GRAVITY
AS
QUANTUM FOAM IN-FLOW

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Abstract

The new information-theoretic *Process Physics* provides an explanation of space as a quantum foam system in which gravity is an inhomogeneous flow of the quantum foam into matter. The older Newtonian and General Relativity theories for gravity are analysed. It is shown that Newtonian gravity may be written in the form of an in-flow. General Relativity is also analysed as an in-flow, for those cases where it has been tested. An analysis of various experimental data demonstrates that absolute motion relative to space has been observed by Michelson and Morley, Miller, Illingworth, Jaseja *et al*, Torr and Kolen, and by DeWitte. The Dayton Miller and Roland DeWitte data also reveal the in-flow of space into matter which manifests as gravity. The experimental data suggests that the in-flow is turbulent, which amounts to the observation of a gravitational wave phenomena. A new in-flow theory of gravity is proposed which passes all the tests that General Relativity was claimed to have passed, but as well the new theory suggests that the so-called spiral galaxy rotation-velocity anomaly may be explained without the need of 'dark matter'. Various other gravitational anomalies also appear to be explainable. Newtonian gravity appears to be strictly valid only outside of spherically symmetric matter systems.

Key words: Process Physics, quantum foam, quantum gravity, absolute motion, dark matter, stellar structure, gravitational anomalies, general relativity, Newtonian gravity

Contents

1 Introduction

The new information-theoretic *Process Physics* [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13] provides for the first time an explanation of space as a quantum foam system in which gravity is an inhomogeneous flow of the quantum foam into matter. An analysis [1, 2] of data from various experiments demonstrates that absolute motion relative to space has been observed by Michelson and Morley [14], Miller [15], Illingworth [16], Jaseja *et al* [17], Torr and Kolen [18], and by DeWitte [19], contrary to common belief within physics that absolute motion has never been observed. The Dayton Miller and Roland DeWitte data also reveal the in-flow of space into matter which manifests as gravity. The experimental data suggests that the in-flow manifest turbulence, which amounts to the observation of a gravitational wave phenomena. The Einstein assumptions leading to the Special and General Theory of Relativity are shown to be falsified by the extensive experimental data.

Contrary to the Einstein assumptions absolute motion is consistent with relativistic effects, which are caused by actual dynamical effects of absolute motion through the quantum foam. Lorentzian relativity is seen to be essentially correct. Vacuum Michelson interferometer experiments or its equivalent [20, 21, 22, 23, 24] cannot detect absolute motion, though their null results are always incorrectly reported as evidence of an absence of absolute motion.

A new in-flow theory of gravity in the classical limit is proposed. It passes all the standard tests of both the Newtonian and the General Relativity theories of gravity. However it appears that this new theory may explain the spiral galaxy rotation-velocity anomaly without invoking dark matter. As well this new theory is expected to predict turbulent flow, and such behaviour is manifest in the existing experimental observations of absolute motion. Other gravitational anomalies also now appear to be capable of being explained.

This paper is a condensed version of certain sections of Cahill [1].

2 A New Theory of Gravity

2.1 Classical Effects of Quantum Foam

We begin here the analysis that will lead to the new theory and explanation of gravity. In this theory gravitational effects are caused solely by an inhomogeneous flow of the quantum foam. The new information-theoretic concepts underlying this physics were discessed in [1, 3, 4]. Essentially matter effectively acts as a 'sink' for that quantum foam. To begin with it should be noted that even Newtonian gravity is suggestive of a flow explanation of gravity. In that theory the gravitational acceleration **g** is determined by the matter density ρ according to

$$\nabla.\mathbf{g} = -4\pi G\rho. \tag{1}$$

For $\nabla\times\mathbf{g}=0$ this gravitational acceleration $\mathbf{g}$ may be written as the gradient of the gravitational potential Φ

$$\mathbf{g}=-\nabla\Phi, \tag{2}$$

where the gravitational potential is now determined by $\nabla^2\Phi=4\pi G\rho$. Here, as usual, G is the gravitational constant. Now as $\rho\geq 0$ we can choose to have $\Phi\leq 0$ everywhere if $\Phi\to 0$ at infinity. So we can introduce $\mathbf{v}^2=-2\Phi\geq 0$ where $\mathbf{v}$ is some velocity vector field. Here the value of $\mathbf{v}^2$ is specified, but not the direction of $\mathbf{v}$. Then

$$\mathbf{g}=\frac{1}{2}\nabla(\mathbf{v}^2)=(\mathbf{v}.\nabla)\mathbf{v}+\mathbf{v}\times(\nabla\times\mathbf{v}). \tag{3}$$

For irrotational flow $\nabla\times\mathbf{v}=\mathbf{0}$. Then $\mathbf{g}$ is the usual Euler expression for the acceleration of a fluid element in a time-independent or stationary fluid flow. If the flow is time dependent that expression is expected to become

$$\mathbf{g}=(\mathbf{v}.\nabla)\mathbf{v}+\mathbf{v}\times(\nabla\times\mathbf{v})+\frac{\partial\mathbf{v}}{\partial t}. \tag{4}$$

This equation is then to be accompanied by the 'Newtonian equation' for the flow field

$$\frac{1}{2}\nabla^2(\mathbf{v}^2)=-4\pi G\rho. \tag{5}$$

While this hints at a fluid flow interpretation of Newtonian gravity the fact that the direction of $\mathbf{v}$ is not specified by (5) suggests that some generalisation is to be expected in which the direction of $\mathbf{v}$ is specified. Of course within the fluid flow interpretation (4) and (5) are together equivalent to the Universal Inverse Square Law for Gravity. Indeed for a spherically symmetric distribution of matter of total mass M the velocity field outside of the matter

$$\mathbf{v}(\mathbf{r})=-\sqrt{\frac{2GM}{r}}\hat{\mathbf{r}}, \tag{6}$$

satisfies (5) and reproduces the inverse square law form for $\mathbf{g}$ using (4):

$$\mathbf{g}=-\frac{GM}{r^2}\hat{\mathbf{r}}. \tag{7}$$

The in-flow direction $-\hat{\mathbf{r}}$ in (6) may be replaced by any other direction, in which case however the direction of $\mathbf{g}$ in (7) remains radial.

Of the many new effects predicted by the generalisation of (5) one is that this 'Inverse Square Law' is only valid outside of spherically symmetric matter systems. Then, for example, the 'Inverse Square Law' is expected to be inapplicable to spiral galaxies. The incorrect assumption of the universal validity of this law led to the notion of 'dark matter' in order to reconcile the faster observed rotation velocities of matter within such galaxies compared to that predicted by the above law.

To arrive at the new in-flow theory of gravity we require that the velocity field $\mathbf{v}(\mathbf{r},t)$ be specified and measurable with respect to a suitable frame of reference. We shall use the Cosmic Microwave Background (CMB) frame of reference for that purpose [25]. Then an 'object' has velocity $\mathbf{v}_0(t) = d\mathbf{r}_0(t)/dt$ with respect to that CMB frame, where $\mathbf{r}_0(t)$ is the position of the object wrt that frame. We then define

$$\mathbf{v}_R(t) = \mathbf{v}_0(t) - \mathbf{v}(\mathbf{r}_0(t), t), \tag{8}$$

as the velocity of the object relative to the quantum foam at the location of the object.

