I: Evidence for Phenomena, Including Magnetic Monopoles, Beyond 4-D Space-Time, and Theory Thereof

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This phenomenology paper presents a framework to understand two little-known properties of light. Firstly Brittin and Gamow have shown that sunlight shining on the Earth's surface lowers the entropy level there because $T_s > T_e > T_{space}$. We have found evidence for this, presented separately, which shows it persists contrary to the second law. Secondly when ferromagnetic particles are strongly illuminated, they move as magnetic monopoles. Mikhailov made repeated measurements and determined that the monopole charge is quantized ($g = ng_D$, $n = 1$–5; $\bar{g} = (0.99 \pm 0.05)g_D$) as predicted by Dirac. But they cease to move as monopoles when the illumination is turned off, and so have been ignored. However, the results are reproducible and we deduce these Dirac monopoles are in another space-time. The chronometric invariant formalism of General Relativity (CIGR) predicts a more complex structure to space-time of 5D, with a second time dimension, mirror time, directed from the future to the past (3,2). We make the hypothesis that light, by lowering the entropy level via the Brittin and Gamow effect, can switch the arrow of time into that of the mirror world of CIGR to reveal phenomena there. We call this the "photo-mirror hypothesis". This reveals magnetic monopoles outside 4D but in mirror space-time, where they are less objective, but reproducible and so real. This explains why monopoles can be observed at low energies (because mirror mass is negative), and the infinite length of the Dirac string.

1 Introduction

Brittin and Gamow have used the quantum theory of radiation to derive an equation which predicts that sunlight shining on the Earth's surface, lowers the entropy level there, apparently contrary to the second law of thermodynamics — see equation (1) below [1]. As we investigated this further, we confirmed the violation of the second law. To explain this, we have found new physics which may help penetrate a number of other unsolved problems in quantum and particle physics, such as magnetic monopoles. However, there are several barriers blocking progress. We start with the theoretical barriers.

1. Murray Gell-Mann said at the Conference in Honour of his 80th birthday "I should like to emphasize particularly… the need to go against certain received ideas. Sometimes they are taken for granted all over the world… 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" [2]. Such prohibitions often concern problems from the past. So it follows, contrary to the current view that references should be up-to-date, that some of the references below, are old ones. For example, another peculiar effect of light is the detection of magnetic monopoles only when strongly illuminated, in 1930 [3].

2. Secondly, theory is sometimes biased against experiment. True, it is accepted that experiment is the final arbiter of reality. However, important discoveries often get ignored, if the correct theoretical interpretation is not given. For example, parity violation was first observed in 1928, but was rejected as an "instrumental effect" [4]. In 1956 Lee and Yang suggested it could be violated theoretically, and Mme Wu "discovered" it shortly after that. Another example is that Irène Curie and Frédéric Joliot failed to discover the neutron because they did not believe Rutherford's neutron hypothesis. Chadwick realised that their January 18th 1932 results were not due to photons but evidence for neutrons, and so made the discovery a few months later. (The Joliot-Curies also failed to discover the positron, even though they had data for it before Anderson.) A fourth example is that the cosmic microwave background radiation from the Big Bang was first observed by A. McKellar in 1941, but misinterpreted [5]. The CMB was rediscovered at the Pulkovo Observatory by Soviet scientist T. A. Shmaonov in 1957 and published in his thesis, where he determined the temperature to be 4±3°K, but it was ignored [6]. Finally in 1964, Penzias and Wilson detected it a third time, and showed the results to Dicke at Princeton, who realised that this was the afterglow of the Big Bang. Finally the discovery was made.

Another example is the case of Felix Ehrenhaft who had the misfortune to make two such discoveries, firstly of fractional electric charges in 1910 onwards, and then magnetic monopoles in 1930, and get rejected for theoretical reasons twice! We go into magnetic monopoles in more detail below.

