because the photon energy corresponding to zero brightness is about 1.55 eV; an x-axis scaling parameter to convert from electron volts to brightness (counts); and a vertical scaling factor to convert from relative intensity to counts. The chi-squares per degree of freedom are 1.49 and 0.94 in Figures 6 and 7 respectively. So the two brightness distributions have the same shape as the halogen light spectrum, independent of the exposure time, as predicted by equation 3. This confirms that halogen photons have caused these domains via the Brittin and Gamow effect.

The problem with Figure 4 and 5 is that they are pictures. So although we see sources, we do not know if these are produced by the incident halogen photons, or by dust particles, or possibly even bacteria. The advantage of the astronomy software is that enables us to quantify the data and plot the brightness distributions and compare them with the halogen energy spectrum. We see in Figures 6 and 7 that they have almost the same shape, which is confirmed by the fits. Therefore these domains have been produced by halogen photons by the mechanism given in equation 3.

Furthermore, these mirror world domains are correlated with photons whose energies are quantised. Therefore we observe the "quantisation" of regions of water probably in mirror-space-time.

We then combined the two spectra. This is shown in Figure 8 and the chi-square per degree of freedom is 1.67. This is good evidence that the domains are being produced by the photons from the halogen lamp. Nothing material has changed — it is just photons in and photons out. But the state of the water has changed proportionately to the energy of the incident photon, and *the effect persists*.

2.6 Scattering from Surface or Volume of Domains

Do these domains reflect or scatter the side illumination from their surface or from their volume? According to equation 3 the decrease in entropy is proportional to the energy of the interacting photon. If the randomness of water is homogeneous, as one expects from the normal second law of thermodynamics, then the volume of the region generated with this reduced entropy δS will be proportional to the energy of the incident photon. Therefore if scattering is from the volume, then the brightness of these domains will be similar to that of the spectrum from the halogen lamp, as observed above.

However, it is probable that scattering comes from the surface for two reasons. Firstly because bulk water is transparent to the side illumination and appears black (e.g. Figure 3). If it scatters side illumination, then the water has changed in some way, for which there is no explanation, except perhaps CIGR. Secondly CIGR predicts there is a triple layer membrane around these domains which is impenetrable to photons, and therefore the scattering comes from the surface.

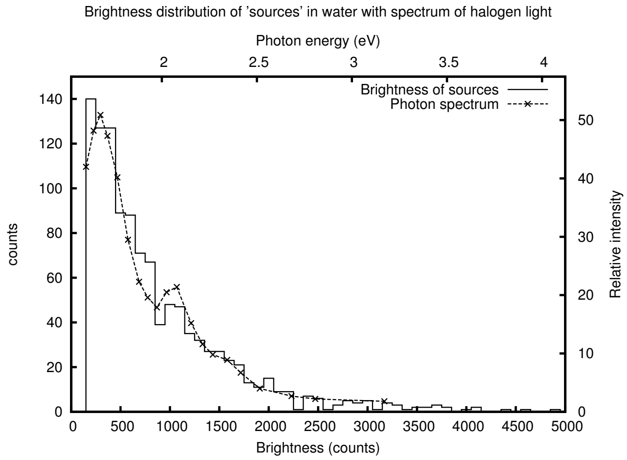

Fig. 6: Brightness distribution after exposure to halogen light for 37.5 hours, plus the spectrum of halogen light in eV. χ^2/DF of fit is 1.49.

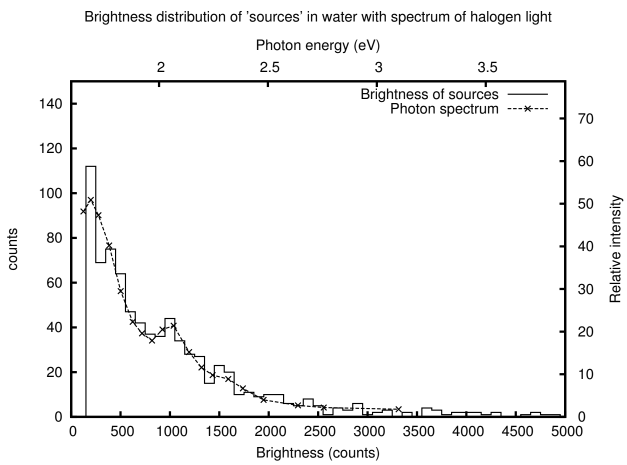

Fig. 7: Brightness distribution after 79.5 hours exposure to halogen light, with halogen spectrum. χ^2/DF of fit is 0.94.