Process Physics appears to be leading to the Lorentzian interpretation of so called 'relativistic effects'. This means that the speed of light is only 'c' wrt the quantum-foam system, and that time dilation effects for clocks and length contraction effects for rods are caused by the motion of clocks and rods relative to the quantum foam. So these effects are real dynamical effects caused by the quantum foam, and are not to be interpreted as spacetime effects as suggested by Einstein. To arrive at the dynamical description of the various effects of the quantum foam we shall introduce conjectures that essentially lead to a phenomenological description of these effects. In the future we expect to be able to derive this dynamics directly from the QHFT formalism. First we shall conjecture that the path of an object through an inhomogeneous and time-varying quantum-foam is determined by a variational principle, namely the path $\mathbf{r}_0(t)$ minimises the travel time (for early investigations of the in-flow approach to gravity see Ives[26] and Kirkwood[27, 28]),

$$\tau[\mathbf{r}_0] = \int dt \left(1 - \frac{\mathbf{v}_R^2}{c^2}\right)^{1/2}, \tag{9}$$

with $\mathbf{v}_R$ given by (8). Under a deformation of the trajectory $\mathbf{r}_0(t) \to \mathbf{r}_0(t) + \delta\mathbf{r}_0(t)$, $\mathbf{v}_0(t) \to \mathbf{v}_0(t) + \dfrac{d\delta\mathbf{r}_0(t)}{dt}$, and we also have

$$\mathbf{v}(\mathbf{r}_0(t) + \delta\mathbf{r}_0(t), t) = \mathbf{v}(\mathbf{r}_0(t), t) + (\delta\mathbf{r}_0(t).\nabla)\mathbf{v}(\mathbf{r}_0(t)) + ... \tag{10}$$

Then

$$\begin{aligned}
\delta\tau &= \tau[\mathbf{r}_0 + \delta\mathbf{r}_0] - \tau[\mathbf{r}_0] \\
&= -\int dt\, \frac{1}{c^2}\mathbf{v}_R.\delta\mathbf{v}_R \left(1 - \frac{\mathbf{v}_R^2}{c^2}\right)^{-1/2} + ... \\
&= \int dt \frac{1}{c^2}\left(\mathbf{v}_R.(\delta\mathbf{r}_0.\nabla)\mathbf{v} - \mathbf{v}_R.\frac{d(\delta\mathbf{r}_0)}{dt}\right)\left(1 - \frac{\mathbf{v}_R^2}{c^2}\right)^{-1/2} + ... \\
&= \int dt \frac{1}{c^2}\left(\frac{\mathbf{v}_R.(\delta\mathbf{r}_0.\nabla)\mathbf{v}}{\sqrt{1 - \frac{\mathbf{v}_R^2}{c^2}}} + \delta\mathbf{r}_0.\frac{d}{dt}\frac{\mathbf{v}_R}{\sqrt{1 - \frac{\mathbf{v}_R^2}{c^2}}}\right) + ... \\
&= \int dt\, \frac{1}{c^2}\delta\mathbf{r}_0 \cdot \left(\frac{(\mathbf{v}_R.\nabla)\mathbf{v} + \mathbf{v}_R \times (\nabla \times \mathbf{v})}{\sqrt{1 - \frac{\mathbf{v}_R^2}{c^2}}} + \frac{d}{dt}\frac{\mathbf{v}_R}{\sqrt{1 - \frac{\mathbf{v}_R^2}{c^2}}}\right) + ...
\end{aligned} \tag{11}$$

Hence a trajectory $\mathbf{r}_0(t)$ determined by $\delta\tau = 0$ to $O(\delta\mathbf{r}_0(t)^2)$ satisfies

$$\frac{d}{dt}\frac{\mathbf{v}_R}{\sqrt{1-\frac{\mathbf{v}_R^2}{c^2}}} = -\frac{(\mathbf{v}_R.\nabla)\mathbf{v} + \mathbf{v}_R \times (\nabla \times \mathbf{v})}{\sqrt{1-\frac{\mathbf{v}_R^2}{c^2}}}. \tag{12}$$

Let us now write this in a more explicit form. This will also allow the low speed limit to be identified. Substituting $\mathbf{v}_R(t) = \mathbf{v}_0(t) - \mathbf{v}(\mathbf{r}_0(t), t)$ and using

$$\frac{d\mathbf{v}(\mathbf{r}_0(t), t)}{dt} = (\mathbf{v}_0.\nabla)\mathbf{v} + \frac{\partial \mathbf{v}}{\partial t}, \tag{13}$$

we obtain

$$\frac{d}{dt}\frac{\mathbf{v}_0}{\sqrt{1-\frac{\mathbf{v}_R^2}{c^2}}} = \mathbf{v}\frac{d}{dt}\frac{1}{\sqrt{1-\frac{\mathbf{v}_R^2}{c^2}}} + \frac{(\mathbf{v}.\nabla)\mathbf{v} - \mathbf{v}_R \times (\nabla \times \mathbf{v}) + \frac{\partial \mathbf{v}}{\partial t}}{\sqrt{1-\frac{\mathbf{v}_R^2}{c^2}}}. \tag{14}$$

Then in the low speed limit $v_R \ll c$ we obtain

$$\frac{d\mathbf{v}_0}{dt} = (\mathbf{v}.\nabla)\mathbf{v} - \mathbf{v}_R \times (\nabla \times \mathbf{v}) + \frac{\partial \mathbf{v}}{\partial t} = \mathbf{g}(\mathbf{r}_0(t), t) + (\nabla \times \mathbf{v}) \times \mathbf{v}_0, \tag{15}$$

which agrees with the 'Newtonian' form (4) for zero vorticity ($\nabla \times \mathbf{v} = 0$). Hence (14) is a generalisation of (4) to include Lorentzian dynamical effects, for in (14) we can multiply both sides by the rest mass m_0 of the object, and then (14) involves

$$m(\mathbf{v}_R) = \frac{m_0}{\sqrt{1-\frac{\mathbf{v}_R^2}{c^2}}}, \tag{16}$$

the so called 'relativistic' mass, and (14) acquires the form $\frac{d}{dt}(m(\mathbf{v}_R)\mathbf{v}_0) = \mathbf{F}$, where $\mathbf{F}$ is an effective 'force' caused by the inhomogeneities and time-variation of the flow. This is essentially Newton's 2nd Law of Motion in the case of gravity only. That m_0 cancels is the equivalence principle, and which acquires a simple explanation in terms of the flow. Note that the occurrence of $1/\sqrt{1-\frac{\mathbf{v}_R^2}{c^2}}$ will lead to the precession of the perihelion of planetary orbits, and also to horizon effects wherever $|\mathbf{v}| = c$: the region where $|\mathbf{v}| < c$ is inaccessible from the region where $|\mathbf{v}| > c$. Also (9) is easily used to determine the clock rate offsets in the GPS satellites, when the in-flow is given by (6).

Eqn.(9) involves various absolute quantities such as the absolute velocity of an object relative to the quantum foam and the absolute speed c also relative to the foam, and of course absolute velocities are excluded from the General Relativity (GR) formalism. However (9) gives (with $t = x_0^0$)

$$d\tau^2 = dt^2 - \frac{1}{c^2}(d\mathbf{r}_0(t) - \mathbf{v}(\mathbf{r}_0(t), t)dt)^2 = g_{\mu\nu}(x_0)dx_0^\mu dx_0^\nu, \tag{17}$$

which is the Panlevé-Gullstrand form of the metric $g_{\mu\nu}$ [29, 30] for GR. All of the above is very suggestive that useful information for the flow dynamics may be obtained from GR by restricting the choice of metric to the Panlevé-Gullstrand form. We emphasize that the absolute velocity $\mathbf{v}_R$ has been measured, and so the foundations of GR as usually stated are invalid. As we shall now see the GR formalism involves two phenomena, namely (i) the use of an unnecessarily restrictive Einstein measurement protocol and (ii) the Lorentzian quantum-foam dynamical effects. Later we shall remove this measurement protocol from GR and discover that the GR formalism reduces to explicit fluid flow equations. One significant implication of this is that the whole spacetime formalism introduced by Einstein evaporates - it is nothing more than an *epicycle effect*, that is, like Ptolemy's epicycles, it is an artifact and arises from not being aware of the influence of certain features of a measurement procedure.

