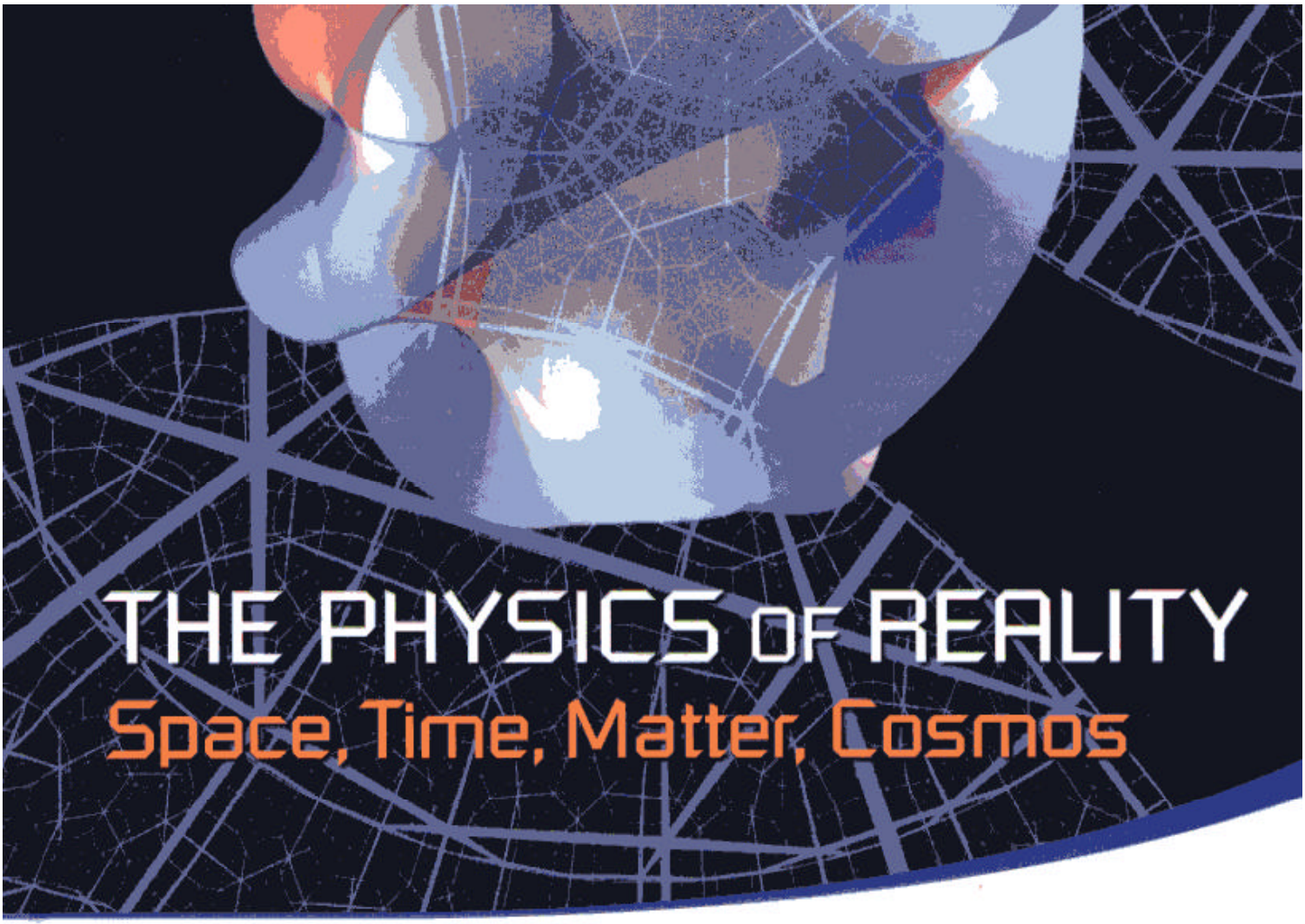

THE PHYSICS OF REALITY

Space, Time, Matter, Cosmos

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Osmaston Miles F. (2013)

Implementing Maxwell's aether illuminates the physics of gravitation: the gravity-electric (G-E) field, evident at every scale, from the ionosphere to spiral galaxies and a neutron star extreme.
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Erratum

On p. 393, Figure 4, at the start of Section 10, should appear like this:-

10. A G-E Field Model for CMEs and Granulation

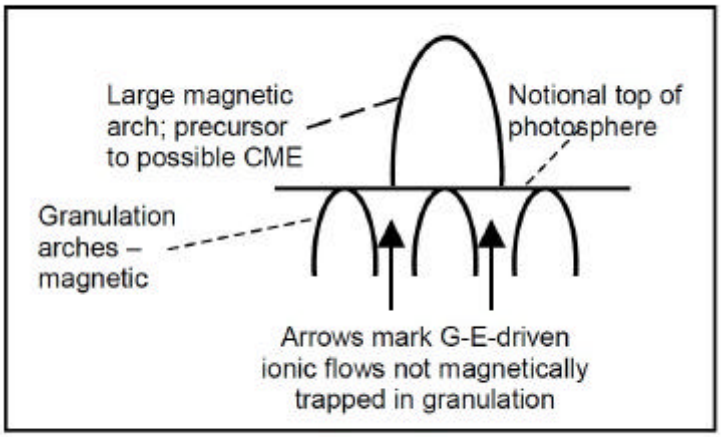

Figure 4. Proposed relationships in the outermost part of the Sun.

IMPLEMENTING MAXWELL'S AETHER ILLUMINATES THE PHYSICS OF GRAVITATION: THE GRAVITY-ELECTRIC (G-E) FIELD, EVIDENT AT EVERY SCALE, FROM THE IONOSPHERE TO SPIRAL GALAXIES AND A NEUTRON STAR EXTREME

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Relativity Theory (RT) incorporates serious inconsistencies:- (1) embracing the function of transverse e.m. (TEM) waves as perfect messengers but denying the presence of a Maxwell's equations aether lest it might invalidate that perfection, despite it being essential for their existence; (2) assuming the physical absurdity that the external physical properties (mass, magnetic moment) of fundamental particles can be developed in zero volume ("spatially infinitesimal singularities"), despite powerful evidence that they are of finite size. It thereby overlooks that if two electromagnetically defined objects are of finite size the force communication between them is progressively velocity-limited, falling to zero at ***c*** [Heaviside 1889]. So this is what happens in electromagnetic accelerators, not mass-increase. For more than a century these defects have hampered progress in understanding the physics of the mass property of particles, thus compelling it to be regarded as 'intrinsic' to those specific infinitesimal points in space.

A rewarding substitute, **Continuum Theory (CT),** outlined here, (A) implements Maxwell's aether as a massless all-pervasive quasi-superfluid elastic continuum of (negative) electric charge, and (B) follows others [Clerk Maxwell, both Thompsons, Larmor, Milner] in seeing mass-bearing fundamental particles as vortical constructs of aether in motion, not as dichotomously different from it. To encompass that motion, these cannot be infinitesimal singularities. Electron-positron scattering provides guidance as to that size. For oppositely-charged particles, one sort contains more aether and the other less, so particle-pair creation is 'easy', and abundantly observed, but has been attributed to 'finding'. This electron-positron relationship defines mean aether density as $>10^{30}$ coulomb.cm^{-3}, thus constituting the near-irrotational reference frame of our directional devices. Its inherent self-repulsion also offers an unfathomable force capability should the means for displacing its local density exist; that, we show, is the nature of gravitational action and brings gravitation into the electromagnetic family of forces.

Under (B) the particle mass is measured by the aether-sucking capability of its vortex, positive-only gravitation being because the outward-diminishing force developed by each makes mutual convergence at any given point the statistically prevalent expectation. This activity maintains a radial aether (charge) density gradient - the Gravity-Electric (G-E) Field - around and within any gravitationally retained assemblage. So Newton's is an incomplete description of gravitation; the corresponding G-E field is an inseparable facet of the action. The effect on ***c*** of that charge density gradient yields gravitational lensing.

We find that G-E field action on plasma is astronomically ubiquitous. This strictly radial outward force on ions has the property of increasing the orbital angular momentum of material, by moving it outwards, but at constant tangential velocity. Spiral galaxies no longer require Cold Dark Matter (CDM) to explain this. The force (maybe 30 V.m^{-1} at solar surface) has comprehensive relevance to the high orbital a.m. achieved during solar planet formation, to their prograde spins and to exoplanet observations. The growth of high-mass stars is impossible if radiation pressure rules, whereas G-E field repulsion is low during dust-opaque infall, driving their prodigious mass loss rates when infall ceases and the star establishes an ionized environment. Its biggest force-effect (~10^{12} V.m^{-1}) is developed at neutron stars, where it is likely the force of supernova explosions, and leads to a fertile model for pulsars and the acceleration of 10^{19} eV extreme-energy cosmic rays. Our only directly observed measure of the G-E field is recorded at about 1 V.m^{-1} in the ionosphere-to-Earth electric potential. And temporary local changes of ionosphere electron density, monitored by radio and satellite, have been discovered to act as earthquake precursors, presumably, we suggest, by recording change of G-E field and gravitational potential at Earth surface when its elastic deformation occurs, even when this is deep below electrically conducting ocean water.

The paper concludes by noting experimental evidence of the irrelevance of the Lorentz transformations in CT and with a discussion of CT's competence in such matters as perihelion advance and Sagnac effect, widely regarded as exclusively RT attributes. Finally we broach the notion that the aether is the site of inertia. This could explain the established equality of gravitational and inertial masses.

In an accompanying paper we explore the cosmological and other aspects of 'making particles out of aether'. This link undermines the expectation of fully distinct dynamical behaviour by particles and aether which motivated the Michelson-Morley experiment.

Keywords: Maxwell's aether; gravitation physics; planetary systems; star formation; spiral galaxies; dark matter; neutron stars; supernovae; origin of inertia; Sagnac effect.

Foreword. This paper is written with certain philosophical maxims in mind. "It is what we think we know that prevents us from learning" (Claude Bernard). If what you think you know leads you to the absurd, then the choice lies between piling on more absurdity and starting afresh. Incisive recognition and avoidance of absurdity is therefore crucial.