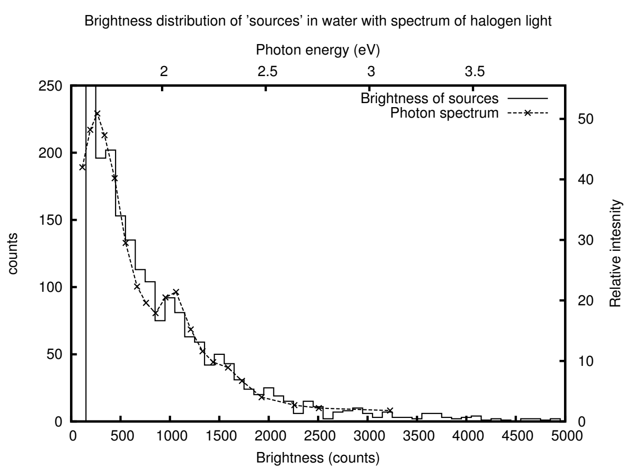

Fig. 8: Combined brightness distributions with halogen spectrum. χ^2 of fit is 1.67.

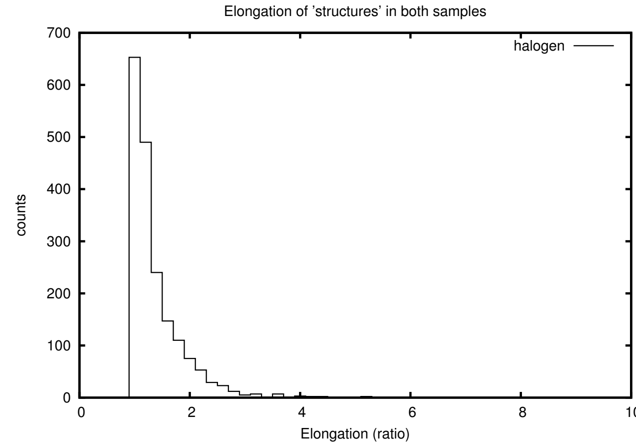

Fig. 9: Histogram of elongation (= major axis/minor axis) for both images.

We investigate the scattering as follows. In the absence of a complete unified theory of CIGR and Quantum Mechanics in water, we reason that these persistant domains probably have a stable shape, such as a spherical one or spheroidal one which is not too elongated. The source extraction software fits an ellipse to each "source" and calculates the major and minor axes, and their ratio, the "elongation", which is $\geqslant 1$. The distributions of the elongations for the two images, are very similar, so we have plotted them together in Figure 9. This is quite a narrow distribution: 74% have elongation less than 1.4. So most domains are only slightly elongated, as we expect for stable structures.

We now investigate the brightness distribution for different ranges of elongation El. Figure 10(a) shows the brightness distribution for elongation El < 1.2; 10(b) for the elongation in the range 1.2–1.4; and 10(c) for elongation El $\geqslant$ 1.4. We see that the more elongated domains tend to have higher brightness. We have shown above that brighter domains tend to be correlated with more energetic photons. Higher energy photons have higher momenta and will interact over longer distances in the water, and so reduce the entropy level in more elongated regions, as observed. This is evidence for this kinematic effect,

In Figure 10(a) (elongation < 1.2) only 5% of the total, have brightness greater than 1300 counts, whereas in 10(b) 20% have brightness greater than 1300, and in 10(c) 41% have brightness greater than 1300. So brighter domains are there in the data, but hardly any are detected in 10(a) with elongation < 1.2. Elongated domains must be in this sample, but with their longer axes pointing towards or away from the microscope, so that they do not appear elongated. If these hidden elongated domains were scattering and reflecting side illumination from their volume, then they would show up as brighter domains in 10(a). But they are not there in significant numbers, and so we conclude that they are scattering and/or reflecting the external light source from their surface, as predicted by CIGR.