However to understand the GR formalism we need to explicitly introduce the troublesome Einstein measurement protocol and the peculiar effects that it induces in the observers historical records, namely that they have a curved spacetime form. Again we emphasize that experimentally this measurement protocol is unnecessarily restrictive - one can do measurements of absolute motion, and then the curvature disappears.

2.2 The Einstein Measurement Protocol

The quantum foam, it is argued, induces actual dynamical time dilations and length contractions in agreement with the Lorentz interpretation of special relativistic effects. Then observers in uniform motion 'through' the foam will on measurement of the speed of light obtain always the same numerical value c. To see this explicitly consider how various observers $P, P', ..$ moving with different speeds through the foam, measure the speed of light. They each acquire a standard rod and an accompanying standardised clock. That means that these standard rods would agree if they were brought together, and at rest with respect to the quantum foam they would all have length Δl_0, and similarly for the clocks. Observer P and accompanying rod are both moving at speed v_R relative to the quantum foam, with the rod longitudinal to that motion. P then measures the time Δt_R, with the clock at end A of the rod, for a light pulse to travel from end A to the other end B and back again to A. The light travels at speed c relative to the quantum-foam. Let the time taken for the light pulse to travel from $A \rightarrow B$ be t_{AB} and from $B \rightarrow A$ be t_{BA}, as measured by a clock at rest with respect to the quantum foam[1]. The length of the rod moving at speed v_R is contracted to

$$\Delta l_R = \Delta l_0 \sqrt{1 - \frac{v_R^2}{c^2}}. \tag{18}$$

In moving from A to B the light must travel an extra distance because the end B travels a distance $v_R t_{AB}$ in this time, thus the total distance that must be traversed is

$$ct_{AB} = \Delta l_R + v_R t_{AB}, \tag{19}$$

[1]Not all clocks will behave in this same 'ideal' manner.

Similarly on returning from B to A the light must travel the distance

$$ct_{BA} = \Delta l_R - v_R t_{BA}. \tag{20}$$

Hence the total travel time Δt_0 is

$$\Delta t_0 = t_{AB} + t_{BA} = \frac{\Delta l_R}{c - v_R} + \frac{\Delta l_R}{c + v_R} \tag{21}$$

$$= \frac{2\Delta l_0}{c\sqrt{1 - \frac{v_R^2}{c^2}}}. \tag{22}$$

Because of the time dilation effect for the moving clock

$$\Delta t_R = \Delta t_0 \sqrt{1 - \frac{v_R^2}{c^2}}. \tag{23}$$

Then for the moving observer the speed of light is defined as the distance the observer believes the light travelled ($2\Delta l_0$) divided by the travel time according to the accompanying clock (Δt_R), namely $2\Delta l_0/\Delta t_R = c$. So the speed v_R of the observer through the quantum foam is not revealed by this procedure, and the observer is erroneously led to the conclusion that the speed of light is always c. This follows from two or more observers in manifest relative motion all obtaining the same speed c by this procedure. Despite this failure this special effect is actually the basis of the spacetime Einstein measurement protocol. That this protocol is blind to the absolute motion has led to enormous confusion within physics. Later we shall see how to overcome the 'blindness' of this procedure, and so manifestly reveal an observer's v_R.

To be explicit the Einstein measurement protocol actually inadvertently uses this special effect by using the radar method for assigning historical spacetime coordinates to an event: the observer records the time of emission and reception of radar pulses ($t_r > t_e$) travelling through the space of quantum foam, and then retrospectively assigns the time and distance of a distant event B according to (ignoring directional information for simplicity)

$$T_B = \frac{1}{2}(t_r + t_e), \quad D_B = \frac{c}{2}(t_r - t_e), \tag{24}$$

where each observer is now using the same numerical value of c. The event B is then plotted as a point in an individual geometrical construct by each observer, known as a spacetime record, with coordinates (D_B, T_B). This is no different to an historian recording events according to some agreed protocol. Unlike historians, who don't confuse history books with reality, physicists do so. We now show that because of this protocol and the quantum foam dynamical effects, observers will discover on comparing their historical records of the same events that the expression

$$\tau_{AB}^2 = T_{AB}^2 - \frac{1}{c^2} D_{AB}^2, \tag{25}$$

is an invariant, where $T_{AB} = T_A - T_B$ and $D_{AB} = D_A - D_B$ are the differences in times and distances assigned to events A and B using the Einstein measurement protocol (24), so long as both are sufficiently small compared with the scale of inhomogeneities in the velocity field.

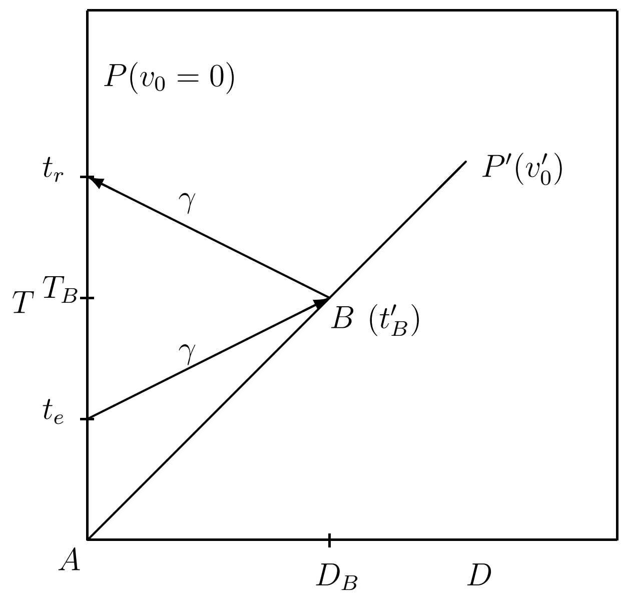

Figure 1: Here $T-D$ is the spacetime construct (from the Einstein measurement protocol) of a special observer P *at rest* wrt the quantum foam, so that $v_0 = 0$. Observer P' is moving with speed v'_0 as determined by observer P, and therefore with speed $v'_R = v'_0$ wrt the quantum foam. Two light pulses are shown, each travelling at speed c wrt both P and the quantum foam. As we see later these one-way speeds for light, relative to the quantum foam, are equal by observation. Event A is when the observers pass, and is also used to define zero time for each for convenience.

To confirm the invariant nature of the construct in (25) one must pay careful attention to observational times as distinct from protocol times and distances, and this must be done separately for each observer. This can be tedious. We now demonstrate this for the situation illustrated in Fig.1.