1. Introduction

Papers whose titles suggest – as does this one – that they strike at the roots of currently accepted scientific thinking often arise from their author's personal discontent with one or more of its tenets. So we note here that the new basis for physical theory, which I have named Continuum Theory (CT), aspects of which

are outlined in this paper, has a more substantial basis than that. Indeed it originates from a discovery I made in 1959 in the course of an intensive and secret research programme to develop airborne astronavigation equipment for use by missile-carrying high-flying aircraft.

The matter at issue was the already well-observed sky brightness distribution at those heights [1] which, to a degree important in this case, does not conform to the expectation of current (primarily Rayleigh) scattering theory, as stressed by Barr [2]. So we tried a treatment involving deflection scattering by an atmosphere-associated randomly moving aether. And, in retrospect somewhat serendipitously, it worked, almost to perfection, as instantly recognized in the establishment. But secrecy prevented my subsequent access to the papers and inhibited public development of it for many years.

Main Contents

So the characterization of the aether presented in this paper is ultimately the product of satisfying the requirement that, in effect, the motion of the aether be closely related to that of the particles in the domain concerned; a 'particle-tied aether', in fact (Osmaston 2003 [3]). But the purpose of this paper is then to show that this characterization has led us, as an inherent by-product, to an insight into the fundamental physics of gravitation that seems to be remarkably rewarded by supporting evidence for its action at all the astronomical scales considered so far.

The quite different but even wider significance of the scattering action which triggered all these studies is discussed in the accompanying second paper [68].

2. The Physical Mechanism of Gravitation: Setting the Scene

The idea that gravitation might be some kind of (large-scale) vortex effect, but in an aether of unknown character, seems to have been originated by Kepler (1609) but was soon followed by Descartes (1637). Newton (1726) picked it up but seems to have decided to concentrate on the behaviour of the force rather than upon its origin.

But, from the early 1860s, the particulate nature of matter now being clear, James Clerk Maxwell, William Thomson (Kelvin) and several others started to think in terms of individual 'particles' – they began with molecules, the smallest objects then known to them – having a vortical character ('vortex rings') of aether in motion as the source of their mutual attraction and mass property.

Here, 150 years later, we will be building upon those endeavours.

Then, in 1865-1878, came Maxwell's famous equations based on the findings of Gauss, Faraday and Ampère. From these he established the properties of an aether, essential for the existence and propagation of transverse electromagnetic (TEM) waves. These are continuous math functions, with no suggestion that the aether could have a particulate nature, such as he had been envisaging at the particle scale. Their crucial, and apparently contradictory, requirement which I address here and implement, as perhaps never before, is that the aether must combine quasi-superfluid behaviour with elasticity in shear.

The final item in our scene is that JJ Thomson's (1897) cathode rays work led people to identify the electron as **the** carrier of electric charge, thus regarding negative electric charge to be particulate in nature, not to be found in any other guise.

Here, we will reason that, on the contrary, the vast majority of negative charge in the Universe exists in a distributed form, with electrons incorporating only a tiny fraction of it.

3. Two Disastrous Absurdities lie in RT's Foundations

Firstly. Embracing the function of transverse e.m. (TEM) waves as perfect messengers between inertial

frames (hence the Lorentz transformations) but denying the presence of a Maxwell's equations aether, essential for their existence. This was like saying "I want the ripples but not the water".

This enabled Einstein to avoid any possibility of transmission effects, associated with the aether, and to postulate "***c*** *is an absolute constant of physics"*. Incisively, this is here seen as physically unrealistic in a real interactive Universe. Everything affects everything else, however slightly that may be. This unrealism has, in turn, spawned a widespread view that there are indeed many such "absolute constants of physics". Rather, a more fertile view for understanding the physics which underlies them might be to regard such numbers as convenient approximations within the range of conditions available for observation.

As noted above, it was in fact the observation and my recognition of one of those TEM wave transmission effects in 1959 which started me along the present trail.

Secondly. Promoting, despite growing contrary evidence, the physical absurdity, central to the GR equations, that fundamental particles are 'infinitesimal singularities'. This would require that their external physical properties – mass, magnetic moment – either be developed within zero volume or (by inventing a new law of physics) treated as 'intrinsic' to that particular infinitesimal space. Perhaps the most explicit evidence of non-zero size is the widely used magnetic resonance imaging (MRI scan) in medicine, which requires the proton's magnetic axis to be long enough to be made to wobble. Another emerges from the electron-positron scattering observations with LEP.

The consequence for fundamental physics of this 'singularity' perspective has been severe. In any e.-m. theory, force communication between two electro-magnetically defined objects is, IF they are of finite size, progressively velocity-limited by access delay, to being zero at ***c*** (e.g. Heaviside [4]. A similar limitation had been inferred experimentally by the physicist *Wilhelm Weber* in 1854 [5]). Retardation on impact will be similarly limited, increasing particle penetration. The shock-wave-like sweep-back angle seen in the Çerenkov effect, daily used for determining particle velocities, constitutes observational confirmation of the effect, albeit in a material where the TEM-wave speed is deliberately reduced by the refractive index. So this is what we observe with electromagnetic accelerators, not mass-increase. The extra mass that actually emerges has been created from the enveloping aether, also accelerated - see later.

This opens our door to the 'designing' of a particle's interior to give each a specific mass, behaving as such to any observer, free of any circumstantial dependence.

4. CT as a Rewarding Replacement for RT: the two-part Basis of Continuum Theory (CT)

(A) Implementing Maxwell's aether as a massless, all-pervasive, compressible, quasi-superfluid continuum of negative electric charge

It is NOT a **carrier** of electric charge; electric charge is its very nature, so it is **massless** and rotation motions do not fly apart;

it is **all-pervasive,** even to the interiors of atoms;

it is **compressible**, constrained by the self-repulsion of its charge;

it is **superfluid,** so its motions can be perpetual, but it is only **quasi-superfluid**, because shearing motions of charge are subject to Ampére's law. This provides magnetic energy storage and effective 'elasticity' in shear needed to support the existence and propagation of transverse electromagnetic (TEM) waves**.** It is also important because the lack of viscosity if it were a pure superfluid would mean that its relative motions would be incapable of inducing the rotational disturbances of it that we will be considering as being in the nature of fundmental particles; (we show later that this property of coupling in shear arises valuably elsewhere also);

it is a true **continuum**, so it cannot exhibit discrete subdivision, although its density may vary.

(B) Following Maxwell [6], W.Thomson (Kelvin) [7], J.J.Thomson [8], Larmor [9] and Milner [10] in making finite-sized particles out of it, as vortical constructs of aether motion.

Milner [10], indeed, regarded the aether as a "fundamental substratum of matter from which we can imagine particles are formed". We will do the same.

In combination, (A) and (B) will lead us in two important directions:-

(a) the physical mechanism of gravitation — this paper;

(b) the particle-associated random motion of the aether — our companion paper [68].

5. Constructing Fundamental Particles out of Aether

5.1. Quantifying the Aether

The aether can only be of one sort of charge, so how do

we get particles with opposite charge? To provide electrons and positrons with opposite **relative** charge, I suppose one to contain *more* aether and the other *less*.[a]

Figure 1 shows notional aether density profiles that would equip otherwise-similar(?) electron and positron aether dynamical configurations with equal and opposite amounts of electric charge (aether).

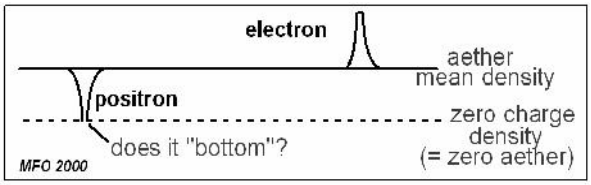

Figure 1. Diagram based on a negative-charge aether. Because of its ubiquitous continuum nature, less than zero aether is not an option.

On this basis the mean charge density of the aether must at least equal the peak charge density in a positron. From the LEP scattering-determined 'effective' electron-positron sizes ($<10^{-16}$cm[b]) and its known (relative) charge we find the **aether mean charge density must be at least 10^{30} Coulombs.cm^{-3} !** *(N.B. 1 Ampere = 1 C.s^{-1})*

In this manner the familiar electron-positron pairs would easily be made without introducing or removing any aether, but merely by 'stirring it up' appropriately, which could explain why they mirror one another. In turn, if the electron exemplifies a particularly stable aether dynamical form, it follows that the mean density of the aether defines the electron as the elementary unit of charge throughout the Universe; and likewise the uniformity of atoms built by its means. This is an important result in a continuous-creation Universe in which (see companion paper [68]), with no BigBang, there was never mutual proximity to give uniformity.

This huge charge density of the aether gives its self-repulsion an immense force potential if it is locally displaced (gravitation, see next Section). Except on the smallest of scales (individual fundamental particles), it also may well provide the irrotational reference frame on which our directional devices depend. Those devices (Foucault pendulum, mechanical gyroscope, laser ring gyro) work in two quite different ways, inertial-gravitational and electromagnetic-Sagnac. So it would not be trivial to do both, the aether being the link. We will return to this in Section 16.

5.2. Mass and Mutual Gravitation as the Result of Vortical Action: a Speculative look Inside a Finite-sized Fundamental Particle made of Aether in Motion (Fig. 2)

If this aether dynamical form (Fig. 2), or something like it, is the origin of the mass property, **TEM waves do not involve the right kind of aether motion to give them mass.**

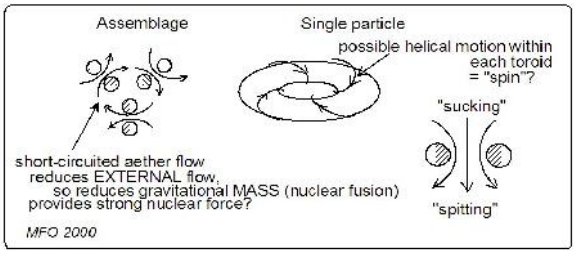

Figure 2. On the right is a cross-section of the central image. The mass of a particle or particle assemblage is measured by its (aether-sucking) ability to attract others. Charge circulation gives its axis and magnetic moment. On the left, three quarks (protons) are stable because of good aether-circuiting although adding an electron (neutrons) causes instability in a free state (~10-minute half-life). Two quarks (mesons) are unstable ($<10^{-7}$ sec) because aether-circuiting is poor also (strong nuclear force is insufficient).

Radiation pressure, often treated as the result of having such mass, is in fact well known as a perfectly valid electromagnetic force. The related, relativistic, idea of TEM waves being subject to gravitational redshift is considered in our companion paper [68].