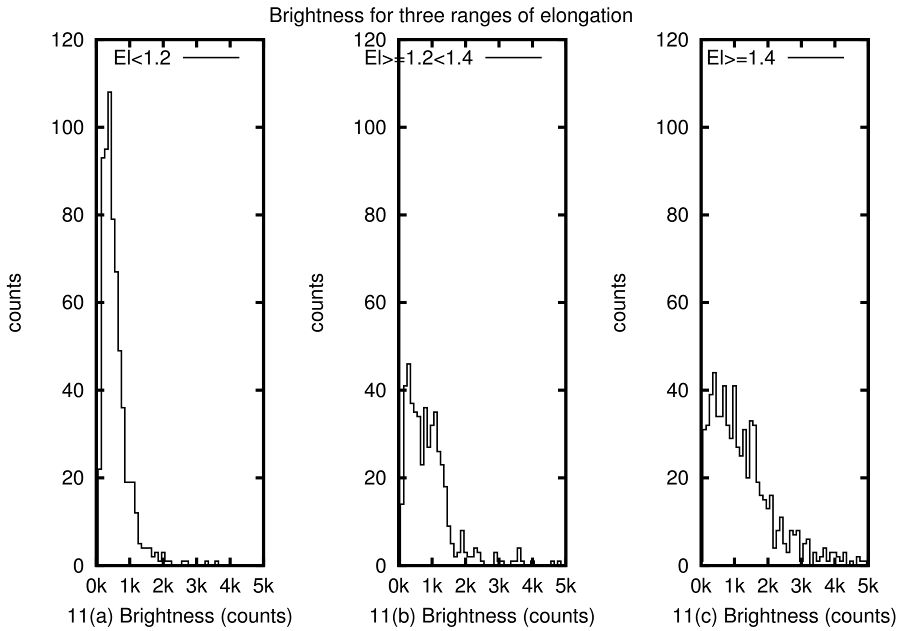

Fig. 10: Brightness distributions for elongation ratio: (a) less than 1.2; (b) in range 1.2-1.4; (c) greater than 1.4. Note the brighter domains are more elongated.

3 Conclusions

In the Brownian motion experiment, we observed reduced entropy levels which persisted, which could not be explained by the structure of water. More details are given in section 1.8: Conclusions for section 1.

We draw the following conclusions from the rheometer and microscope experiments:

1. Light shining on water increases the viscosity and this persists, which confirms the persistant reduction in entropy level previously observed in the exploratory Brownian motion experiment. However the spread in errors is much greater than that for water which has not been significantly exposed to visible light.

2. Measurements with a rheometer provide evidence that light from a halogen lamp produces two components in the water.

3. Water is transparent, so only a small fraction of the photons interact with it. Therefore, it is the small reductions in entropy produced (locally) by the interaction of individual photons (equation 3), which have to be detected,

4. Using a special microscope technique developed by Schweitzer, we have observed hidden domains in water previously exposed to halogen light (0.2 to 1.5 microns in size), which reflect or scatter side illumination, and which persist in time. These domains could be the second component observed in the rheometer experiment above.

5. The brightness distributions of these domains *match the energy spectrum of the halogen lamp well, suggesting that photons have caused these domains.* The brightness distributions are independent of the exposure times (c.f. Figures 6 and 7), as predicted by equation 3. We have previously shown that visible light lowers the entropy level of water. Furthermore, equation 3 predicts that these domains are low entropy regions created by individual photons interacting with the water, and the data confirms this. There are two samples, so this evidence for the Brittin and Gamow effect is reproducible.

6. These reduced entropy states persist for 20 and 27 days respectively, contrary to the normal second law of thermodynamics. The question is, what causes this persistence? Is it the structure of water, or some external agency such as mirror space-time? The most advanced theory of the structure of water at this time is coherent quantum electrodynamics (CQED), which predicts domains of about 100 nm determined by the internal energy levels of water. The domains observed in Figures 4 and 5 are $\times 2$ to $\times 15$ larger, and their brightness distributions shown in Figures 6 and 7, are determined by *the energies of the incident photons*, not the energy levels of water. Therefore they are a different phenomenon from that predicted by CQED. (The significance of this for CQED is discussed in Appendix B.) We therefore need a different theoretical explanation.