By definition the speed of P' according to P is $v'_0 = D_B/T_B$ and so $v'_R = v'_0$, where T_B and D_B are the protocol time and distance for event B for observer P according to (24). Then using (25) P would find that $(\tau^P_{AB})^2 = T_B^2 - \frac{1}{c^2}D_B^2$ since both $T_A = 0$ and D_A=0, and whence $(\tau^P_{AB})^2 = (1 - \frac{v'^2_R}{c^2})T_B^2 = (t'_B)^2$ where the last equality follows from the time dilation effect on the P' clock, since t'_B is the time of event B according to that clock. Then T_B is also the time that P' would compute for event B when correcting for the time-dilation effect, as the speed v'_R of P' through the quantum foam is observable by P'. Then T_B is the 'common time' for event B assigned by both observers[2]. For P'

[2]Because of gravitational in-flow effects this 'common time' is not the same as a 'universal' or 'absolute time'; see later.

we obtain directly, also from (24) and (25), that $(\tau_{AB}^{P'})^2 = (T'_B)^2 - \frac{1}{c^2}(D'_B)^2 = (t'_B)^2$, as $D'_B = 0$ and $T'_B = t'_B$. Whence for this situation

$$(\tau_{AB}^{P})^2 = (\tau_{AB}^{P'})^2, \tag{26}$$

and so the construction (25) is an invariant.

While so far we have only established the invariance of the construct (25) when one of the observers is at rest wrt to the quantum foam, it follows that for two observers P' and P'' both in motion wrt the quantum foam it follows that they also agree on the invariance of (25). This is easily seen by using the intermediate step of a stationary observer P:

$$(\tau_{AB}^{P'})^2 = (\tau_{AB}^{P})^2 = (\tau_{AB}^{P''})^2. \tag{27}$$

Hence the protocol and Lorentzian effects result in the construction in (25) being indeed an invariant in general. This is a remarkable and subtle result. For Einstein this invariance was a fundamental assumption, but here it is a derived result, but one which is nevertheless deeply misleading. Explicitly indicating small quantities by Δ prefixes, and on comparing records retrospectively, an ensemble of nearby observers agree on the invariant

$$\Delta\tau^2 = \Delta T^2 - \frac{1}{c^2}\Delta D^2, \tag{28}$$

for any two nearby events. This implies that their individual patches of spacetime records may be mapped one into the other merely by a change of coordinates, and that collectively the spacetime patches of all may be represented by one pseudo-Riemannian manifold, where the choice of coordinates for this manifold is arbitrary, and we finally arrive at the invariant

$$\Delta\tau^2 = g_{\mu\nu}(x)\Delta x^\mu \Delta x^\nu, \tag{29}$$

with $x^\mu = \{T, D_1, D_2, D_3\}$.

2.3 The Origins of General Relativity

Above it was seen that the Lorentz symmetry of the spacetime construct would arise if the quantum foam system that forms space affects the rods and clocks used by observers in the manner indicated. The effects of absolute motion with respect to this quantum foam are in fact easily observed, and so the velocity $\mathbf{v}_R$ of each observer is measurable. However if we work only with the spacetime construct then the effects of the absolute motion are hidden. Einstein was very much misled by the reporting of the experiment by Michelson and Morley of 1887, as now (see later) it is apparent that this experiment, and others since then, revealed evidence of absolute motion. The influence of the Michelson-Morley experiment had a major effect on the subsequent development of physics. One such development was the work of Hilbert and Einstein in finding an apparent generalisation of Newtonian gravity to take into account the apparent absence of absolute motion. Despite the deep error in this work the final formulation, known as General Relativity, has had a number of successes including the perihelion precession of mercury, the bending of light and gravitational red shift. Hence despite the incorrect treatment of absolute motion the formalism of general relativity apparently has some validity. In the next section we shall *deconstruct* this formalism to discover its underlying physics, but here we first briefly outline the GR formalism.

The spacetime construct is a static geometrical non-processing historical record, and is nothing more than a very refined history book, with the shape of the manifold encoded in a metric tensor $g_{\mu\nu}(x)$. However in a formal treatment by Einstein the SR formalism and later the GR formalism is seen to arise from three fundamental assumptions:

(1) **The laws of physics have the same form in all inertial reference frames.**
(2) **Light propagates through empty space with a definite speed c independent of the speed of the source or observer.**
(3) **In the limit of low speeds the new formalism should agree with Newtonian gravity.** (30)

There is strong evidence that all three of these assumptions are in fact wrong, see [1, 2]. Nevertheless there is something that is partially correct within the formalism, and that part needs to be extracted and saved, with the rest discarded. From the above assumptions Hilbert and Einstein guessed the equation which specify the metric tensor $g_{\mu\nu}(x)$, namely the geometry of the spacetime construct,

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = \frac{8\pi G}{c^2}T_{\mu\nu}, \tag{31}$$

where $G_{\mu\nu}$ is known as the Einstein tensor, $T_{\mu\nu}$ is the energy-momentum tensor, $R_{\mu\nu} = R^{\alpha}_{\mu\alpha\nu}$ and $R = g^{\mu\nu}R_{\mu\nu}$ and $g^{\mu\nu}$ is the matrix inverse of $g_{\mu\nu}$. The curvature tensor is

$$R^{\rho}_{\mu\sigma\nu} = \Gamma^{\rho}_{\mu\nu,\sigma} - \Gamma^{\rho}_{\mu\sigma,\nu} + \Gamma^{\rho}_{\alpha\sigma}\Gamma^{\alpha}_{\mu\nu} - \Gamma^{\rho}_{\alpha\nu}\Gamma^{\alpha}_{\mu\sigma}, \tag{32}$$

where $\Gamma^{\alpha}_{\mu\sigma}$ is the affine connection

$$\Gamma^{\alpha}_{\mu\sigma} = \frac{1}{2}g^{\alpha\nu}\left(\frac{\partial g_{\nu\mu}}{\partial x^{\sigma}} + \frac{\partial g_{\nu\sigma}}{\partial x^{\mu}} - \frac{\partial g_{\mu\sigma}}{\partial x^{\nu}}\right). \tag{33}$$

In this formalism the trajectories of test objects are determined by

$$\Gamma^{\lambda}_{\mu\nu}\frac{dx^{\mu}}{d\tau}\frac{dx^{\nu}}{d\tau} + \frac{d^2x^{\lambda}}{d\tau^2} = 0, \tag{34}$$

which is equivalent to minimising the functional

$$\tau[x] = \int dt\sqrt{g^{\mu\nu}\frac{dx^{\mu}}{dt}\frac{dx^{\nu}}{dt}}, \tag{35}$$

wrt to the path $x[t]$.

For the case of a spherically symmetric mass a solution of (31) for $g_{\mu\nu}$ outside of that mass M is the Schwarzschild metric

$$d\tau^2 = (1 - \frac{2GM}{c^2 r})dt^2 - \frac{1}{c^2}r^2(d\theta^2 + \sin^2(\theta)d\phi^2) - \frac{dr^2}{c^2(1 - \frac{2GM}{c^2 r})}. \tag{36}$$

This solution is the basis of various experimental checks of General Relativity in which the spherically symmetric mass is either the Sun or the Earth. The four tests are: the gravitational redshift, the bending of light, the precession of the perihelion of Mercury, and the time delay of radar signals.