There is clearly a pattern here of unexpected experimental results being rejected, sometimes for decades, even indefinitely (e.g. Ehrenhaft). One possible explanation was given by Einstein when he said to Heisenberg: "It is the theory which decides what we can observe" [7]. In effect it is theory which tells us what we can think. This is fine, when the theory is correct. However, experiment is the final arbiter of the truth, and so experimentalists are closer to Nature, and it is Nature which should tell us what to think. Therefore, when unusual experimental results are obtained, experimentalists should be encouraged to develop the theoretical explanation, especially when they can support their reasoning with mathematics already in the literature, as in this paper.

3. One of the prohibitions to thinking is the second law of thermodynamics. It is thought to be absolute, and 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 almost overwhelming evidence that entropy tends to increase with time. However, the Universe is a big place and we now know that 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. So it is perfectly rational to look for processes which create order out of chaos.

The author has done some experiments on phenomena which apparently violate the second law of thermodynamics, and so are inexplicable [8]. It is the objective of this paper to present a phenomenological framework to understand these results. In the process, we find that this new framework also explains experiments on magnetic monopoles, and observations of fractional electric charges [9].

4. There are also experimental barriers to solving problems in quantum and particle physics. Firstly, particle physics has been re-branded "high energy physics", which is a technique, not a subject. Low energy particle physics is still an important and active area of research [10]. However, it does not get the support nor attention it deserves, because of high energy physics. High energy experiments are massive technological achievements, so low energy experiments can appear insignificant. It is the purpose of these papers to demonstrate the reverse. We present new approaches, both theoretical and experimental, into magnetic monopoles, quarks, preons, and possibly dark matter.

5. Furthermore, experimental physics is currently based upon determining *objective* facts in 4D space-time, for example, by controlled experiment. However, if one relies upon objective facts only, this assumes that the Universe can be reduced to objective facts, or at least if there are any non-objective aspects, they can be ignored. There is no proof of this, and it could lead to an infinite regression. (For example, if matter in the Universe is made from some fundamental objective substance S_A, then what is this made of? Either it is something non-objective, or it is another objective substance S_B, and so on.) So less-than-objective phenomena could be more fundamental than objective ones.

In order to bring experimental physics up to date and more in line with theoretical physics (which frequently incorporates other dimensions or space-times), *we propose that the requirement of objectivity should be relaxed*. For example, if one makes measurements in other spaces or dimensions then, assuming it is possible, *there is inevitably some reduction in control and/or objectivity*. It is currently not recognised that such less-objective results do occur occasionally, and so they tend to be rejected because they are not objective (i.e. not in 4-D space time). We argue that such results should be considered physically real *if they can be reproduced*. We have examined the literature and find that magnetic monopoles are an example of this. They are only detected under intense illumination and so may be linked to the Brittin and Gamow effect.

Our method to challenge these barriers, is to reason from experiment upwards, as opposed to that from theoretical principles downwards, *because it is experiment which can guide us to the true nature of reality*. Never-the-less, we include some mathematics when it is available and can help us understand the experiments.

2 Magnetic Monopoles

We present experimental evidence from the literature, for real ($\nabla \cdot \boldsymbol{B} \neq 0$) magnetic monopoles, as opposed to the pseudo-monopoles ($\nabla \cdot \boldsymbol{H} \neq 0$) sometimes observed in spin ices or other solid-state phenomena.

Over the last 70 years there have been numerous searches for real magnetic monopoles with mostly negative results. Compilations of these searches conclude that there is no reproducible evidence for magnetic monopoles [11, 12]. But there is an assumption behind this conclusion, namely that magnetic monopoles must be particles which can be detected objectively in 4-D space-time, because that is what controlled experiment is limited too. Firstly, in Dirac's theory there is a line connecting two monopoles which has to be *infinitely long*, and yet the universe is finite [13]. This infinite length of the Dirac string is normally explained away as an artefact of the calculation. However, it is there in the theory and implies that both monopoles are outside 4-D space-time, just as the Dirac equation implies the existence of antimatter. (In principle one monopole could be inside 4-D space-time and the other outside, but that would require preferential treatment for one monopole over another, which the theory does not provide. So we reject this.) If they are outside 4D space-time, then it would not be possible to detect them objectively by the normal methods of experimental physics (e.g. by controlled experiment). Therefore the conclusion of the above compilations is not strictly correct. It should read "there is no reproducible evidence for magnetic monopoles *in 4-D space-time*". However, this is not evidence for or against magnetic monopoles because they are not predicted to be in 4-D space-time.