In the same vein, we [3] have considered neutrinos to be pure eddies of aether, without vortical action, so devoid of any mass property, their energy content being that associated with the aether's eddy motion.

On the basis of Figures 1 and 2 the creation of mass-bearing electron-positron, or other particle-antiparticle pairs is possible merely by the addition of the appropriate rotational energy of aether motion[c]. So here again, if the Second Law is to be sustained, the energy-content of aether motions must be recognized in energy-balance (e.g. entropy) calculations [3]. In our second paper [68] we develop the important Universal

[a] In this suggestion I am apparently preceded by an editorial in The Electrician (1891)[11], commenting on William Crookes' presidential address to the IEE, that he had failed to consider the existence of positive and negative electricity as possibly being "two converse manifestations of one and the same entity" (see p.329), although according to Isobel Falconer (pers comm 2010) this idea was not altogether new even then. There may be other priorities unnoted here.

[b] G.E.Kalmus, pers.comms.1991, 1996

[c] That creation of mass may, on an $E = mc^2$ basis, have occurred from the energy put in, is not a new idea, but our concern is with how that transformation occurs, not just to invoke the magical action of a boson.

cosmogony aspects of 'making particles out of randomly moving aether', which would be impossible unless aether motion contains energy.

The origin of gravity. Mutual attraction by vortical-structured particles predominates statistically over repulsion because of the inevitable force gradient around a body. At a given position on that gradient, infinitesimal convergence has more force-effect than identical separation. That's why we only have

positive-only gravitation – no negative.

6. Gravitational Action – Generation of the Radial Gravity-Electric (G-E) Field

So in a gravitational assemblage the particles are, by partial self-orientation, 'busy' sucking aether out of the interior. This reduction is opposed by the restorative elastic **self-repulsion of the aether's electric charge**, which is therefore **the underlying nature of Newtonian gravity**. Extreme force is available if the 'sucking' is intense.

But the resulting radial gradient of aether density is an electric field - **the G-E field**. Similar interaction with the rest of the Universe causes the G-E field to extend indefinitely outside the body, as does its Newtonian field also.

So the Newtonian field and the Gravity-Electric (G-E) field are but facets of a single physical mechanism and one is never present without the other.

Because of this direct relationship, G-E field strength at the surface of an object will apparently increase, perhaps linearly but in a manner to be determined, with the Newtonian potential there, being highest at neutron stars, with white dwarfs second.

But note that, unlike the Newtonian, the G-E field is a **discriminatory force**, only producing actual radial repulsion on sufficiently ionized plasma and other entrained material.

7. Quantifying the G-E Field

7.1. The *G-E Field of the Earth – Observations*

Persistent potential difference exists — Earth surface to ionosphere. Around 90% of all steep lightning strikes bring negative charge to ground. Satellites observe sprites from base-ionosphere (~75km) to thunderclouds. The overall potential difference from the F-layer (~300km) is assessed at ~250kV **(= ~1 V.m^{-1})** [12]

The account given by [13] that local changes in ionosphere electron density behave as precursors to major earthquakes, has aroused much interest. But their occurrence even when these occur deep beneath electrically conducting sea-water [14,15] probably rules out interpretation based either on the effusions from active fractures or on the electromagnetic effects of deforming crystalline rock. So we propose that they may actually reflect gravity and G-E field changes at the Earth surface level as it is deformed elastically by plate dynamical forces.

7.2. The G-E Field of Stars

A linear extrapolation from the Earth value, based on gravity, would give the following, but it is unclear at present whether linear extrpolation with ***g*** is actually appropriate:-

~30 V.m^{-1} at the solar surface, and
approaching 10^{12} V.m^{-1} at a neutron star.

8. Seven Major Sites of G-E Field Action

1) Inside stars it is an additional radial support force, reducing the required rate of nucleosynthesis. Solar neutrino deficiency[d] and longer stellar timescales (OK in a no-Big-Bang Universe – see companion paper [68]). Raises the 'Chandrasekhar mass limit' for Type Ia supernovae, as recently observed [16,17].

2) Outside stars, its radial charge density gradient gives lensing (lower density gives lower ***c*** in Maxwell's equations). So ***c*** is not 'a constant of physics'.

3) Building massive stars. This is not possible unless the G-E field is the main agent (not radiation pressure (RP)) of their subsequent prodigious rates of mass loss (e.g. 1 solar mass/20 ka). Growth is then possible by the scant G-E action upon dust-opaque plasma-poor infall from a cloud. So the Newtonian infall force wins, as long as the star remains in the cloud. On emerging, the star will ionize its envelope, and the G-E field plus RP will take over, giving the big mass-loss rates. That mass-loss will enhance the opacity of the neighbour-hood, encouraging more high-mass stars to form. Is this the mechanism of the starburst phenomenon?

The next four sites, listed below, are dealt with in more detail in the succeeding Sections of this paper.

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[d] Nuclear reaction rate inside the Sun varies approximately as the 25th power of the temperature, so a tiny drop in temperature, far too small to have an observable helioseismological effect, would suffice to halve the reaction rate and explain the halved neutrino output.

4) Inner heliosphere. Coronal energy, accelerating the solar wind, releasing CMEs, causing photosphere opacity and driving granulation.

5) During planetary system formation. Outward force driving the plasma-rich protoplanetary disc wind, needed for moving planetary nuclei from very close-in positions (*cf*. ~22% of all exoplanets detected) to attain their high specific orbital angular momenta, relative to solar or other 'parent' star a.m.

6) In spiral galaxies. Driving axial-infall material outwards at **constant tangential velocity**, removing the need for Cold Dark Matter (CDM) to explain this very widespread dynamical pattern. (Same basic pattern as for planets (5)).

7) At the surfaces of neutron stars. For driving supernova explosions that leave a neutron core, for driving pulsar beams and accelerating the high-end cosmic rays (10^{19} eV).

9. The G-E Field in the Inner Heliosphere: a Small Selection of the Effects

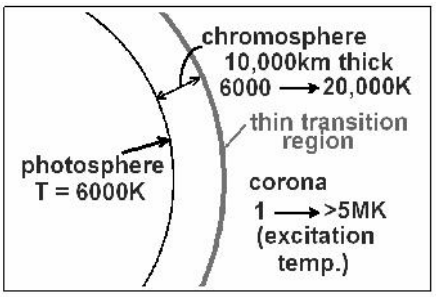

Figure 3. Approximate layout of the inner heliosphere region.

1) Coronal energy support generally. The *acceleration* of the Fast Solar Wind (FSW) particle streams from coronal holes suggest the action of an electric gradient upon ions.

2) Coronal Mass Ejections (CMEs). Bunches (>10^9 tonnes) of ions seen to *accelerate outward* to 400-600km.s^{-1}. Some ion speeds attain ~2000km.s^{-1}.

3) The coronal emission line spectrum shows hugely stripped ion species *e.g*. Fe^{XXIV} (helium-like). This implies impact by other high-velocity ions — very high *excitation* temperature; *not* LTE.

4) In coronal streamers, Fe^{XIII} and Si^{XII} ions are often abundant in emission and stay there for months. This requires electrical support. Gravitational settling time is of the order of a day.

5) The solar visual 'surface', the photosphere, is due to the strong absorption and opacity of the negative H ion [18]. Its very low Ionization Potential (0.75 eV) makes it radiant. Its abundance there needs a source of electrons. These electrons were detached from solar wind ions and returned to the Sun by the electric gradient; they cannot have come from H (IP=13.6 eV).

6) Solar wind ions (FIP mostly 4.5-8.2 eV) arise at low chromosphere temperature level (7 kK+). Their extraction and differential acceleration requires an electric field.

7) Strong light-isotope enhancement in frequent wind events (>1000-fold for ^{3}He/^{4}He) [19] all the way to Mg. Selection for charge-to-mass ratio is the property of an electric field.

Simple calculation suggests that all or most of these are well within the capacity of our extrapolated (Sect. 7.2) **30 V.m^{-1}** at the solar surface.

Our inference (Fig. 1) that the polarity of the aether's charge is negative is based on these phenomena. Note that the acceleration will be due not only to the progressive action of the G-E field itself but also to any increasing ionization by mutual impact. Perhaps this is what is happening in the transition zone, the electrons detached being those seen entrained in the solar wind.

10. A G-E Field Model for CMEs and Granulation

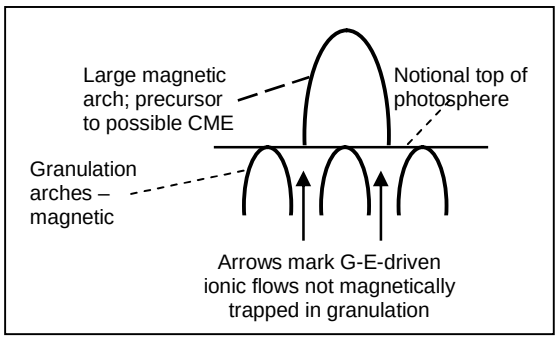

Figure 4. Proposed relationships in the outermost part of the Sun.

The basis for our model (Fig. 4) is that the G-E field is continually driving positive ions outwards from the solar interior. We attribute the growth of magnetic arches to this flow, in the following manner. When an incipent magnetic arch forms, the ions will spiral up its legs in opposite directions. When they meet at the top and many of them are retained by the magnetic field, they will accumulate there and the radial G-E field

force upon them will load the arch and stretch it outward. This will continue for as long as the footpoints of the arch are in registration with those streams of ions from the interior. If this registration is lost, this loading will weaken and the arch will shrink again. This is the observed majority behaviour.

But occasionally the loading will become sufficient to break the arch, releasing the accumulated ions as a CME. Strong radio emission is precursory and concurrent with CMEs, which we attribute to the synchrotron radiation from the spiralling ions.

Sunspots expose deeper levels in the solar interior and the temperature there is seen to be **lower** than that of the photosphere. That's why they look dark. This means that the granulation cannot, as widely assumed, be driven by thermal convection. We propose that the effective photosphere temperature is due to the trapping of ions and their G-E field-acquired energy, in arches analogous to those at the higher, proto-CME, level. The ions which feed the latter are those that escape between the granulation structures. Solar flares, on the other hand, are then perhaps when a group of granulation arches fail, CME-like, releasing more energetic ions than those which produce CMEs.