However the solution (36) is in fact completely equivalent to the in-flow interpretation of Newtonian gravity. Making the change of variables $t \to t'$ and $\mathbf{r} \to \mathbf{r}' = \mathbf{r}$ with

$$t' = t + \frac{2}{c}\sqrt{\frac{2GMr}{c^2}} - \frac{4GM}{c^2}\tanh^{-1}\sqrt{\frac{2GM}{c^2 r}}, \tag{37}$$

the Schwarzschild solution (36) takes the form

$$d\tau^2 = dt'^2 - \frac{1}{c^2}(dr' + \sqrt{\frac{2GM}{r'}}dt')^2 - \frac{1}{c^2}r'^2(d\theta'^2 + \sin^2(\theta')d\phi'), \tag{38}$$

which is exactly the Panlevé-Gullstrand form of the metric $g_{\mu\nu}$ [29, 30] in (17) with the velocity field given exactly by the Newtonian form in (6). In which case the trajectory equation (34) of test objects in the Schwarzschild metric is equivalent to solving (14). Thus the minimisation (35) is equivalent to that of (9). This choice of coordinates corresponds to a particular frame of reference in which the test object has velocity $\mathbf{v}_R = \mathbf{v} - \mathbf{v}_0$ relative to the in-flow field $\mathbf{v}$, as seen in (9).

It is conventional wisdom for practitioners in General Relativity to regard the choice of coordinates or frame of reference to be entirely arbitrary and having no physical significance: no observations should be possible that can detect and measure $\mathbf{v}_R$. This 'wisdom' is based on two beliefs (i) that all attempts to detect $\mathbf{v}_R$, namely the detection of absolute motion, have failed, and that (ii) the existence of absolute motion is incompatible with the many successes of both the Special Theory of Relativity and of the General Theory of Relativity. Both of these beliefs are demonstrably false.

The results in this section suggest, just as for Newtonian gravity, that the Einstein General Relativity is nothing more than the dynamical equations for a velocity flow field $\mathbf{v}(\mathbf{r}, t)$. Hence the non-flat spacetime construct appears to be merely an unnecessary artifact of the Einstein measurement protocol, which in turn was motivated by the misreporting of the results of the Michelson-Morley experiment. The successes of General Relativity should thus be considered as an insight into the fluid flow dynamics of the quantum foam system, rather than any confirmation of the validity of the spacetime formalism. In the next section we shall deconstruct General Relativity to extract a possible form for this dynamics.

2.4 Deconstruction of General Relativity

Here we deconstruct the formalism of General Relativity by removing the obscurification produced by the unnecessarily restricted Einstein measurement protocol. To do this we adopt the Panlevé-Gullstrand form of the metric $g_{\mu\nu}$ as that corresponding to the observable quantum foam system, namely to an observationally detected special frame of reference. This form for the metric involves a general velocity field $\mathbf{v}(\mathbf{r},t)$ where for precision we consider the coordinates $\mathbf{r},t$ as that of observers at rest with respect to the CMB frame. Note that in this frame $\mathbf{v}(\mathbf{r},t)$ is not necessarily zero, for mass acts as a sink for the flow. We therefore merely substitute the metric

$$d\tau^2 = g_{\mu\nu}dx^\mu dx^\nu = dt^2 - \frac{1}{c^2}(d\mathbf{r}(t) - \mathbf{v}(\mathbf{r}(t),t)dt)^2, \tag{39}$$

into (31) using (33) and (32). This metric involves the arbitrary time-dependent velocity field $\mathbf{v}(\mathbf{r},t)$. This is a very tedious computation and the results below were obtained by using the symbolic mathematics capabilities of *Mathematica*. The various components of the Einstein tensor are then

$$\begin{aligned} G_{00} &= \sum_{i,j=1,2,3} v_i\mathcal{G}_{ij}v_j - c^2\sum_{j=1,2,3}\mathcal{G}_{0j}v_j - c^2\sum_{i=1,2,3}v_i\mathcal{G}_{i0} + c^2\mathcal{G}_{00}, \\ G_{i0} &= -\sum_{j=1,2,3}\mathcal{G}_{ij}v_j + c^2\mathcal{G}_{i0}, \qquad i=1,2,3. \\ G_{ij} &= \mathcal{G}_{ij}, \qquad i,j=1,2,3. \end{aligned} \tag{40}$$

where the $\mathcal{G}_{\mu\nu}$ are given[3] by

$$\begin{aligned} \mathcal{G}_{00} &= \frac{1}{2}((trD)^2 - tr(D^2)), \\ \mathcal{G}_{i0} &= \mathcal{G}_{0i} = -\frac{1}{2}(\nabla\times(\nabla\times\mathbf{v}))_i, \qquad i=1,2,3. \\ \mathcal{G}_{ij} &= \frac{d}{dt}(D_{ij} - \delta_{ij}trD) + (D_{ij} - \frac{1}{2}\delta_{ij}trD)trD \\ & \quad -\frac{1}{2}\delta_{ij}tr(D^2) - (D\Omega - \Omega D)_{ij}, \qquad i,j=1,2,3. \end{aligned} \tag{41}$$

Here

$$D_{ij} = \frac{1}{2}(\frac{\partial v_i}{\partial x_j} + \frac{\partial v_j}{\partial x_i}) \tag{42}$$

is the symmetric part of the rate of strain tensor $\frac{\partial v_i}{\partial x_j}$, while the antisymmetric part is

$$\Omega_{ij} = \frac{1}{2}(\frac{\partial v_i}{\partial x_j} - \frac{\partial v_j}{\partial x_i}). \tag{43}$$

In vacuum, with $T_{\mu\nu}=0$, we find from (31) and (40) that $G_{\mu\nu}=0$ implies that $\mathcal{G}_{\mu\nu}=0$. It is then easy to check that the in-flow velocity field (6) satisfies these equations. This

[3]The $\mathcal{G}_{\mu\nu}$ also arise in the tetrad formulation of GR [31].

simply expresses the previous observation that this 'Newtonian in-flow' is completely equivalent to the Schwarzschild metric. We note that the vacuum equations $\mathcal{G}_{\mu\nu} = 0$ do not involve the speed of light; it appears only in (40). It is therefore suggested that (40) amounts to the separation of the Einstein measurement protocol, which involves c, from the supposed dynamics of gravity within the GR formalism, and which does not involve c. However the details of the vacuum dynamics in (41) have not actually been tested. All the key tests of GR are now seen to amount to a test *only* of $\delta\tau[x]/\delta x^\mu = 0$, which is the minimisation of (9), when the in-flow field is given by (40), and which is nothing more than Newtonian gravity. Of course Newtonian gravity was itself merely based upon observations within the Solar system, and this may have been too special to have revealed key aspects of gravity. Hence, despite popular opinion, the GR formalism is apparently based upon rather poor evidence.

2.5 Gravity as Inhomogeneous Quantum-Foam Flow

Despite the limited insight into gravity which GR is now seen to amount to, here we look for possible generalisations of Newtonian gravity and its in-flow interpretation by examining some of the mathematical structures that have arisen in (41). For the case of zero vorticity $\nabla \times \mathbf{v} = 0$ we have $\Omega_{ij} = 0$ and also that we may write $\mathbf{v} = \nabla u$ where $u(\mathbf{r}, t)$ is a scalar field, and only one equation is required to determine u. To that end we consider the trace of $\mathcal{G}_{ij}$. Note that $tr(D) = \nabla.\mathbf{v}$, and that

$$\frac{d(\nabla.\mathbf{v})}{dt} = (\mathbf{v}.\nabla)(\nabla.\mathbf{v}) + \frac{\partial(\nabla.\mathbf{v})}{\partial t}. \tag{44}$$

Then using the identity

$$(\mathbf{v}.\nabla)(\nabla.\mathbf{v}) = \frac{1}{2}\nabla^2(\mathbf{v}^2) - tr(D^2) - \frac{1}{2}(\nabla \times \mathbf{v})^2 + \mathbf{v}.\nabla \times (\nabla \times \mathbf{v}), \tag{45}$$

and imposing

$$\sum_{i=1,2,3} \mathcal{G}_{ii} = -8\pi G\rho, \tag{46}$$

we obtain

$$\frac{\partial}{\partial t}(\nabla.\mathbf{v}) + \frac{1}{2}\nabla^2(\mathbf{v}^2) + \frac{1}{4}((trD)^2 - tr(D^2)) = -4\pi G\rho. \tag{47}$$