Furthermore, if a phenomenon is not objective, then it is currently rejected by most physicists as *not* being physically real. Therefore, the above monopole surveys usually omit most, if not all, of the references to the following experiments which provide reproducible evidence for magnetic monopoles, but of a non-objective nature. They are non-objective because *these monopoles are only visible under intense illumination*. When the intense illumination is turned off, they disappear, in the sense that the particle being observed ceases to move as a monopole, and moves as a neutral particle or dipole. *Thus these monopoles do not seem to exist in their own right.* However, these results are reproducible, and so we argue they are physically real. Here is a summary of the published evidence.

2.1 Ehrenhaft

Ehrenhaft first reported observation of single magnetic charges, which were only detectable under intense illumination, in 1930 [3], before Dirac's paper in 1931 [13]. However, Dirac did not recognise Ehrenhaft's results [14, 15]. Not only were Ehrenhaft's results non-objective, but they were obtained at very low energies. So Dirac rejected them, not just because high energies imply objectiveness, but because he thought the very strong force between monopoles would require high energies to separate them. We explain how they can be separated at low energies below.

Dirac's rejection of Ehrenhaft's monopoles creates another problem, namely that there would be two different types of monopole: that predicted by Dirac's theory, and that observed by Ehrenhaft. This is unlikely.

The essence of Ehrenhaft's observations is that when microparticles of ferromagnetic substances (such as iron, nickel or cobalt) are suspended in a gas atmosphere and subjected *simultaneously* to a uniform magnetic field *and to intense illumination by light,* they move as objects carrying single magnetic charges. If the magnetic field $\boldsymbol{H}$ is reversed, then the direction of motion of the single magnetic charges is reversed (magnetic dipoles would not do this). This effect was confirmed by Benedict and Leng [16].

Ehrenhaft did a number of other experiments [17], and when he did not get the recognition he felt he deserved, he made more extreme claims, such as that "light magnetises matter" [18]. He was convinced that he had discovered free magnetic charges and should get the kind of recognition of someone such as Ampère or Faraday. He claimed he had created a magnetic current by causing the monopoles to move [19]. He also claimed to have discovered "magnetolysis", being the magnetic equivalent of electrolysis [20]. Many physicists were unconvinced that "light makes magnetism", suspected it could be due to surface effects, found the effect not objectively real, and so tended to ridicule the results [21]. Einstein took the observations seriously, but wanted a better explanation [22].

Kemple made a review of experimental searches for monopoles up to 1961, including not only the work of Ehrenhaft, but also by his contemporaries. He noted that other experimenters could not reproduce some of these results, and therefore concluded that this work is not evidence for magnetic monopoles [23]. However, this is not strictly correct, because even though some of the experiments may not have been confirmed, the basic observation of magnetic monopoles under intense illumination, was confirmed by Benedict and Leng [16].

2.2 Mikhailov

There the matter might have rested, had it not been that Mikhailov repeated Ehrenhaft's magnetic charge experiment with better technique, and confirmed the result [24–26]. In his first experiment, he used iron microparticles suspended in an atmosphere of argon, illuminated by a laser with power up to 1 kW/cm^2, and in the presence of crossed uniform electric and magnetic fields, which were switched by a square waveform with a frequency of a few Hertz. The particles were observed with a microscope, and moved under the influence of the crossed electric and magnetic fields ($\boldsymbol{E}$ and $\boldsymbol{H}$). By observing their motion, one could *select the signs of the electric and magnetic charges of the particles being observed, thereby confirming Ehrenhaft.*

The observed microparticles had a mass $M \leqslant 10^{-14}$ gram and size $r \leqslant 10^{-5}$ cm, and their motion was governed by Stokes' law. By making measurements on particles carrying both an electric and a magnetic charge, it was possible to measure the ratio g/q independently of the Stokes' coefficient, and hence of the size of the particle. From observations of 1200 such particles, Mikhailov found that *the magnetic charge is quantized*. But his initial value of g disagreed with Dirac's prediction. However, Akers pointed out that *Mikhailov had ignored components of the particle's velocity orthogonal to* $\boldsymbol{E}$ and $\boldsymbol{H}$, and so this interpretation of the result could be incorrect [27].