11. Is this Positive Behaviour of the Sun and Stars Permanent?

Effectively, Yes. A simple estimate for the Sun shows that removal of all the negative aether in its interior would provide more than 40 orders more coulombs of effective positive charge than is required to expel all its protons. Evcn the hugely denser packing of mass inside neutron stars seems insufficient to reverse this conclusion. Hence our estimate of their intense G-E fields (Sect. 7.2) and their effects (later in this paper).

12. Constructing the Solar Planetary System – and Others

Repeatedly, but virtually unavailingly, Jeans [20], Lyttleton [21], Jeffreys [22], Spencer-Jones [23], Woolfson [24] and Gold [25] have stressed that the material in the Sun and in our planetary system must have had dynamically separate origins, NOT the common origin implied by the Single Contracting Solar Nebula (SCSN) model of Kant and Laplace.

The near match between the planetary compositions and the solar spectrum has been thought to validate SCSN. But the Sun is an unmixed star with a tachocline at ~$0.71R_{sun}$. The mass above it is open to modification, see below, so it may not match the deep interior, as SCSN assumes.

An important constraint on construction is the finding [26] that the very short-life isotope 41Ca (half-life 102ka), present in CAIs (refractory Calcium-Aluminium-rich Inclusions in meteorites), and its relation to 26Al (half-life 717ka) also in chondrules, requires that construction be completed (no more accretion on the relevant asteroid) within about 1Ma after the 41Ca had been produced by a stellar explosion. That seems impossible in SCSN.

With these points in mind, we will now show that the G-E field has an essential rôle to play.

12.1. The four main Dynamical Problems

1) Mean specific angular momentum (defined as the product of orbital radius and velocity) of the planet materials is >130,000 times the a.m. of that in the Sun. Together with the a.m. of the >10-fold more mass they were formed from, *Where did all this a.m. come from? Could action of the G-E Field have done it?*

2) The 6-degree tilt of the planetary dynamical plane w.r.t. the solar equator. *Tilting in SCSN would cause vigorous precession and loss of their good conformity (bar Mercury) to that plane.*

3) All but one of our planets preserve near-circular orbits, recording the completion of construction in the presence of nebular gas-drag. But in the presence of nebular gas, protoplanetary bodies would spiral into the Sun in far less time than it takes to build a planet. *Could the G-E field prevent that?*

4) If you restore Uranus' axis to an upright position so that its inner satellites are prograde, like the other Giant Planets, the spins of all but one (Venus) of the planets are prograde; a systematic behaviour that speaks of gravitational nucleation. But vorticity in a Keplerian disc is retrograde. *Where did they nucleate and get their spins? Was the velocity pattern in the protoplanetary disc Keplerian?*

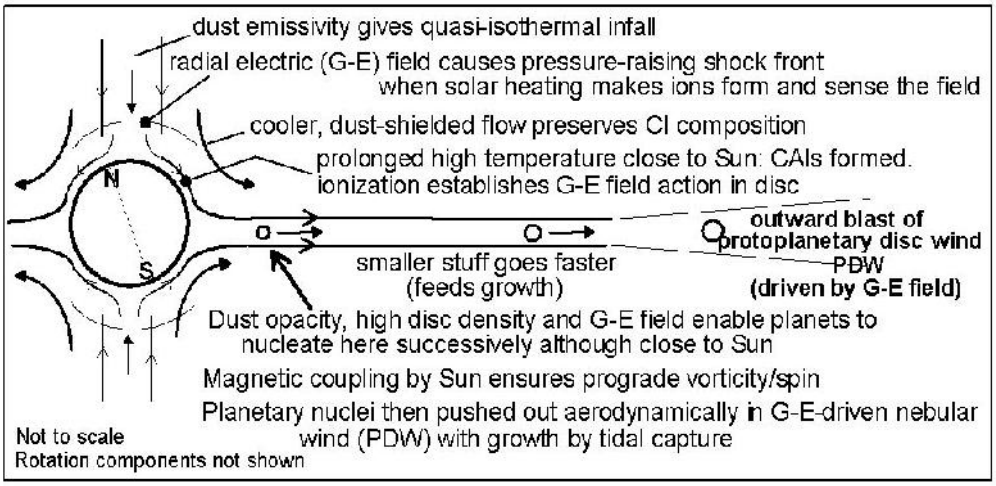

Figure 5. Principal features of the planet-forming second stage of the CT new scenario for forming the solar and other planetary systems, showing the conditions during protosolar traverse of the second dust cloud, whose initial temperature would have been 10K or less. So the resulting protoplanetary disc would be much cooler than in SCSN. Infall will have been bipolar, as shown, only if the protoSun's velocity through the cloud was low. Growth by tidal capture preserves the protoplanet's prograde spin if captures are a dynamically balanced population..

12.2. The CT Two-stage new Scenario for Planet Formation in the Solar System (Fig. 5) and Others

In this scenario the protoSun formed in one dust cloud and became an already H-burning star. Later, (stage 2) it traversed another cloud, with high dust-opacity materials, from which the planets were formed *and* the outer 2.5% of the Sun's mass (above the tachocline) was added to and not mixed in, so their compositions nearly match.

Passing near a recent stellar explosion in this cloud enabled short-life radionuclei to be acquired.

In contrast to SCSN the flow pattern was a throughput of materials, drawn from the cloud and passed outward as the protoplanetary disc, and further.

This 2-stage new scenario (originated by me in 2000 [27]) for formation of the Solar System (SS) has now been repeated, with developments, ten times at different venues. These developments have increasingly underlined the part that needs to have been played by the solar G-E field and this is our objective here also.

The major backdrop feature to have emerged since then is that throughout that interval an almost unvarying ~22% of all exoplanets that had been detected orbit their star, whatever its size, within 12 solar radii (semi-major axis) of it's centre. Why so many so close? Why is the SS now so different, with Mercury, our nearest, at 83 solar radii? Figure 6 shows the recent situation in 2012 as the total number approached 750.

In our CT scenario (Fig. 5) the dynamics of infall are critically determined in the manner outlined above (Sect. 8) in connection with infall to build high-mass stars. The imbalance which here determines that the infall is quasi-polar and the outflow quasi-equatorial is initially determined by the centrifugal force added by the quasi-equatorial magnetic coupling to that part of the new envelope that has become ionized. This determines the prograde orbital direction of any protoplanets nucleated in the resulting disc.

I speculate that the presence of such a magnetic field, thought to be dependent in turn upon the presence of a tachocline, probably absent in the A and earlier-type stars subject to high infall rates, is what may determine whether a protoplanetary disc is the result or that the star continues to build.

Once the disc outflow has started, it carries this plasma out to great radial distances, adding a large integrated G-E field force on it, which drives the Protoplanetary Disc Wind (PDW). Within this PDW the protoplanetary nuclei grow by tidal capture of smaller self-accreted lumps being blown past them.

Preservation of the early-acquired systematically prograde spins — the result of the magnetic coupling — means that the widely-supposed random impact process of Safronov, Weidenschilling and others, which would yield a random result, cannot have been the means of growth. To make it systematically efficient the tidal capture process needs the assistance (at least at the first pass) of nebular gas-drag, as provided here, and it greatly increases the capture cross-section and

the resulting growth rate. Further evidence that proto-planetary growth was **not** mainly by impact is that it would end, probably in post-nebula time, in multiple occurrence of late giant impacts. In fact, all except Mercury preserve the nearly circular orbits inherited from construction in the presence of nebular gas-drag.

Glose-in gravitational nucleation is facilitated because the disc density is there at its highest and it avoids encountering the Roche condition constraint, which would inhibit it, because the G-E field, acting on the ionized component, will generate a force gradient in the opposite direction to the Newtonian gravity one. If these gradients exactly balance, the Roche condition becomes irrelevant. A further factor would be that the dust opacity of the nebular material could greatly shield the nucleation process from the solar radiation, keeping it cool for gravitational nucleation.

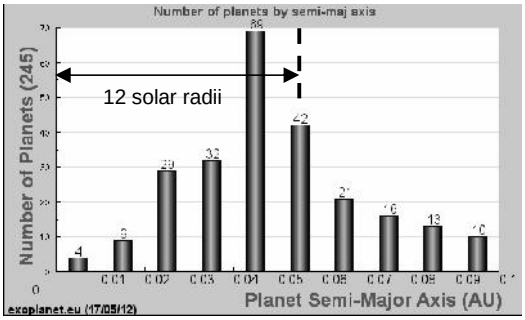

Figure 6. Distribution of close-in exoplanets as at 15th May 2012. Modified derivation from J.Schneider at *exoplanet.eu*. The preferred nucleation distance is clearly about 10 solar radii.

We note above (Fig. 6) that so many exoplanets orbit their star within 12 solar radii of its centre. But in that position it is far too hot for them to have been there long. To have migrated inward, as proposed in various other SS scenarios, including the currently favoured 'Nice' model [28, 29], how did they acquire that higher orbital a.m. to start with?

So we infer that we are seeing these exoplanets not long after emerging from being formed in close-in positions within a high-opacity cloud, which shielded them from their star (and from our view). Now deprived of a G-E field-driven PDW to move them outwards, they are stuck there until they vanish by evaporation in the inferno, leaving only those earlier-formed planets in those systems that had got far enough out to avoid such a fate. Mercury is our closest-in example of that.

If the G-E field were absent, it seems there would be no planets anywhere except close-in ones destined to become exposed to an evaporative inferno as soon as their star left the opacity of the cloud.

The disc density and the masses of the planets formed within it would be largely controlled (a) by the density of the second cloud (which will surely vary from place to place), (b) by the mass of the gathering star and (c) by its velocity of passage through it. In principle, therefore, the scenario may be capable of generating objects with masses up to those of brown dwarfs and beyond, perhaps even the junior partners of disparate binaries.

Since (b) and (c) will change very little along the path the inwards-younging sequence of planet masses in a given system will provide a crude record of (a), the second-cloud density along the star's path. In the SS example the planetless asteroid belt may mark a substantial gap in the density of that cloud. We suggest that the asteroids and many of the Giant Planet's (GP's) satellites may be representative of the outward-moving feedstock bodies from which the planets grew by tidal capture. But those now in the asteroid belt gap had no planet to do that and were left there when the Sun moved out of the second cloud and the PDW died.

12.3. Chemical Considerations

A chemical corollary of solar passage through the second cloud is that feedstock body compositions will reflect any variations present along that path. So the surface compositions of the late-formed small bodies too small to have undergone convective overturn, such as all except the largest asteroids, e.g. Ceres and Vesta, will only reflect the cloud chemistry along the last part of the path. Meteorites derived from these surfaces will show that composition.