This is seen to be a possible generalisation of the Newtonian equation (5) that includes a time derivative, and also the new term $C(\mathbf{v}) = \frac{1}{4}((trD)^2 - tr(D^2))$. First note that for the case of the Solar system, with the mass concentrated in one object, namely the Sun, we see that the in-flow field (6) satisfies (47) since then $C(\mathbf{v}) = 0$. As we shall see later the presence of the C term is also well hidden when we consider the Earth's gravitational effects, although there are various known anomalies that indicate that a generalisation of Newtonian gravity is required. Hence (47) in the case of the Solar system is indistinguishable from Newtonian gravity, or the Schwarzschild metric within the General Relativity formalism so long as we use (9), in being able to determine trajectories of test objects. Hence (47) is automatically in agreement with most of the so-called checks on Newtonian gravity and later General Relativity. Note that (47) does not involve the speed of light c. Nevertheless we have not derived (47)) from the underlying QHFT, and indeed it is not a consequence of GR, as the $\mathcal{G}_{00}$ equation of (41) requires that $C(\mathbf{v}) = 0$ in vacuum. Eqn.(47) at this stage should be regarded as a conjecture which will permit the exploration of possible quantum-flow physics and also allow comparison with experiment.

However one key aspect of (47) should be noted here, namely that being a non-linear fluid-flow dynamical system we would expect the flow to be turbulent, particularly when the matter is not spherically symmetric or inside even a spherically symmetric distribution of matter, since then the $C(\mathbf{v})$ term is non-zero and it will drive that turbulence. In the following sections we shall see that the experiments that reveal absolute motion also reveal evidence of turbulence.

Because of the $C(\mathbf{v})$ term (47) would predict that the Newtonian inverse square law would not be applicable to systems such as spiral galaxies, because of their highly non-spherical distribution of matter. Of course attempts to retain this law, despite its manifest failure, has led to the spurious introduction of the notion of dark matter within spiral galaxies, and also at larger scales. From

$$\mathbf{g} = \frac{1}{2}\nabla(\mathbf{v}^2) + \frac{\partial \mathbf{v}}{\partial t}, \tag{48}$$

which is (4) for irrotational flow, we see that (47) gives

$$\nabla.\mathbf{g} = -4\pi G\rho - C(\mathbf{v}), \tag{49}$$

and taking running time averages to account for turbulence

$$\nabla.{<}\mathbf{g}{>} = -4\pi G\rho - {<}C(\mathbf{v}){>}, \tag{50}$$

and writing the extra term as ${<}C(\mathbf{v}){>} = 4\pi G\rho_{DM}$ we see that ρ_{DM} would act as an effective matter density, and it is suggested that it is the consequences of this term which have been misinterpreted as 'dark matter'. Here we see that this effect is actually the consequence of quantum foam effects within the new proposed dynamics for gravity, and which becomes apparent particularly in spiral galaxies. Note that (47) is an equation for $\mathbf{v}$, and now involves the direction of $\mathbf{v}$, unlike the special case of Newtonian gravity (5). Because $\nabla \times \mathbf{v} = 0$ we can write (47) in the form

$$\mathbf{v}(\mathbf{r},t) = \frac{1}{4\pi}\int^t dt' \int d^3r'(\mathbf{r}-\mathbf{r}')\frac{\frac{1}{2}\nabla^2(\mathbf{v}^2(\mathbf{r}',t')) + 4\pi G\rho(\mathbf{r}',t') + C(\mathbf{v}(\mathbf{r}',t'))}{|\mathbf{r}-\mathbf{r}'|^3}, \tag{51}$$

which allows the determination of the time evolution of $\mathbf{v}$.

The new flow dynamics encompassed in (47) thus accounts for most of the known gravitational phenomena, but will lead to some very clear cut experiments that will distinguish it from the two previous attempts to model gravitation. It turns out that these two attempts were based on some key 'accidents' of history. In the case of the Newtonian modelling of gravity the prime 'accident' was of course the Solar system with its high degree of spherical symmetry. In each case we had test objects, namely the planets, in orbit about the Sun, or we had test object in orbit about the Earth. In the case of the General Relativity modelling the prime 'accident' was the mis-reporting of the Michelson-Morley experiment, and the ongoing belief that the so called 'relativistic effects' are incompatible with absolute motion. We shall consider in detail later some further anomalies that might be appropriately explained by this new modelling of gravity. Of course that the in-flow has been present in various experimental data is also a significant argument for something like (47) to model gravity. Key new experimental techniques will be introduced later which wil enable the consequences of (47) to be tested. If necessary these experiments will provide insights into possible modifications to (47).

2.6 In-Flow Superposition Approximation

We consider here why the presence of the $C(\mathbf{v})$ term appears to have escaped attention in the case of gravitational experiments and observations near the Earth, despite the fact that the presence of the Earth breaks the spherical symmetry of the matter distribution of the Sun.

First note that if we have a matter distribution at rest in the space of quantum foam, and that (47) has solution $\mathbf{v}_0(\mathbf{r}, t)$, then when the same matter distribution is uniformly translating at velocity $\mathbf{V}$, that is $\rho(\mathbf{r}) \to \rho(\mathbf{r} - \mathbf{V}t)$, then a solution to (47) is

$$\mathbf{v}(\mathbf{r}, t) = \mathbf{v}_0(\mathbf{r} - \mathbf{V}t) + \mathbf{V}. \tag{52}$$

This follows because (i) the expression for the acceleration $\mathbf{g}(\mathbf{r}, t)$ gives

$$\begin{aligned}
\mathbf{g}(\mathbf{r}, t) &= \frac{\partial \mathbf{v}_0(\mathbf{r} - \mathbf{Vt})}{\partial t} + ((\mathbf{v}_0(\mathbf{r} - \mathbf{V}t) + \mathbf{V}).\nabla)(\mathbf{v}_0(\mathbf{r} - \mathbf{V}t) + \mathbf{V}), \\
&= \frac{\partial \mathbf{v}_0(\mathbf{r} - \mathbf{Vt})}{\partial t} + \mathbf{g}_0(\mathbf{r} - \mathbf{Vt}) + (\mathbf{V}.\nabla)\mathbf{v}_0(\mathbf{r} - \mathbf{V}t), \\
&= -(\mathbf{V}.\nabla)\mathbf{v}_0(\mathbf{r} - \mathbf{V}t) + \mathbf{g}_0(\mathbf{r} - \mathbf{Vt}) + (\mathbf{V}.\nabla)\mathbf{v}_0(\mathbf{r} - \mathbf{V}t), \\
&= \mathbf{g}_0(\mathbf{r} - \mathbf{Vt}),
\end{aligned} \tag{53}$$

as there is a cancellation of two terms in (53), and where $\mathbf{g}_0(\mathbf{r})$ is the acceleration field when the matter distribution is not in translation, and (ii) clearly $C(\mathbf{v}_0(\mathbf{r} - \mathbf{V}t) + \mathbf{V}) = C(\mathbf{v}_0(\mathbf{r} - \mathbf{V}t))$, and so this term is also simply translated. Hence apart from the translation effect the acceleration is the same. Hence the velocity vector addition rule in (52) is valid.