Mikhailov reanalysed his results and found that the magnetic charge in this experiment, is in fact the solution of a quadratic equation and so gives *two* possible values. One value is the one he had previously reported, the other being *that predicted by Dirac*. In order to distinguish between these two roots, Mikhailov redesigned the experiment to remove this ambiguity and also possible surface effects.

He condensed super-saturated vapour onto solid ferromagnetic particles in a diffusion chamber, which created a smooth surface round each particle and so eliminated surface effects. These ferromagnetic particles, surrounded by fluid, were allowed to drop through a beam of light, under the force of gravity in a magnetic field $\boldsymbol{H}$, which was periodically inverted. Under these conditions, particles exhibiting the magnetic charge effect, fall in a zig-zag path. He observed 428 such tracks with a mean magnetic charge of $\bar{g} = (2.5^{+1.6}_{-1.3}) \times 10^{-8}$ gauss $\times$ cm^2, which agrees with the value predicted by Dirac of $g_{\mathrm{D}} = 3.29 \times 10^{-8}$ gauss $\times$ cm^2 within the errors. In this way, Mikhailov showed unambiguously that he was observing Dirac "monopoles", and furthermore, these were not due to surface effects on the particles [28].

He also repeated his previous experiment, choosing the correct root, and found that the ferromagnetic particles carried from 1 to 5 magnetic charges. The histogram of magnetic charges clearly shows 5 separate peaks corresponding to $g = ng_D$, where n = 1 to 5, with the peaks being gaussian-like with some gaps in between [29]. This confirms that the magnetic charge is quantised as predicted by Dirac, and rules out Schwinger monopoles which have twice the magnetic charge ($g_S = 2g_D$) [30].

The microparticles measured by Mikhailov were composite ($M \leqslant 10^{-14}$ gram), so the monopoles could be composite pseudo-particles (instantons). However, the charge of these pseudo-particles would then not be quantised with the monopole charge predicted by Dirac [31].

He also reanalysed his previous experiments, selecting the correct root and dividing the data by n, and obtained a narrow bell-shaped distribution centred on $\bar{g} = (3.27 \pm 0.16) \times 10^{-8}$ gauss $\times$ cm^2 = 0.99 g_D with an accuracy of ±5% [31]. Therefore, by these ingenious experiments, Mikhailov has observed Dirac monopoles, *but only when illuminated by light*. The problem is they are non-existent in their own right, because they cease to move as monopoles when the light is turned off. There has been no satisfactory explanation for this.

2.3 Discussion

These results are reproducible, because several experimentalists have observed more than 1600 single magnetic charges. Furthermore, they apparently obey gaussian statistics (e.g. the bell-shaped distribution) and are statistically significant. Therefore we argue, these single magnetic charges *should be considered a real physical phenomena.* However we have shown above that surveys of the objective methods of physics have failed to detect them, and concluded there is no evidence for them in 4-D space-time. *One possible explanation is that the monopoles observed only under intense illumination, are not in 4-D space-time but in another space-time,* as predicted by Dirac's theory.

Nevertheless, this is not a complete explanation. We also need a theory which predicts the existence of this second space-time, together with a mechanism which enables light to switch space-time into this second space-time. We now present such a combined theory.

3 Sunlight Shining on the Earth's Surface

We start with an existing theory of an unexpected property of light which does the switching, and then introduce a version of General Relativity which predicts a more complex structure to space-time. The basic idea is that light switches the direction of the flow of time into that of another space-time.