On the other hand, the overall 'contamination' of the above-tachocline Sun and its spectrum will be some sort of average for the entire path, and therefore be a record of the mean composition from which the entire planetary system was made. For this reason the compositions of meteorites from the outsides of asteroids (as commonly selected for their lack of hydrous alteration) should no longer be regarded as our best records of overall solar planetary system composition.

While on the meteorite topic we may note that there is no chondrite-meteorite evidence that asteroid accretion continued after about 4564 Ma (youngest true chondrules). SCSN-type models (e.g. the 'Nice model' [28, 29]) which invoke planetary accretion for many tens of Ma after that seem inconsistent with this.

12.4. Orbital Eccentricities and their Causes

As noted above, the solar planets have predominantly very circular orbits, consistent with completing their growth in a gas-drag nebular disc environment. The preserved circularity of the Earth's orbit probably denies that the Moon can be the product of a giant impact upon the Earth. But the ejecta from such an impact on Mercury, which certainly had one (tilted and eccentric orbit, two-thirds of its mantle missing), offers a dynamically potential source of the lunar material for prograde tidal capture by the Earth and its reassembly in orbit [30].

On the other hand, rather than by impact, the high eccentricity of some exoplanet orbits may have another cause. It has emerged [31]**,** supported by the *exoplanet.eu* database [32], that for those in the close-in position their orbits are circular, but increasing eccentricity seems to have been developed by those with increasing orbit size. This could be attributable to the star's axis being very oblique relative to its direction of motion through the cloud. This would give a shorter path from infall to disc on one side than on the other and a correspondingly unbalanced strength of PDW, thus building the orbital eccentricity every time around.

Evidently the inclination of the solar axis w.r.t. its direction of travel through the cloud was not enough to cause such eccentricity in the solar planets, even though it was probably the cause of the 6 degree tilt of the resulting protoplanetary disc relative to the solar equator. This axis-inclination 'tolerance' can perhaps be assigned to the latitudinal range of the quasi-equatorial magnetic coupling to the disc plasma. In which case the high eccentricities seen in only some of the exoplanet population may mark only the stars that had rather high axial inclinations to their path.

12.5. Growth by Tidal Capture: Evidence from the GP Satellite Population

Strong support that SS planetary growth was by tidal capture is provided by the satellite population of the Giant Planets (GPs). Of the 166 currently known satellites of the four GPs the outer ones are small and have mixed prograde and retrograde motions. But, of the 56 which orbit their planet at 4 Gm or less, all except one are prograde. These were identified [33, 34] as the residual part (half?) of a tidal capture population, from which the retrograde captures will by tidal action have spiralled inward to grow the central body.

12.6. Growth of Planetary a.m. by G-E Field Action; Numerical Support from SS Dimensions

Now let us return to the planetary a.m. problem noted at the beginning. Specific a.m., being defined as the product of tangential velocity and the radius at which it occurs, means that the outwards push developed in an ionized disc dominated by action of the G-E field has the property, which it shares (hitherto unrecognized?) with radiation pressure, of (for example) doubling the a.m. every time the distance from the centre is doubled. For this a.m. creation to work in the case of the Solar System, the second-stage material must be acquired to a near-Sun position and be moved outward by the G-E field, with the planets growing as this is done. This is exactly what our new scenario achieves (Fig. 5).

To do that the outward movement of a large body must depend on there being sufficient aerodynamic push by the PDW. This push will fall with radial distance because both the ionic density of the PDW and the G-E field strength will do so. But we assume it will at least remain adequate for propelling feedstock materials past the body for it to capture tidally. In Section 12.7 we reason and cite chemical evidence that the nebular density was indeed at least 40 times that hitherto assumed in the canonical SCSN.

For our PDW to be driven by the strictly radial G-E field force would imply that the Newtonian force is wholly overridden. In that case the tangential velocity does not alter with radius, retaining the low value present near the root of the disc (at 10 solar radii?), where solar magnetic coupling may determine the tangential velocity. In fact the Sun, with its ~26.5 day rotation period, is in a class of slow rotators, whereas other G-type stars of similar mass have periods of 5 days or less [35]. So I infer that in generating the planetary system, magnetic coupling slowed solar rotation about 5-fold. Taking the G-E field-driven a.m. growth of disc material as starting at the outside of a polar infall column with a diameter 10% of the solar radius, simple arithmetic shows that the required full 120,000-fold a.m. differential is achieved at the orbit of Jupiter and beyond, if that 5-fold solar slowing is included.

But these a.m. values incorporate the Keplerian orbital velocities which now prevail whereas, with the G-E field on the nebular plasma in control, the tangential/orbital velocity of the created planets might all have been similar at only a few times the present 2km/s equatorial velocity of the Sun. But as the Sun

moved out of the second cloud and the PDW strength waned, the transition to Newtonian gravitation means that those that were then orbiting too slowly for that must have speeded up by spiralling inward **at constant a.m**. from well outside its present distance. This validates our use of present a.m. values.

There is no sign, so far, that any of the exoplanet-harbouring stars is spinning fast enough to account directly for the orbital a.m. of its more distant planets, so this G-E field-based resolution of the problem is almost certainly needed there too.

In the foregoing discussion we made the simplifying assumption that the tangential velocity of the G-E-driven PDW would not change with distance fom the Sun. In fact, that would only be true if the PDW only contained plasma responsive to the G-E field. But to make the planets we have to assume that the PDW was loaded aerodynamically with large amounts of neutral material subject only to Newtonian gravity. This would mean that the tangential velocity profile of the actual PDW would have been a compromise between 'flat' and the Keplerian pattern, corresponding to the degree of that loading.

Later in this paper we apply similar considerations to the 'flat' tangential velocity profiles of spiral galaxies, so we may point out here that deviations from that 'flatness' are likely to reflect differences in that 'Newtonian mass loading', rather than imply other dynamical agency.

A remarkable example of these different forces acting (now) in the same astronomical object is provided by the bright young star Fomalhaut and its 'planetary nebula'. Here, as in other planetary nebulae ('The Ring Nebula' M57 and 'The Helix Nebula' NGC 7293) there is a light-emitting ring or band seen to be made up of thousands of narrow streaks aligned almost perfectly radially to the (quite distant) central star. I see these as mass loss from the central star, but being formed like the plasma tails of comets (also strictly radial from the Sun [36]), although this is normally attributed to the solar wind, which we now see as driven by the G-E field. **But** a planet, named Fomalhaut b, recently found just inside the ring [37], is *not* moving radially but on a CCW orbit. Evidently, despite its own G-E field, which makes any such body behave in a moderately positive manner (Sect. 11), this is in this case too slight to prevent an orbital response to the Newtonian gravity field of the star, unless the disc wind is dense enough to drive it outward aerodynamically. This explains why Newtonian dynamics serve so well at present throughout most of the solar planetary system.

12.7. Origin of Solar System Water: Vital By-product of the G-E Field-based Resolution of the a.m. Problem

The origin of SS water is currently widely accepted as still being an unresolved problem. We now show how the restricted nebula-present (say <5Ma) timescale for the completion of planetary construction, dictated by satisfying the planetary a.m. problem, has the effect of constraining the mode of the construction of planetary iron cores in a manner that also provides the formation of SS water.

Although many people have regarded the comets as the source of SS water, this merely passes the problem to where that water came from. Our scenario offers the PDW mechanism for getting it out there only if we can provide a source nearer home. Interstellar dust clouds seem low in water, so not much can have been imported from there and we must look for a way of making it chemically in the inner part of the SS during planet construction. This approach is supported by the observation that CAIs passed rapidly from a low oxygen fugacity during formation in a refractory environment (see Fig. 5) to one that was 5 orders of magnitude higher where they acquired their Wark-Lovering rims [38], probably while on their way in the disc to the asteroid environment.

It so happens that for many years (1960-1978) A.E. Ringwood, a famous petrologist and Director of the Research School of Earth Sciences at ANU, argued that the Earth's core was made by the reduction by the nebular hydrogen proto-atmosphere of the always-present FeO in volcanically erupted lavas (Fig. 7). This meant that the protoplanet had to grow until volcanism became established. A concomitant of this process would be the formation of huge amounts of water by reaction; an SS benefit foreseen by Ringwood.

A requirement of the Ringwood model was that the nebula should be a cool one, below 600K, not the hot one embraced by SCSN, so that the iron would then be present as FeO, for planetary construction and volcanic eruption, not as reduced Fe. It was subsequently affirmed that this is thermodynamically correct [39]. Such a cool nebular disk and PDW is just what our 2-stage scenario produces (Fig. 5), from a very cold source cloud, even after allowance for admixing with that inner part of the pole-to-equator flow that got heated by the Sun.

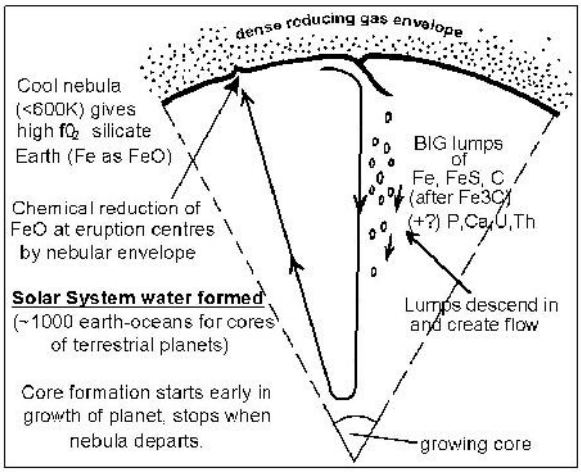

Figure 7. Principles of the Ringwood mode of core formation. Fe loading of the descending limb ensures convective penetration and speeds core formation, as does heat from the release of gravitational energy. The size of the lumps, even if they liquefy, ensures minimal chemical interaction with the co-descending mantle.

An important aspect of the Ringwood model in the present context is that nebular opacity shields the body from solar radiation, so the body builds its own thermal microcosm, dependent mainly on accretion rate and not on orbital distance. The iron cores in three of Jupiter's Galilean satellites [40] then present no special problem, despite being so far ('snowline') from the Sun. Nor do those now suspected to be present in the asteroids Ceres and Vesta as the result of the DAWN space-mission.