Now for Earth based gravitational phenomena the motion of the Earth takes place within the velocity in-flow towards the Sun, and the velocity sum rule (52) is only approximately valid as now $\mathbf{V} \to \mathbf{V}(\mathbf{r}, t)$ and no longer corresponds to uniform translation, and may manifest turbulence. To be a valid approximation the inhomogeneity of $\mathbf{V}(\mathbf{r}, t)$ must be much smaller than that of $\mathbf{v}_0(\mathbf{r} - \mathbf{V}t)$, which it is[4]. Nevertheless turbulence

[4]The Earth's centripetal acceleration about the Sun is approximately 1/1000 that of the gravitational acceleration at the surface of the Earth.

associated with the $C(\mathbf{v})$ term is apparent in experimental data. The validity of this approximation plays a special role in explaining why the entrainment hypotheses regarding the detection of Earth's absolute motion was unnecessary.

2.7 Measurements of G

As noted in Sect.2.1 Newton's Inverse Square Law of Gravitation may only be strictly valid in cases of spherical symmetry. The theory that gravitational effects arise from inhomogeneities in the quantum foam flow implies that there is no 'universal law of gravitation' because the inhomogeneities are determined by non-linear 'fluid equations' and the solutions have no form which could be described by a 'universal law'. Fundamentally there is no generic fluid flow behaviour. The Inverse Square Law is then only an approximation, with large deviations expected in the case of spiral galaxies. Nevertheless Newton's gravitational constant G will have a definite value as it quantifies the effective rate at which matter dissipates the information content of space.

From these considerations it follows that the measurement of the value of G will be difficult as the measurement of the forces between two of more objects, which is the usual method of measuring G, will depend on the geometry of the spatial positioning of these objects in a way not previously accounted for because the Newtonian Inverse Square Law has always been assumed, or in some case a specified change in the form of the law has been used. But in all cases a 'law' has been assumed, and this may have been the flaw in the analysis of data from such experiments. This implies that the value of G from such experiments will show some variability as a systematic effect has been neglected in analysing the experimental data, for in none of these experiments is spherical symmetry present. So experimental measurements of G should show an unexpected contextuality. As well the influence of surrounding matter has also not been properly accounted for. Of course any effects of turbulence in the inhomogeneities of the flow has presumably never even been contemplated.

The first measurement of G was in 1798 by Cavendish using a torsional balance. As the precision of experiments increased over the years and a variety of techniques used the disparity between the values of G has actually increased. In 1998 CODATA increased the uncertainty in G from 0.013% to 0.15%. One indication of the contextuality is that measurements of G produce values that differ by nearly 40 times their individual error estimates [32]. It is predicted that these G anomalies will only be resolved when the new theory of gravity is used in analysing the data from these experiments.

2.8 Gravitational Anomalies

In Sect.2.7 anomalies associated with the measurement of G were briefly discussed and it was pointed out that these were probably explainable within the new in-flow theory of gravity. There are in-fact additional gravitational anomalies that are not well-known in physics, presumably because their existence is incompatible with the Newtonian or the Hilbert-Einstein gravity theories.

The most significant of these anomalies is the Allais effect [33]. In June 1954 Allais[5] reported that a Foucault pendulum exhibited peculiar movements at the time of a solar eclipse. Allais was recording the precession of a Foucault pendulum in Paris. Coincidently during the 30 day observation period a partial solar eclipse occured at Paris on June 30. During the eclipse the precession of the pendulum was seen to be disturbed. Similar results were obtained during another solar eclipse on October 29 1959. There have been other repeats of the Allais experiment with varying results.

Another anomaly was reported by Saxl and Allen [34] during the solar eclipse of March 7 1970. Significant variations in the period of a torsional pendulum were observed both during the eclipse and as well in the hours just preceding and just following the eclipse. The effects seem to suggest that an "apparent wavelike structure has been observed over the course of many years at our Harvard laboratory", where the wavelike structure is present and reproducible even in the absence of an eclipse.

Again Zhou and Huang [35] report various time anomalies occuring during the solar eclipses of Sepetmber 23 1987, March 18 1988 and July 22 1990 observed using atomic clocks.

All these anomalies and others not discussed here would suggest that gravity has aspects to it that are not within the prevailing theories, but that the in-flow theory discussed above might well provide an explanation, and indeed these anomalies may well provide further phenomena that could be used to test the new theory. The effects associated with the solar eclipses could presumably follow from the alignment of the Sun, Moon and the Earth causing enhanced turbulence. The Saxl and Allen experiment of course suggests, like the other experiments analysed above, that the turbulence is always present. To explore these anomalies detailed numerical studies of (47) are required with particular emphasis on the effect on the position of the Moon.

2.9 Galactic In-flow and the CMB Frame

Absolute motion (AM) of the Solar system has been observed in the direction ($\alpha = 17.5^h, \delta = 65^0$), up to an overall sign to be sorted out, with a speed of 417 ± 40 km/s [1]. This is the velocity after removing the contribution of the Earth's orbital speed and the Sun in-flow effect. It is significant that this velocity is different to that associated with the Cosmic Microwave Background [6] (CMB) relative to which the Solar system has a speed of 369 km/s in the direction ($\alpha = 11.20^h, \delta = -7.22^0$), see [25]. This CMB velocity is obtained by finding the preferred frame in which this thermalised 3^0K radiation is isotropic, that is by removing the dipole component. The CMB velocity is a measure

[5] Maurice Allais won the Noble Prize for Economics in 1988.

[6] The understanding of the galactic in-flow effect was not immediate: In [9] the direction was not determined, though the speed was found to be comparable to the CMB determined speed. In [10] that the directions were very different was noted but not appreciated, and in fact thought to be due to experimental error. In [11] an analysis of some of the 'smoother' Michelson-Morley data resulted in an incorrect direction. At that stage it was not understood that the data showed large fluctuations in the azimuth apparently caused by the turbulence. Here the issue is hopefully finally resolved.

of the motion of the Solar system relative to the universe as a whole, or aleast a shell of the universe some 15Gyrs away, and indeed the near uniformity of that radiation in all directions demonstrates that we may meaningfully refer to the spatial structure of the universe. The concept here is that at the time of decoupling of this radiation from matter that matter was on the whole, apart from small observable fluctuations, at rest with respect to the quantum-foam system that is space. So the CMB velocity is the motion of the Solar system with respect to space *universally*, but not necessarily with respect to the *local* space. Contributions to this velocity would arise from the orbital motion of the Solar system within the Milky Way galaxy, which has a speed of some 250 km/s, and contributions from the motion of the Milky Way within the local cluster, and so on to perhaps larger clusters.

On the other hand the AM velocity is a vector sum of this *universal* CMB velocity and the net velocity associated with the *local* gravitational in-flows into the Milky Way and the local cluster. If the CMB velocity had been identical to the AM velocity then the in-flow interpretation of gravity would have been proven wrong. We therefore have three pieces of experimental evidence for this interpretation (i) the refractive index anomaly discussed previously in connection with the Miller data, (ii) the turbulence seen in all detections of absolute motion, and now (iii) that the AM velocity is different in both magnitude and direction from that of the CMB velocity, and that this velocity does not display the turbulence seen in the AM velocity.

That the AM and CMB velocities are different amounts to the discovery of the resolution to the 'dark matter' conjecture. Rather than the galactic velocity anomalies being caused by such undiscovered 'dark matter' we see that the in-flow into non spherical galaxies, such as the spiral Milky Way, will be non-Newtonian [1]. As well it will be interesting to determine, at least theoretically, the scale of turbulence expected in galactic systems, particularly as the magnitude of the turbulence seen in the AM velocity is somewhat larger than might be expected from the Sun in-flow alone. Any theory for the turbulence effect will certainly be checkable within the Solar system as the time scale of this is suitable for detailed observation.