3.1 Brittin and Gamow's Theory

In a little-known theory, Brittin and Gamow have suggested that sunlight shining on the Earth, pumps entropy out into space, thereby allowing negentropy to accumulate on the Earth's surface. The Sun's radiation consists of high temperature photons coming from the surface at $T_s \simeq 5{,}900°$ K, which spreads out in space and becomes diluted. By the time it reaches the Earth's surface, it's energy density corresponds to a temperature of the Earth ($T_e \simeq 300°$ K), so these photons are not in thermodynamic equilibrium.

Brittin and Gamow use the quantum theory of radiation to show that the net entropy change when sunlight interacts with the Earth's surface is [1]:

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

which is negative because $T_s > T_e$. So the entropy at the Earth's surface is reduced. They reason that this is not contrary to the second law of thermodynamics because it is simply due to the temperature gradient $T_s > T_e > T_{space}$, but see below. (Note this effect can also occur with light from an artificial source, such as an halogen lamp.) However, there is a hidden complication, independent of whether the source is natural or artificial.

The problem is that this mechanism enables negative entropy to build up on the Earth's surface, only if it can be stored. In the case of sunlight, they calculate that photosynthesis has an efficiency of about 10% for capturing this negative entropy. Brittin and Gamow suggest that this is the source of order for the food chain, which Schrödinger proposed to be a current of negative entropy [32, 33]. If this is the only mechanism for storage, then this is not a purely physical theory because it relies upon plants (and hence biochemistry) to capture the negentropy. However, we now show that there is a mechanism in physics to store the negentropy produced.

3.2 Discussion of Brittin and Gamow Effect

In classical thermodynamics, the entropy increases with the arrow of time [34]. What happens to time when a solar photon interacts with the Earth's surface, thereby lowering its entropy level? Is the direction of time reversed (e.g. locally), either momentarily or more persistently, when the photon lowers the entropy level? We conclude that it logically must be reversed, because otherwise Eddington's arrow of time would be violated, and the second law of thermodynamics also. Therefore what is missing from Brittin and Gamow's theory, is a theory of space-time with a second time dimension which is directed from the future to the past. (Experimental evidence for this reasoning is given in the following reference [8].)

There are a number of theories with two time dimensions, but these are compactified or otherwise unsuitable [35, 36]. However, Köhn has found a solution to the cosmological problem using two time dimensions. The second time dimension is not compactified, but it is limited to a spacial scale of the Planck length [37]. Elsborg and Köhn have extended this theory to the problem of magnetic monopoles, and developed the theory of magnetic monopoles in this second time dimension [38]. They adopt the orthodox view noted above, that magnetic monopoles have not been observed [11, 12]. Therefore they continue the assumption from Köhn's first paper that the second time dimension only acts on the scale of the Planck length, so that monopoles cannot be observed experimentally at the macroscopic scales now present in the Universe. However, the above evidence for monopoles overrules this aspect of their approach, and requires the second time dimension to be macroscopic. Furthermore, it needs to be directed from the future to the past. Nevertheless, this an interesting paper which provides the mathematical analysis which shows that magnetic monopoles can exist in 5D (3,2) space-time.

There is, however, another theoretical approach. A little-known extension of the theory of General Relativity, has a second macroscopic time dimension directed from the future to the past.

4 General Relativity: Chronometric Invariants

In the 1930s, Landau and others realised that General Relativity is incomplete, because it does not correct for the reference frame of the Observer. As a result, what is observed in a specific reference frame, *is not well defined by the existing theory*. So without the Observer, General Relativity is *incomplete*. The case for including the Observer is thus compelling. Some progress was made by Landau and Lifshitz for specific cases [39]. Zelmanov developed the strict mathematical formalism to calculate the observable values for any tensor quantity in 1944. However this methodology for the general case, was not published until 1956 [40, 41]. The mathematical details of the theory are given in the references. We just present a short summary of the main points here.

Physically observable quantities are obtained by projecting four-dimensional quantities onto the time lines and three-dimensional space of the Observer's reference frame. *Physically observable quantities must be invariant with respect to transformations of time*, and so they are *chronometrically invariant quantities*. Thus the general case of the Observer was incorporated into General Relativity in Russia in the era of the Soviet Union. Cattaneo later obtained similar results [42–44].