The problem that this great distance has raised for the provision of molten iron for the cores-by-percolation model, endorsed in hot SCSN, has been met by the idea of a deep internal 'magma ocean' in the body, from which the iron might percolate. But the growth by tidal capture, seen above to be necessary for dynamical reasons, almost certainly contains a negative feedback mechanism that would prevent the capture rate ever heating the body to that point. The tidal capture rate depends on internal viscosity, and falls if it liquefies and the energy-loss mechanism is lost.

If all the iron in the Earth's core originated as FeO, this would produce over 400 Earth-ocean volumes of water. Although this would likely equip the early Earth with a water-saturated mantle mineralogy (and there is good evidence that it did [41, 42]), this would account for only a few ocean volumes. So Ringwood 1979 [43] had to abandon this idea because there seemed no way of getting rid of the remaining dense hydrous nebular atmosphere which would result. Our G-E-field-driven PDW would now do that, especially during the final outward clear-out as the Sun exited the second cloud.

Up till that moment of nebular clear-out each planet had been completely shielded from solar radiation by nebular opacity, but outwards-progressing removal of that opacity would expose the hydrous atmosphere to ionization by solar EUV, thus rendering it susceptible to expulsion by the G-E field force. The gaseous envelopes of the four Giant Planets were probably sourced from this material, by gravitational capture as it passed [44], the remainder passing out to form or be accreted by the bodies in the cometary region.

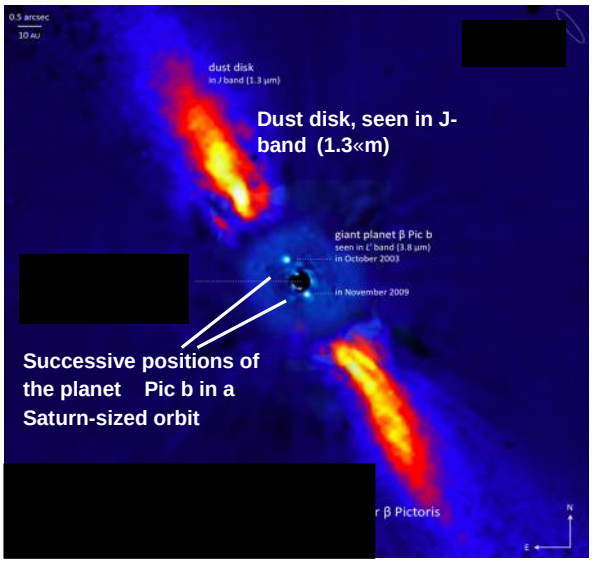

Figure 8. Aftermath of the formation of the giant planet β Pictoris b: a remarkable visual example of G-E field action. The star itself has been artificially obscured. Image modified from NASA APOD 2010 July 3. Credit: A.-M. Lagrange, D. Ehrenreich (LAOG), et al., ESO. See also [47].

This late-stage acquisition of the GP envelopes has a direct bearing on their earlier tidal capture of all those prograde satellites, discussed in Section 12.5. Many of that population have silicate-rich densities, so it means that the GPs began as silicate-rich central bodies with a viscous tidal attribute. The arrival of the gaseous envelopes made the interiors liquid and lose that attribute. The moment of so doing is recorded by the interruption of retrograde Triton's inward spiral [44]. Jupiter, first in the gravitational ring-fence, clearly captured the most (perhaps 310 Earth-masses of its present total of 318) and got spun-up the most. For that to happen, the material must have had prograde vorticity — the signature of G-E field action from the prograde-spinning inner planets.

This reasoning, using only the Jovian acquisition

and ignoring what went further, and to the cometary belts, yields a minimum figure for the nebular density in the inner SS, at the moment clear-out began, which is some 40 times the canonical SCSN value. This offers usefully toward securing protoplanetary nucleation in close-in positions, securing the vigour of the PDW for dynamical purposes, securing the vigour of the water-forming reaction during core genesis and to keep down volatile losses from levitated molten chondrules [45].

Finally, if iron cores are made in this way, dependent upon 'convective' overturn in bodies that have grown big enough for that to begin, what is the nature of the many iron-group meteorites thought to be derived from much smaller asteroids? The answer here is that if there is no overturn, but nebular reduction of erupted FeO occurs, the resulting former volcanic magma chamber, in which iron has sunk to the bottom, will remain on the surface, accessible to meteorite derivation by impact. Careful consultation of [46] shows that different kinds of meteorite do indeed offer an almost complete record of different levels in such a differentiation chamber.

I conclude that the cores-by-percolation models, and their appeal to the hot SCSN model, are invalidated by an inability to satisfy the observed values of planetary a.m., whereas our CT scenario not only does so but also provides a well-researched origin for Solar System water. Its effects on the physical properties of the Earth's mantle, changing over time as the ocean water was released from it in volcanism, has had major consequences for the evolution of the Earth, including the replacement of its CO_2-rich atmosphere by an oxygen-bearing one, which is why we are here [42].

12.8. Solar/Stellar exit from the Second Cloud: Clear-out of the Nebula from the Protoplanetary disc

This nearly edge-on infra-red image (Fig. 8) [47] of the Beta Pictoris planetary system offers a remarkably persuasive illustration of the clear-out stage. It seems to show the G-E field-driven clear-out of the remaining still-warm dust and plasma of the protoplanetary disc from which the giant planet **Pic b** had been formed.

The inner zone, around the planet, is seen in L-band (3.8 μm) whereas the main flow pattern, at J-band (1.3 μm), has evidently remained warmer, presumably due either to higher density or to water vapour/ice-restricted cooling. The rather abrupt inner boundary of that flow probably marks an abrupt exit from the planetogenic second cloud through which the star had passed.

Visually, the outwards morphology of the flow seems irresistible and extends to distances that would be far into the cometary regions of the SS.

12.9. Planetary Systems, Solar and Exoplanet; the Essential Functions of the Solar/Stellar G-E Field: Summary and Earth-consequences

• The traditional hot Single Contracting Solar Nebula (SCSN), ending with giant impacts, is untenable or incompetent for multiple reasons, both dynamical and chemical. These include:- planetary angular momentum provision, prograde spins, low eccentricities, prograde satellite population of the GPs, too-long construction timescales, no incorporation of short-life isotopes, inability to provide for SS water. ….But, in contrast….

• G-E field action in the new scenario (Fig. 5) provides:-

(a) for unhampered infall of the high-opacity second-cloud material, just as it does for building up high-mass stars (Sect. 8, Item 3);
(b) a protoplanetary disc wind (PDW) which builds up the a.m. of planets, by moving each outward aerodynamically in a non-Keplerian pattern, with little change in tangential velocity, after nucleation in a close-in position, consistent with exoplanet observations.

Of wider interest in (b) is that this tangential velocity profile is just what we discuss in the next Section as being observed in Spiral galaxies. G-E field action at such vastly different scales would be nice confirmation of its truly fundamental nature.

We have found that not only do these two G-E field actions lead to resolutions of all the evident inadequacies of SCSN but they also yield the following stark conclusion. **Without those actions, the only planets anywhere would be ephemeral ones nucleated in close-in positions, but destined, upon emergence from the protection of nebular opacity, to vanish there by evaporation in the stellar heat.**

Thus it appears that our very existence on this planet depends upon the G-E field in two distinct ways. **I**t has provided for the existence of a planet at sufficient distance from the Sun. And it has prescribed the Earth's

construction in a manner that has given it the water that has dominated its evolution, and ours.

13. The G-E Field in Spiral Galaxies

13.1. The 'flat' Tangential Velocity Profiles

Spiral galaxies typically exhibit tangential velocity profiles which, instead of the outward-decreasing Keplerian expectation with a central mass, tend actually to remain almost flat, outward all the way from its rise across the galactic 'bulge' to far beyond the limits of optical visibility, as betrayed by 21 cm H 1 radiation.

Since its first recognition in the 1970s this has been attributed to the presence, surrounding the entire galaxy, of vast quantities of mysterious Cold Dark Matter (CDM), having no other known physical properties. CDM masses of over 10 times the observable baryonic mass of the galaxy have been inferred. But, for orbiting (as often assumed) mass of any kind to be doing it, there's a **wholly insuperable a.m. problem** that hasn't been thought of. To escape that by regarding the CDM as static would then raise the question as to how a.m.-containing galaxies habitually form in the middle of such patches of CDM.

But such a profile, as we have just seen for planetary systems, is exactly what the radial G-E field would do, when driving outward the material of a plasma-rich disc. Consistent with that, and diagnostic of its electrical action, it has also been found [48] that in Elliptical galaxies (plasma-poor by nature) the profile is, on the contrary, near-Keplerian.

To validate this interpretation, we now show that the plasma flow in the arm-dominated part of the disc is indeed outward, after polar infall, as in our planetary systems scenario (Fig. 5). That, of course, conflicts with the rather instinctive general view that the spiral arms are being wound more tightly. In turn it raises the question, dealt with in our companion paper [68], of how tightly-wound galaxies formed in the first place.

13.2. The Entire Structure of Spiral Galaxies is Dominated by the Action of G-E Field-driven Galactic Winds (Fig. 9, a,b,and c).

1. The constant tangential velocity means geometrically that the arms trail as they move (are driven) outward – yes, outward.

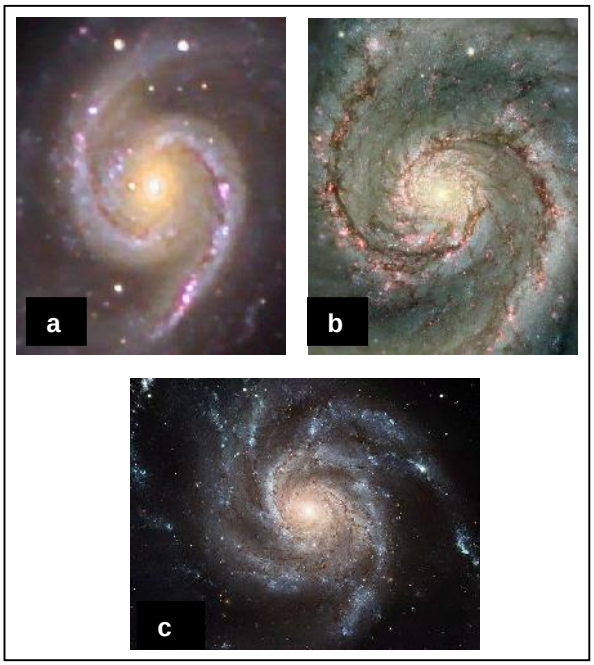

Figure. 9. Spiral galaxy forms. All three are rotating CCW but the arms are **unwrapping.** In (c) they are actually being blown apart. (a) NGC 1566. (b) M51/NGC5194. (c) M101/NGC5457. Image credits given in the footnote e[e]. Image (a) has been cropped here.