7. We conclude that this persistence is caused by some external agency. This could be the second time dimension in the mirror world of CIGR. If this is the case, then the domains will be surrounded by the triple layer membrane which we have predicted will scatter light.

8. We present evidence above that these domains scatter light from their surface (not their volume), which is evidence for the triple-layer membrane around them, predicted

by CIGR. These results are preliminary evidence for the second time dimension of mirror space-time, and the membrane predicted by CIGR.

9. Mirror space-time provides a physical mechanism for storing the negative entropy produced by the Brittin and Gamow effect, hence their persistence. Furthermore, these domains have an "inside" and an "outside" because they are surrounded by the membrane.

10. There is one problem with the above result. We have concluded that there is a second time dimension directed from the future to the past, without any direct evidence. For example, we have not sent a signal from the future to the past. However we have also concluded that the above phenomenon has an "inside" and an "outside", because of the membrane. Currently our instruments are located on the "outside" and therefore cannot make direct measurements on the "inside", where the second time dimension is predicted to exist. In the previous paper [3], we have shown that when phenomena occur outside normal 4-D space-time, then they may not be determined completely objectively by experiment. Nevertheless, *if they are reproducible, as above, then they should be considered physically real*. In addition to this, we present experimental evidence for a signal from the future to the past in a separate paper [28].

11. We have thus found evidence for a physical mechanism which reverses the second law of thermodynamics *and creates persistent ordered states*. Note that this occurs outside normal 4-D space-time, so that the second law continues to apply in 4-D space-time.

12. Together these results are evidence for the photo-mirror hypothesis. This effect depends upon Quantum Mechanics and CIGR and so is preliminary evidence for unification (see Appendix D).

3.1 Discussion

In the previous paper [3], we have used the photo-mirror hypothesis to explain the evidence for magnetic monopoles, which are observed only under intense illumination. The independent evidence above for the photo-mirror effect justifies this usage. There are however, two differences. The above results are due to single photons, whereas magnetic monopoles require intense illumination to reveal them. Furthermore, the above domains in water persist, whereas the monopoles disappear rapidly when the illumination is switched off. Both these could be due to the very strong interaction between monopoles. The theory needs to be worked out in more detail.

The chronometric invariant formalism of General Relativity, makes predictions about physically observable quantities which have been confirmed. However, General Relativity does not predict physically observable quantities. For example, it does not predict (as far as the author knows) Galileo's Principle (that objects with different masses have the same fall times) nor Newton's Law of Universal Gravitation. As a result there appear to be two theories of gravitation. Recently, however, the chronometric invariant formalism has been used to predict both Galileo's Principle and Newtom's Law [29]. So it is the more complete theory.

Furthermore, the evidence presented above for the second time dimension, is evidence for a 5th dimension, so space-time is 5-D (3,2). It is well-known that General Relativity is formulated in 4-D space-time. Therefore it seems to the author (an experimentalist) that the chronometric invariant formalism of General Relativity is actually a new theory, and so deserves its own name. The key point is that putting the Observer into General Relativity has changed the theory so much that the structure of space-time has changed. However this is not for the author to decide, and so for this current series of papers we will continue to refer to chronometric invairant General Relativity (CIGR). But a better name is desirable.

3.2 Predictions

In view of the above evidence for a unified phenomenon (the photo-mirror effect), we make the prediction that Quantum Mechanics can be unified with Chronometric Invariant General Relativity (CIGR), and the standard model embedded within it. The hidden sector of this hypothetical new unified theory would probably be based upon mirror space-time.

We have shown above that water detects individual photons interacting with it precisely, and that this can be explained by mirror space time. In effect the above techniques open a window into another world. We make the prediction that water is sensitive to other unusual phenomena occurring in mirror space-time. For example, it is possible that water can be used to detect some other new type of radiation which lowers entropy levels, if it exists [23].

Without mechanism(s) for the creation and storage of order, there can be no complexity [14]. So the above evidence for a mechanism for the creation of order, and a mechanism for its storage, is possibly the beginning of a theory of complexity, based on fundamental physics. The theory needs to be worked out in more detail.