This important extension of General Relativity is not well known in the West [45, 46]. Borissova and Rabounski, have developed this theory further. They find that the chronometric invariant equations of motion for mass-bearing particles into the past and into the future, are *asymmetric in time*. They conclude there is a fundamental asymmetry of the directions of time in the in-homogeneous space-time of General Relativity. They hold up a "mirror" to time and find that it does not reflect completely, and that there is a different world "beyond the mirror". The four-dimensional momentum vector for a particle with non-zero rest mass, m_0 is:

$$P^\alpha = m_0 \frac{dx^\alpha}{ds}, \quad P_\alpha P^\alpha = 1, \quad \alpha = 0, 1, 2, 3. \tag{2}$$

When a vector (or tensor) is projected onto the time line and spacial section of an observer, these projections give the physically observable quantities for that observer [40]. Using the properly observable time interval $d\tau = \sqrt{g_{00}}\, dt + \frac{g_{0i}}{c\sqrt{g_{00}}}\, dx^i$ [39, 40], the above four-dimensional momentum vector has two projections onto the time line, namely [47, 48]:

$$\frac{P_0}{\sqrt{g_{00}}} = \pm m, \quad \text{where } m = \frac{m_0}{\sqrt{1 - v^2/c^2}} \tag{3}$$

whereas it has only one spacial projection:

$$P^i = \frac{m}{c}\, v^i = \frac{1}{c}\, p^i, \text{ where } v^i = \frac{dx^i}{d\tau}, \ i = 1, 2, 3, \tag{4}$$

where p^i is the three-dimensional observable momentum. They conclude that any massive particle, having two time projections, *exists in two observable states*, entangled to each other: the positive mass state is in our world, while the negatively charged mass state is in the mirror world. Using the techniques of chronometric invariants, they find that there are three separate areas: our world (i.e. normal 4-D space-time), the mirror world, and a membrane which separates the two [47].

The flow of time is well defined mathematically in General Relativity. It is determined by the sign of the derivative of the coordinate time t with respect to the proper time $(dt/d\tau)$. Using $w = c^2(1 - \sqrt{g_{00}})$ and $v_i = -c\frac{g_{0i}}{\sqrt{g_{00}}}$, Borissova and Rabounski derive the following quadratic equation:

$$\left(\frac{dt}{d\tau}\right)^2 - \frac{2 v_i v^i}{c^2\left(1 - \frac{w}{c^2}\right)} \frac{dt}{d\tau} + \frac{1}{\left(1 - \frac{w}{c^2}\right)^2}\left(\frac{1}{c^4}\, v_i v_k v^i v^k - 1\right) = 0, \tag{5}$$

the two roots of which are [48]:

$$\left(\frac{dt}{d\tau}\right)_{1,2} = \frac{1}{1 - \frac{w}{c^2}}\left(\frac{1}{c^2}\, v_i v^i \pm 1\right). \tag{6}$$

This equation has three possible solutions $dt/d\tau > 0$, $dt/d\tau < 0$, and $dt/d\tau = 0$. In our world, $dt/d\tau > 0$ and time flows from the past to the future. *In the mirror world $dt/d\tau < 0$ and so time flows in the opposite direction.* Between the two is a membrane where time has stopped $dt/d\tau = 0$. Thus the two worlds are separate, because of the membrane, but equal. So that to an Observer (in our world), time in the mirror world flows from the future to the past. A summary of their results is shown in Table 1 [49].

The membrane which separates the two worlds, has its own unique three-fold structure. On our world side and the

Table 1: Summary of Spacial Properties of Chronometric Invariant General Relativity.