2. Dust and less-ionized material, seen as red lanes, has less G-E field drive, so it accumulates along the insides of arms – an ubiquitous and characteristic asymmetry (9a, 9b), widely applied for tracing arms.

3. This dust encourages massive star formation, enabled by G-E field action, in 'starbursts' [49] spaced along the arms (9a).

4. Moving the arms outward, without changing tangential velocity, geometrically requires them to extend over greater length of arc, so they rupture abundantly (seen as black, oblique (9b), or as completely freeing quasi-linear chunks of arm, which clearly once belonged to the assemblage (9c)).

5. Except at these gaps, ionized material is selectively driven out of the arms, and seen as outwards-trailing blue escapes (9a, 9b).

[e] Image credits: (a) NGC1566. www://spiegelteam.de, with permission from Volker Wendel; (b) m51_hstAPOD_2001Ap10; (c) M101_medNGC5457HST, from Wikipedia ('Pinwheel Galaxy'); a very apt dynamical description! NGC1376 is very similar.

13.3. Spiral Galaxy disc wind: Where from?

The CT answer:

In planetary system formation we saw (Fig. 5) that the infall material for the protoplanetary disc wind (PDW) had arrived quasi-axially, was ionized during near-star passage to the disc, enabling the G-E field to expel it within the disc.

I propose an identical flow pattern for Spiral galaxies, ionization being effected at or in the stellar mass concentration constituting the galaxy's bulge.

For planetary systems the source is a low-ionization dust cloud. For galaxies, I propose (companion paper [68]) a low-ionization cosmological source for the material, now abundantly evident as the 21 cm neutral hydrogen (HI) emission, thought to be of cosmological significance, for whose study the Square Kilometer Array (SKA) is being built in southern latitudes.

14. G-E Field Actions at Neutron stars

The surface gravitational potential of a neutron star is "typically a few times 10^{12} m/s^2 ", "with a maximum of 7 x 10^{12} m/s^2". The former, at $log_{10}\ g \sim 13.5$, is over 10^{11} times that of the Earth, so a very large corresponding G-E field is to be expected, although the extrapolation relationship is as yet unclear. (Related neutron star parameters are:- Radius - ~12km; Mass - 1 to 2 M_{sun}) (Wikipedia June 2012).

We note in passing that several neutron stars are known to possess planetary systems. One even has a potentially protoplanetary disc [50]. The problem has been how they acquired them after the supernova explosion which would have blown all such material beyond recall. Our 2-stage new scenario for planetary system formation (Sect. 12.2/Fig, 5), seems well adapted for explaining these acquisitions. There certainly would be plenty of G-E field to drive them rapidly away, while the acquired protoplanetary nebular disc was still present, from the vicious radiative environment of the star.

14.1. G-E Field Actions in Supernovae

Supernovae of types Ib, Ic and II, are due to the onset of degeneracy – fusing protons and electrons – in a high-mass stellar interior, the result being a neutron core. I propose that the intense G-E field from that core is what causes the explosive ejection of all the remaining ionic material, and why all the neutrons stay behind.

Hitherto it has been supposed that the 'explosion' is the bounce resulting from sudden inward collapse, but a study of the process has failed to reveal the necessary bounce capability [51]. To confirm our G-E field interpretation, evidence of outward acceleration of the material should be sought, as seen in solar CMEs.

Type 1A supernovae also yield a neutron core product, but *via* a white dwarf route. These have been regarded as cosmological distance-measuring standard candles, on account of the Chandrasekhar 1.38 (formerly 1.44) solar mass constraint on their pre-collapse masses and energy-release. But we noted above (Sect. 8, Para. 1) that the support provided by the internal G-E field in stars would postpone collapse to higher mass values. Recently several such 'super-Type 1a' supernovae have indeed been observed to have had pre-collapse masses up to 2.8 solar masses. [16,17,52].

14.2. G-E field Actions in Pulsars

Having lost all its overburden in the supernova explosion, the outermost layer of a neutron star will no longer be under degeneracy-inducing pressure.

Free neutrons have a half-life of ~10 minutes, so this outermost layer will decay; the protons being accelerated away by the G-E field. But the electrons will form a surface 'sea' which the G-E field will strongly pressurize onto the surface. This 'sea' will deepen until that pressure attains the degeneracy value.

Almost inevitably, therefore, 'islands' of exposed and actively decaying neutrons may be present. These islands will produce intense outward-accelerating streams of protons. I propose that the synchrotron radiation from these streams is the pulses from pulsars.

Any given neutron star could have many such islands on its surface, sending beams in different directions, thus greatly increasing the probability that we lie on the spatial sweep of at least one as the star spins. So undetected ones will be rarer than we thought.

Far better than the 'magnetic axis oblique rotator', this mechanism could provide for multipulse (e.g. Vela), pulse shape differences, and altering interpulse time intervals.

14.3. G-E Field Actions: Cosmic rays (CR)

CR energies range, with logarithmically increasing rarity, from 10^9 eV (the defining lower limit for the name) to a 'toe' at somewhat beyond 10^{19} eV. The G-E field seems a prime candidate for accelerating them, but simple calculation for protons suggests that, at our

linear-extrapolated 10^{12} V/m (Sect. 7.2), it may be some three orders of magnitude too low, so this will need attention. A link between CRs and pulsars has been been detected during solar occultation of pulsars [53].

There is a 'knee' in the abundance, at ~3 x 10^{15} eV, beyond which the rarity slope steepens [54], but there seems to be no firm observation as to the nuclear species beyond that. This is partly perhaps because the events are so much rarer but partly also influenced by the current expectation, based on the view that they must be of extragalactic origin, which is that they should include a wide variety of species.

If, however, our proposal is correct that the G-E field at neutron stars is the accelerating agent, then the clear prediction here is that protons should be virtually the only nuclear species present at these high energies.

At lower energies, the reported appearance of He and C nuclei, in addition to the predominant protons, strongly suggests white dwarf (WD) sources [55], whose surface gravity lies in the range $\log_{10} g = 7.5 - 8.5$. So WD gravity is second only to neutron stars, but >5.5 orders lower. This compares well with the rather nominal 5 orders toe-to-knee drop in CR energies. That savours of our speculated linearity of the G-E Field/Gravity relationship. Most WDs die slowly without exploding, so there are lots of them to source the many CR above the knee.

15. Relativistic (RT) Matters and CT

So far, this contribution has concentrated on matters upon which RT has little or no bearing. So the wide-ranging benefits we have inferred are specific to CT. We now consider the CT perspective and competence on a few matters thought to underly the strength of RT.

15.1. *Lorentz Transformations are Inapplicable in CT*

In devising RT and adopting the Lorentz transforms, Einstein followed Leibniz (c. 1695) in being unable to recognize the presence of a connecting intermediary between any two apparently separated objects. So these were perforce the only items in a discussion of the relationship. But CT's recognition of an ubiquitous aether requires the full details of motions in the intervening aether, so that vector addition may be applied. As I discussed in [3], Ives & Stillwell [56] performed a beautiful experiment to test, in a single physical system — gravity waves on a relatively moving tray of mercury — whether this change of perspective does indeed require use of those transforms in one case but not in the other. They confirmed, both mathematically and observationally, that this is indeed the case, all three "relativistic adjustments" — the Fitzgerald contraction, the Larmor-Lorentz change of clock rate and the Fresnel convection coefficient — were both expected and observed BUT with ***c*** in this experiment being not the velocity of light, but the velocity of gravity waves on mercury. Thus there is nothing special about the velocity of light in these formulations so long as there is a transmitting medium (e.g. mercury) for the waves. The "relativistic adjustments" arise only if one chooses to deny that the waves can, along any part of their path, travel faster than ***c*** relative to the observer, although travelling no faster than ***c*** relative to the local medium. Evidently, by restoring the local aether as the reference frame for the propagation of change, as in CT, all the phenomena currently attributed to SR effects become equally explicable.

15.2. *Gravitational Communication and the Perihelion Advance of Mercury*

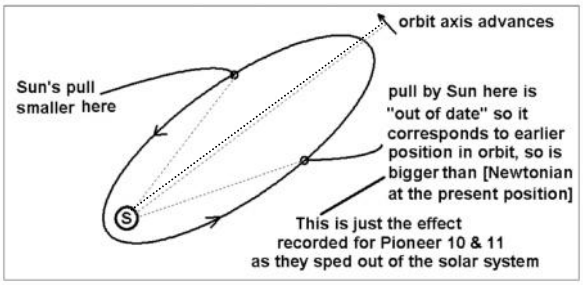

Figure 10. The qualitative effect of gravitational communication time. See Anderson et al [58] for the Pioneer observations. Can they not be an experimental verification of Gerber's result?

The application of Newton's Laws of gravitation is customarily treated as a field theory in which the test particle senses the field of the central body instantaneously and reacts to it, the assumption being that the field is an intrinsic property of the central body and is unaffected by the arrival of the test particle. But if Newton's Third Law, that action and reaction are equal and opposite, is to be satisfied one needs to establish how the reaction force gets from a non-contact position of the particle to the central body which is the source of the field, to generate its reaction.

For this purpose the limiting velocity of communication must be the maximum ***c*** permitted in

RT and in CT, the latter being dictated by the properties of the only intermediary available — the aether. But such a set-up fails to cover what will happen if the force between the bodies is a stimulated response, each to the presence of the other, as in CT[f].

For CT, therefore, we eschew the use of a field theory, adopting one that recognizes the limitations of communication time. A successful account of the periastron advance/perihelion advance of Mercury is neither original nor unique to GR. In CT, as outlined above, gravity is an interaction intercommunicated at finite velocity (***c***) due to the particles sensing and reorienting their sucking poles in response to the aether density gradient generated by the other body. In 1898 Paul Gerber [56] successfully modelled this kind of response delay with the implication that if the distance, and the force demand, is changing, then the interactive force actually communicated will have a magnitude that relates to a slightly previous position. The qualitative effects of this are illustrated in Fig. 10.