The incorporation of the Observer into General Relativity (i.e. CIGR) requires a second time dimension, which automatically includes thermodynamics and complexity. Since these have been left out of many unified theories in the past, the unification of Quantum Mechanics with CIGR may well be the way to successful unification. The evidence for magnetic monopoles in mirror space-time [3], and for a new type of radiation in sunlight [23], support this conclusion.

4 Limitations

CIGR has not yet been properly unified with Quantum Mechanics yet, and so this may change some of its predictions, and clarify some of the details above.

Acknowledgements

We thank David Schweitzer for developing this microscope technique, for making measurements of samples we supplied, and providing the photo micrographs of same commercially. We also thank E. Bertin for making the astronomical source extraction software available via open source. We thank Brian Josephson for suggesting we do research into the physics of water as a detector. No Data is associated with this manuscript.

Appendix A: The "Memory of Water"

For completeness we mention the following. Some readers may think that the persistent effects observed above are due to the phenomenon known as the "memory of water". This may occur when a chemical substance is dissolved in water and then is serially diluted. However, there is no accepted explanation for this latter phenomenon, and so it is disputed. In the above experiments, photons are massless, and cannot be "dissolved" in water. Their interaction is purely dynamical. Nor was anything diluted — it is not even clear how one can dilute pure water. Therefore the above experiment of light shining on water, is investigating a completely different phenomenon from the "memory of water".

That being said, it is possible that mirror space-time may play a role in explaining the "memory of water". It is just that the structure of matter (e.g. the solute) is more complex than that of a photon, and its interaction with water also more complex. Therefore the phenomena of photons interacting with water reported in this paper, are different from the "memory of water".

Appendix B: Theories of Structure of Water

In the various experiments above, it is just photons in and photons out. So how can the decrease in entropy persist, if the water molecules move at random? This raises questions about the structure of water, so we consider theories of this. In 1891 Roentgen suggested that as ice melts, many of the less dense (ice floats) tetrahedral "ice molecules" persist intact in the liquid water as it warms. In this way, he tried to explain one of its more peculiar properties, namely that the density of water increases as its temperature is raised from 0° to a maximum at 4° C [30]. This approach was rejected by Bernal and Fowler for quantum mechanical reasons [31].

Another peculiarity of water is that in addition to the normal chemical bonds, water molecules also interact by the hydrogen bond, which is weaker and directional. Preparata states this is phenomenological in origin [32]. In 1950 Pople presented a quantum mechanical theory of the structure of water [33]. In 1951, Lennard-Jones and Pople showed that there may be a network of hydrogen bonds linking all the molecules together into one large molecule $(H_2O)_n$ [34]. The problem is that the water molecules move around and the hydrogen bonds, which are highly directional, make or break after a few picoseconds [35]. As the bonds make or break fluctuating EM fields are produced, and there is also the Earth's magnetic field, both of which Quantum Mechanics ignores, but quantum electrodynamics (QED) does not.

Preparata and del Giudice have solved the equations of QED for bulk matter and applied it to liquids, solids and water in particular [36]. This theory *replaces* the static picture of chemical bonds linking individual molecules together ("electrostatic meccano" or "erector set"), *with a dynamical interaction between groups of molecules spread over larger distances.* This theory, often referred to a coherent QED or CQED, is a new theory of condensed matter. Their approach is to consider water not to be "molten ice" but "condensed vapour" [37]. When this theory is applied to water, they find that the water molecules form two groups: coherent domains in which the molecules oscillate between the ground state and an excited state, and interstitial water which is random and surrounds these domains.

They predict that the excited state is at 12.07 eV (in the UV region), which produces domains of about 100 nm in extent, and that the radiation is trapped in these domains [38]. Enz agrees that the coherent domains probably exist, but questions whether their boundaries are precisely defined, so the radiation may not be completely trapped [39]. Whilst this theory explains a number of indirect experimental results, there has not been any direct experimental confirmation of these domains in water, nor has any UV radiation been detected leaking out. Therefore this theory has not been proven strictly to be correct.

Furthermore, the results of the experiments above, do not provide any direct evidence to support this theory. For example, Figure 3 does not show any sign of the predicted 100 nm domains in the control sample of distilled water (condensed from vapour). But the microscope experiment was not designed to detect these and so the resolution may not have been good enough. Instead, the domains observed in Figures 4 and 5 are ×2 to ×15 times larger. Furthermore *their size distribution is determined by the energies of the incident photons, not by the internal energy levels of water.* So the phenomena observed are completely different from those predicted by CQED. But this does not necessarily rule out CQED.