Mass	Particles	Energies	Class of motion	Area	Time	Entropy
$m > 0$	massive particles	$E > 0$	move at sub-light speeds	our world	$dt > 0$	$\Delta S > 0$
$m = 0$	massless particles (photons)	$E > 0$	move at the speed of light	our world		
$m = 0$	light-like vortices	$E = 0$	moving and rotating at the speed of light	the membrane	$dt = 0$	
$m = 0$	massless particles (photons)	$E < 0$	move at the speed of light	the mirror world		
$m < 0$	massive particles	$E < 0$	move at sub-light speeds	the mirror world	$dt < 0$	$\Delta S < 0$

mirror world side, are streams of light-like particles (photons), moving at the speed of light, but with opposite energies and frequencies. Between the two in the membrane, time has stopped because $dt/d\tau = 0$, and so this region is a void which is purely spacial. However, in this void there are light-like vortices, previously unknown, which have zero relativistic masses (unlike photons which, although massless, have non-zero relativistic masses). These light-like vortices move and rotate at the speed of light, but have no energy because for them time has stopped — they are purely spacial.

In this theory, a mass-bearing particle has two time projections, one in each world, and exists in two observable states. Each particle is in effect a four dimensional dipole object, which exists in two states: in our world with positive mass and energy; in the mirror world with negative mass and energy (NB this negative mass state is not anti-matter, because the inertial mass of anti-matter is positive). However, they cannot "annihilate" or rather "nullify" (since the net energy is zero) because they are separated by the membrane. Furthermore our world and the mirror world have the same background space, and *the three-dimensional momentum remains positive in both sectors*. More details are given in the references above.

This theory of physically observable quantities, is normally referred as the "Chronometric Invariant Formalism of General Relativity". However, correcting for the Observer's reference frame in this way, changes the structure of space-time from 4D (3,1) to 5D (3,2) and so it is a major extension of General Relativity. We will refer to this extended theory as "Chronometric Invariant General Relativity" (CIGR), in this and related papers. However, words are important [21], so another name may be adopted. In CIGR, our world (normal 4-D space-time) and the mirror world have the same background space. So time in the mirror world is a macroscopic time dimension. Furthermore. mirror time is directed from the future to the past, so we would expect entropy in the mirror world *to be constant or decrease with our time*.

5 Photo Mirror Hypothesis

We make the hypothesis that light can switch matter into the mirror world state, by means of the Brittin and Gamow effect, because this reduces the entropy level which reverses the direction of time.

$$\text{normal}\,(x,t),\ \frac{dt}{d\tau} > 0 \ \underset{\Delta S>0}{\overset{\Delta S<0}{\rightleftharpoons}}\ \frac{dt}{d\tau} < 0,\ \text{mirror}\,(x,-t). \quad (7)$$

We predict this will occur locally where each photon interacts (in which case $\Delta Q = h\nu$ in equation 1). This reversal could be momentary or persistent depending on the phenomenon being observed. We call this the "photo-mirror hypothesis".

Note that when it occurs, this is a low energy effect for two reasons. Firstly according to CIGR, any massive particle exists in a 4-dimensional dipole state with positive mass and energy in our world and negative mass and energy in the mirror world. Since the mirror world state already exists, *it does not require any energy to produce it*. All that is required is the reversal of the direction of time *to reveal it*, which can be done by visible photons with energies of a few electron volts (equation 1). The author provides experimental evidence for this in a separate paper [8].

The reader may question why, if photons can switch space-time into the mirror world state, it has not been observed before. Firstly, the effect is subtle and occurs at very low energies. Secondly, physicists are so convinced that the second law of thermodynamics is absolute, that few have looked for the creation of order. Thirdly, it switches space-time into the mirror world where phenomena are less objective and so tend to get ignored or rejected (e.g. the magnetic monopoles above). Furthermore, any random processes which increase entropy will switch the direction of time back to normal (4-D space-time). Limitations of this are discussed below.

5.1 Explanation of Magnetic Monopoles

The explanation for these magnetic monopoles is that photons in the intense illumination, switch the direction of time experienced by the ferromagnetic particles (via the Brittin and Gamow effect), from normal 4D space-time into the mirror world space-time, where the magnetic monopoles exist and can be observed. Therefore the intense illumination does not "make magnetism" as Ehrenhaft claimed, but "reveals magnetic monopoles" in this other space-time.