It is also clear that the time of obervers at rest with respect to the CMB frame is absolute or universal time. This interpretation of the CMB frame has of course always been rejected by supporters of the SR/GR formalism. As for space we note that it has a differential structure, in that different regions are in relative motion. This is caused by the gravitational in-flow effect locally, and as well by the growth of the universe.

2.10 In-Flow Turbulence and Gravitational Waves

The velocity flow-field equation (47) is expected to have solutions possessing turbulence, that is, random fluctuations in both the magnitude and direction of the gravitational in-flow component of the velocity flow-field. Indeed all the Michelson interferometer experiments showed evidence of such turbulence. The first clear evidence was from the Miller experiment, as shown discussed in [1]. Miller offered no explanation for these fluctuations but in his analysis of that data he did running time averages. Miller may have in fact have simply interpreted these fluctuations as purely instrumental effects.

While some of these fluctuations may be partially caused by weather related temperature and pressure variations, the bulk of the fluctuations appear to be larger than expected from that cause alone. Even the original Michelson-Morley data, plotted in [1] shows variations in the velocity field and supports this interpretation. However it is significant that the non-interferometer DeWitte [1] data also shows evidence of turbulence in both the magnitude and direction of the velocity flow field. Just as the DeWitte data agrees with the Miller data for speeds and directions the magnitude fluctuations are very similar in absolute magnitude as well.

It therefore becomes clear that there is strong evidence for these fluctuations being evidence of physical turbulence in the flow field. The magnitude of this turbulence appears to be somewhat larger than that which would be caused by the in-flow of quantum foam towards the Sun, and indeed following on from Sect.2.9 some of this turbulence may be associated with galactic in-flow into the Milky Way. This in-flow turbulence is a form of gravitational wave and the ability of gas-mode Michelson interferometers to detect absolute motion means that experimental evidence of such a wave phenomena has been available for a considerable period of time, but suppressed along with the detection of absolute motion itself. Of course flow equations do not exhibit those gravitational waves of the form that have been predicted to exist based on the Einstein equations, and which are supposed to propagate at the speed of light. All this means that gravitational wave phenomena is very easy to detect and amounts to new physics that can be studied in much detail, particularly using the new 1st-order interferometer discussed in [1].

2.11 Absolute Motion and Quantum Gravity

Absolute rotational motion had been recognised as a meaningful and obervable phenomena from the very beginning of physics. Newton had used his rotating bucket experiment to illustrate the reality of absolute rotational motion, and later Foucault and Sagnac provided further experimental proof. But for absolute linear motion the history would turm out to be completely different. It was generally thought that absolute linear motion was undetectable, at least until Maxwell's electromagnetic theory appeared to require it. In perhaps the most bizarre sequence of events in modern science it turns out that absolute linear motion has been apparent within experimental data for over 100 years. It was missed in the first experiment designed to detect it and from then on for a variety of sociological reasons it became a concept rejected by physicists and banned from their journals despite continuing new experimental evidence. Those who pursued the scientific evidence were treated with scorn and ridicule. Even worse was the impasse that this obstruction of the scientific process resulted in, namely the halting of nearly all progress in furthering our understanding of the phenomena of gravity. For it is clear from all the experiments that were capable of detecting absolute motion that there is present in that data evidence of turbulence within the velocity field. Both the in-flow itself and the turbulence are manifestations at a classical level of what is essentially quantum gravity processes.

Process Physics has given a unification of explanation and description of physical phenomena based upon the limitations of formal syntactical systems which had nevertheless achieved a remarkable encapsulation of many phenomena, albeit in a disjointed and confused manner, and with a dysfunctional ontology attached for good measure. As argued in [1, 2] space is a quantum system continually classicalised by on-going non-local collapse processes. The emergent phenomena is foundational to existence and experientialism. Gravity in this system is caused by differences in the rate of processing of the cellular information within the network which we experience as space, and consequentially there is a differential flow of information which can be affected by the presence of matter or even by space itself. Of course the motion of matter including photons with respect to that spatial information content is detectable because it affects the geometrical and chronological attributes of that matter, and the experimental evidence for this has been exhaustively discussed in [1, 2]. What has become very clear is that the phenomena of gravity is only understandable once we have this unification of the quantum phenomena of matter and the quantum phenomena of space itself. In Process Physics the difference between matter and space is subtle. It comes down to the difference between informational patterns that are topologically preserved and those information patterns that are not. One outcome of this unification is that as a consequence of having a quantum phenomena of space itself we obtain an informational explanation for gravity, and which at a suitable level has an emergent quantum description. In this sense we have an emergent quantum theory of gravity. Of course no such quantum description of gravity is derivable from quantising Einsteinian gravity itself. This follows on two counts, one is that the Einstein gravity formalism fails on several levels, as discussed previously, and second that quantisation has no validity as a means of uncovering deeper physics. Most surprising of all is that having uncovered the logical necessity for gravitational phenomena it also appears that even the seemingly well-founded Newtonian account of gravity has major failings. The denial of this possibility has resulted in an unproductive search for dark matter. Indeed like dark matter and spacetime much of present day physics has all the hallmarks of another episode of Ptolemy's epicycles, namely concepts that appear to be well founded but in the end turn out to be illusions, and ones that have acquired the status of dogma.

If the Michelson-Morley experiment had been properly analysed and the phenomena revealed by the data exposed, and this would have required in 1887 that Newtonian physics be altered, then as well as the subsequent path of physics being very different, physicists would almost certainly have discovered both the gravitational in-flow effect and associated turbulence.

It is clear then that observation and measurement of absolute motion leads directly to a changed paradigm regarding the nature and manifestations of gravitational phenomena, and that the new 1st-order interferometer described in [1] will provide an extremely simple device to uncover aspects of gravity previously denied by current physics. There are two aspects of such an experimental program. One is the characterisation of the turbulence and its linking to the new non-linear term in the velocity field theory. This is a top down program. The second aspect is a bottom-up approach where the form of the velocity field theory, or its modification, is derived from the deeper informational process physics. This is essentially the quantum gravity route. The turbulence is of course essentially a gravitational wave phenomena and networks of 1st-order interferometers will permit spatial and time series analysis. There are a number of other gravitational anomalies which may also now be studied using such an interferometer network, and so much new physics can be expected to be uncovered.

3 Conclusions

Here a new theory of gravity has been proposed. It passes all the key existing tests, and also appears to be capable of explaining numerous gravitational anomalies. The phenomena present in these anomalies provide opportunities for further tests of the new gravitational physics. This new theory is supported by the Miller abolute motion experiment in that it reveals the turbulent in-flow of space associated with gravity, as well as the existence of absolute motion itself. This clearly refutes the fundamental postulates of the Einstein reinterpretation of the relativitsic effects that had been developed by Lorentz and others. Indeed these experiments are consistent with the Lorentzian relativity in which reality displays both absolute motion effects *and* relativistic effects. As discussed in detail in [1] it is absolute motion that actually causes these relativistic effects. Both General Relativity and the Newtonian theory, for which GR was constructed to agree with in the low speed limit, are refuted by these experiments. These developments are discussed more extensively in [1]. As well the dynamical structure of stars needs to be reexamined in the light of this new theory, and this may have some relevance to the neutrino flux problem.

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