CQED predicts coherent domains surrounded by interstitial water which is random. If an incident photon, with an energy of 1 to 3 eV, interacts with a coherent domain of $\approx 10^7$ water molecules oscillating between the ground state and 12.07 eV, then it might be scattered away with little effect on the entropy of that 100 nm domain. However, if it interacts with the interstitial water, then it could lower the entropy level by the Brittin and Gamow effect. *But that reduction would not persist because the interstitial water is random. So even if this is the correct theory of water, then mirror space-time of CIGR is required to explain the observed results.*

Whilst these results do not prove CQED wrong, it does not provide any support for it. Furthermore CQED is clearly incomplete because it does not include the mirror space-time of CIGR. In fact it is likely that the correct theory of water will be based upon Quantum Mechanics unified with CIGR.

Appendix C: Details of Microscope Technique

The microscope technique used to take the black and white images shown above, was developed by David Schweitzer. The technique requires a good quality high-powered microscope (e.g. a Nikon optifot), with a phase contrast lens and dark filter, a light source, fluorescence adaptor, video camera with CCD image sensor, computer with video card, software and printer. The technique involves first examining the sample with normal illumination to see if it contains any bacteria, dust particles or other impurities. If the sample is clear, as expected for distilled water, then a drop of the water is placed onto a microscope slide and allowed to evaporate at ambient temperature. (If the rate of evaporation is too slow, a gentle source of heat may be applied.) Whilst it is evaporating, it is illuminated horizontally from the side (we call this "side illumination"), the temperature of the light source is adjusted (a reddish white light was used), and it is observed vertically from above. (NB This is not the same as dark-field microscopy.) Schweitzer has found that if there are hidden "structures" present in the water, then these reflect light and become visible when the thickness of the water film has decreased to about 0.1 mm (possibly because of distortion), and the illumination, magnification and other settings are correct. The images shown above, were taken with the solarizing filter phase contrast 4, the Table tilted by 1.95° and microscope magnification of $\times 1000$.

The random walk (Brownian motion) experiment at the beginning of this paper and the black and white images were all obtained using distilled water and exposure was to a 500 watt halogen lamp at 80 cms, which gave 1100 lux at the surface of the water. The viscosity measurements were made with HPLC grade water and a 400 watt halogen lamp (equivalent to 500 watts) also at 80 cms. The software used for the pattern recognition and source extraction was SExtractor version 2.25.0 by E. Bertin.

Appendix D: Unification

"Unification" is a project in physics which dates back to Einstein, who was convinced there is one set of equations which describe the whole Universe. So he spent the last 30 years of his life trying to unify the two main theories of physics, Quantum Mechanics and General Relativity, in order to develop the final theory. However the process of unification dates from before Einstein. For example before Newton's theory of gravity, it was thought that the laws of motion of a projectile through the air above the Earth's surface, were different from those of planets in the heavens. Newton's theory provided a unified explanation of terrestrial and celestial gravitation. (Note that the derivation of Newton's theory from CIGR, mentioned above, links CIGR to this first step towards unification.) Then before Maxwell, electricity and magnetism were thought to be completely different phenomena. Maxwell's equations unified the two into electromagnetism. After Einstein in the 1960s, electromagnetism was unified with the weak nuclear interaction (which causes beta-decay) in the electro-weak interaction, which led to the discovery of the W- and Z-bosons.

However, the unification of General Relativity and Quantum Mechanics has stalled, despite herculean efforts (e.g. quantum gravity; string theory; loop quantum gravity, and so on) [40]. In a sense the problem is simple. Quantum mechanics is a "digital" theory of ultra-small phenomena, whilst General Relativity is an analogue theory of large scale phenomena. About the only place where the two might come together is at the event horizon of a black hole, which cannot be easily studied in the laboratory. However, putting the Observer into General Relativity introduces low energy, small scale phenomena, such as thermodynamics, where CIGR and Quantum Mechanics can come together. The above evidence for the photo-mirror effect is highly significant, because it depends upon Quantum Mechanics and CIGR, and so is experimental evidence for unification.

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