This overcomes Dirac's objection to Ehrenhaft's monopoles, namely that magnetic monopoles would only be observed at high energies, because of the very strong force between pairs of them [14], in the following way. The monopoles are in mirror space-time where the masses are negative. Therefore the attractive force between two monopoles would cause them *to fly apart*, so dipoles would not form. Thus by switching the direction of time, light can reveal the monopoles at low energies.

Furthermore, Dirac also concludes that a monopole may be connected to a string extending to infinity. If the monopoles are in one space, and the dipole is in another, then the Dirac string between a monopole and the corresponding pole of the dipole, is naturally infinitely long. Therefore observation of monopoles in mirror space-time and of magnetic dipoles in normal 4-D space-time, provides a natural physical explanation for the infinite length of the Dirac string, and confirms this aspect of his theory. In view of these results, Ehrenhaft, Benedict and Leng, and Mikhailov really did observe Dirac monopoles at these very low energies.

6 Limitations

The photo-mirror hypothesis involves both quantum mechanics (the Brittin and Gamow effect) and the chronometric invariant formalism of General Relativity (CIGR), so it implies unification. But quantum mechanics and CIGR have not yet been unified, nor the standard model embedded therein, so there may be limitations. However the author has obtained *independent experimental evidence* for the photo-mirror effect, which justifies its usage above to explain the magnetic monopole data [8].

7 Conclusions

We have made the hypothesis that there may be phenomena which experiment can detect, but which are not completely objective, for example because they are not in normal 4-D space-time. Magnetic monopoles are an example of this, because they can only be detected under intense illumination, so that when the illumination is turned off, they cease to move as monopoles, and so do not seem to exist in their own right. However, if a phenomenon can be detected repeatedly (for example these magnetic monopoles), *we suggest it should be considered physically real.*

We have presented reproducible evidence for magnetic monopoles which appear to exist outside 4-D space-time. We conclude that the current method of experimental physics is flawed, because it limits observations to objective phenomena in 4-D space time. Phenomena beyond 4-D space-time, if they can be observed, are currently rejected. The solution is to relax the criterion of objectivity, and recognise reproducible phenomena as being physically real. This is especially the case if there is a theory for that phenomenon.

Several experimenters have observed more than 1600 magnetic monopoles under intense illumination, so they are reproducible. Mikhailov has determined that these monopoles have the charge predicted by Dirac: $\bar{g} = (3.27 \pm 0.16) \times 10^{-8}$ gauss $\times$ cm^2 = 0.99 g_D with an accuracy of $\pm 5\%$. Furthermore, he determined that this charge is quantised ($g = n g_D$ with n = 1 to 5). This rules out Schwinger monopoles because $g_S = 2 g_D$ [30]. This also rules out pseudo-particles (instantons) because they would not be quantised, and certainly not with the Dirac charge [31]. We conclude that Dirac monopoles have been observed, but not in 4-D space-time because they are only observed when they are intensely illuminated.

To explain these monopoles, we combine the Brittin and Gamow effect and Chronometric Invariant General Relativity (CIGR) to make the photo-mirror hypothesis, namely that visible light lowers the entropy level and reverses the direction of time, thereby switching space-time into mirror space-time of CIGR, where time is directed from the future to the past. Therefore the photons of the intense illumination switch the ferromagnetic particles, via the photo-mirror hypothesis, into the mirror world space-time state, where the magnetic monopoles exist and are observed. In this way, the *intense illumination reveals magnetic monopoles in mirror space-time.*

Mirror space-time explains two aspects of Dirac's theory of monopoles: their observation at low energies, and the infinite length of the Dirac string. Firstly, we find the monopoles are in mirror space-time where the masses are negative. Therefore the attractive force between two monopoles would cause them to fly apart, so dipoles would not form. Thus by switching the direction of time, light can reveal the monopoles at low energies. Secondly, observation of magnetic monopoles only in mirror space-time and dipoles only in normal 4-D space-time, provides a natural physical explanation for the infinite length of the Dirac string.

This is evidence for phenomena beyond 4-D space-time. In effect, under certain circumstances, light gives us a window into another world. The photo-mirror hypothesis links a quantum mechanical effect (Brittin and Gamow) with General Relativity (CIGR), which implies unification.

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