Gerber's achievement was to make the gravitational potential time- and route-dependent, as distinct from that of Weber, which depended on position only. Gerber inverted the problem. From the then-approximately-known perihelion ad-vance rate to be explained he set out to determine the effective velocity of commun-ication, which he found to be close to ***c,*** as then known.

The relation Gerber obtained for this in 1898 was the now-familiar

$$d\omega/dt = \text{S®=}G\ \text{j}_{\odot}/Pa\boldsymbol{c}^2(1 - \text{-}e^2)$$

(period, major axis, eccentricity along the RHS denominator)

which Einstein incorporated within GR in 1915 but refused to acknowledge Gerber's priority, despite the 1917 republication [59] of Gerber's paper by an infuriated editor [60]. As a matter of history, Gerber's work was discussed by Mach [61] whose full obituary Einstein wrote as a close friend in 1912, so it is unlikely that Gerber's paper was unknown to Einstein when he published GR.

This remarkable formal identity resulting from two quite different physical approaches could be an important general warning to those who consider formulae to be distinctive of one theory and one alone. But if this formal identity was deliberately devised by Einstein in his formulation of GR, knowing that it worked, this caveat would bear less weight.

This lack of a formal difference upon which to base his objections to Gerber's interpretation seems to have forced Roseveare [62][g] , a relativist, to raise two others, both of which are invalid within CT.

Note that the orbital precession of electrons within atoms, responsible for spectral fine structure, is a phenomenon of identical character to that of perihelion advance, so is no longer to be seen as relativistic either.

15.3. Gravitational Light Deflection, Distortion of Space-Time, and the G-E Field

The verity of the GR prediction of lensing and its value is now no longer in doubt. Remarkably, CT, just like the perihelion advance matter, offers what seems likely to be the formal equivalent in this case also. This is that the G-E field constitutes a radial gradient of aether charge density which, by Maxwell's equations (as noted in Sect. 8, Item 2), will cause the value of ***c*** to be lower, nearer the Sun. In GR the deflection is attributed to gravitational distortion of space-time (but without any physical account of how that is done). Only termino-logically different from the distortion of TEM-wave propagation space arising in CT, it is likewise possibly proportional to the actual gravitational potential at each point on the path of the TEM-wave.

An important possible diagnostic between them is that it seems that the CT deflection should operate only on the E-vector, so the lensed light forming arcs would be polarized radially to the central object, which is not the case under GR. It should be simple to check observationally.

15.4. Black Holes

From the start, and at many subsequent points in this paper, we have demonstrated the gains in physical understanding to be achieved by recognizing that the mass property of fundamental particles needs space within the particle in which this can be developed.

[f] To clarify this point, note that in CT gravitation is the product of the interaction of two objects. The Sun, if alone in the Universe, would have no **external** gravitational field, i.e. no means of generating an external aether density gradient. The aether pumped out of it would, by compressional adjustment of its density, effectively redistribute to infinity, given time.

[g] As already pointed out **[3]**, Roseveare's derivation of Gerber's result is confused. He starts (p.137) assuming a field-propagation-rate theory, in which gravity falls with recession velocity, and would result in perihelion retard, but then (p.137-138), apparently realizing his mistake, swaps to an intercommunication-response-time theory (like CT) and obtains the correct result. It is remarkable and serious that this *non sequitur* wasn't picked up editorially before publication. The destructive effect of so doing may have been why it was not.

Hitherto, for nearly a century, these properties have been treated unquestioningly as intrinsic to the particle concerned, and contained within infinitesimal singularities. That is the basis upon which the relativistic Schwarzschild black hole model and its relatives have rested. Its defining feature, the presence of infinite gravitational field at its centre, is the mark of not having had available the understanding of the physics of gravitation that motivates this paper.

Such models have seemed to be supported by the observation of very high velocities of orbital circulation, augmented in some cases by the assumption of relativistic mass increase at those orbital velocities. But in the following Section we introduce the notion of velocity-limited inertia. Since centrifugal force is inertial in nature this has an effect opposite to the relativistic one; the faster the orbital velocity, the less is the central mass required to keep it there.

16. The Irrotational Aether, Sagnac effect and the Origin of Inertia

16.1. CT, Sagnac Effect and Global Communications

We here take up the matter raised in Section 5.1 that the ultra-high charge density of the aether would render it irrotational, with potential to provide our measure of absolute direction, customarily termed sidereal. Two kinds of device are known and widely used; (i) Foucault pendulum and mechanical gyroscope — using inertia/gravitation; (ii) ring laser gyro — using TEM-wave propagation/Sagnac effect. That such different kinds of device should both do the job points strongly to the aether as the link, because it is tied not only to TEM-wave propagation but, as shown above, to the gravitational process also.

This sets the Sagnac effect in a new light. As Sagnac himself contended [63], the TEM-waves are propagating at their proper velocity ***c*** in an irrotational frame while the apparatus spins within it, thus making the travel time to reach the moving receiver longer in the forward direction than in the backward. It was shown experimentally [64] that the effect varies with path length, *i.e*. transit time, not the circuit area originally supposed by Michelson (he moved one side of a rectangle) and assumed in popular treatments. Thus the Sagnac effect has nothing to do with the supposition that TEM-waves travel at different speeds in the two directions. Classical and Special Relativity (SR) treatments both yield the correct result because SR introduces effects which cancel out. But SR fails to relate Sagnac to its gyro property of providing an 'absolute' directional reference frame, whereas this classical form does.

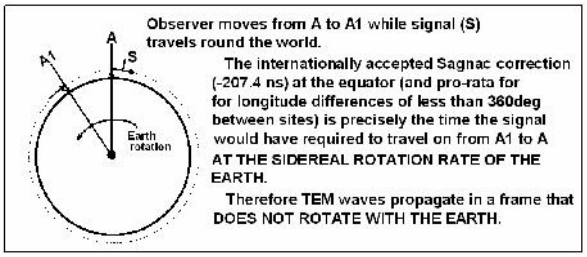

Figure 11. Global correlation of time signals. The CT significance of the Sagnac correction for Earth rotation.

A globally significant result of this understanding is illustrated in Fig. 11. The 207.4 ns figure is, of course, before applying a correction for height above sea level. Evidently the huge charge density of the aether does indeed give it (nearly?) perfect torsional rigidity. Presumably, therefore, the aether doesn't rotate with the Sun or galaxies either?

This result bears upon the MM and subsequent aether drift experiments. As discussed in detail by Kelly [65] these have found that, although undetected in the MM experiment of 1887, they are now consistent with the observation of a drift that corresponds to the surface rotational linear velocity within a non-rotating aether frame. This suggests that we must be aware of the aether's differing responses to rotational and to linear displacements. Its torsional rigidity is apparently enough to overcome its particle-tiedness in the context of rotations as rapid as the Earth's; but the observed lack of aether drift in the case of the much lower angular velocity relating to the Earth's orbital motion implies that it fails to do so in those circumstances.

That the motions of aether in between particles made out of aether should be only partially tied to their motions seems an entirely reasonable outcome, avoiding the difficulty that would have arisen had the MM result been rigorously correct.

Importantly, it is compatible with the evidence, derived in our companion paper [68], that the random motion of the intervening aether in an assemblage of randomly moving particles is a spatially very smoothed reflection of those individual motions.

16.2. The Aether as the Site of Inertial Action

Interpretations of inertia based on Mach's Principle continue to be sought and this was the declared aim, as

a friend of Mach, by Einstein too in the formulation of GR, though close inspection suggests that GR does not succeed in so doing. A primary snag with a strictly Machian interpretation of inertia, requiring communication 'with the rest of the Universe' has been the evident lack of time-lag in its behaviour. By embracing the infinite communication velocity inherent in field theory, as noted above, this is a problem which GR avoids. Our CT aether, as noted, has both an immense force capability and the possibility of providing a reference frame that substitutes for Newton's 'absolute space'. So one wonders whether the rather local enveloping and all-pervasive aether, with negligible 'communication time', could be the volume from which inertial action originates.

There is an important consequence of thereby retaining a velocity of inertia intercommunication (with the aether of a very local 'rest of the aether Universe') which is limited to ***c.*** It is that this will cause **inertial force to be *c*-limited** in just the same manner as we explored above in the case of the supposed relativistic mass increase when under ***c***-limited electromagnetic acceleration force. I return to this in the accompnying paper [68] as the basis for a remarkably fertile new model for the nature of quasars.

By making the aether the underlying agent for both gravitational mass, as above, and for inertial mass (expressed in centrifugal force) one would hope automatically to achieve the rigorous equality of gravitational and inertial mass shown by the Ëotvos experiments and which has so long been a problem.

17. Three Experimental Checks

The foregoing account of CT incorporates a huge range of apparently supportive observations, but additional checks, where possible, are always desirable for any theory, new or otherwise. The following would be especially valuable. Others are proposed in the companion paper [68], in the context of phenomena discussed there.

1) Simplest and most diagnostic (Sect. 15.3), the light in gravitiationlly lensed arcs should be checked for polarization.

2) Central to the whole basis of CT is the charge density and polarity of the aether. The negative polarity of the aether's charge was inferred originally by me from noting that the Sun expels positive ions. A possible experimental method to determine independently the polarity and charge density of the aether is sketched in Figure 12 but careful assessment is required as to whether enough experimental sensitivity can be achieved.

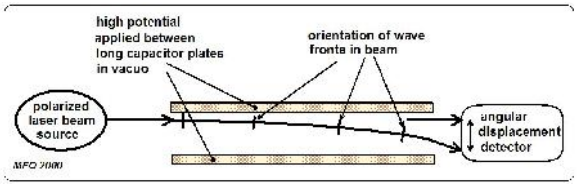

Figure 12. Suggested aether density and polarity experiment

The CT view of Maxwell's dielectric displacement current is that the charging of a capacitor involves the displacement of aether away from one plate and towards the other. In Maxwell's equations the velocity of TEM-wave propagation rises with increasing elastic modulus of the medium, which relates to the charge density of the aether. So a charge density (*i.e.* aether density) gradient, set up in the aether between the plates of a charged capacitor, will progressively tilt the wave fronts and deflect the beam.

As noted (Sect. 15.3), it is likely that the deflected light will be polarized. So rotation of the polarized source would modulate the deflection. If the aether is a continuum of negative charge the beam deflection will be towards the negative plate. This experiment would also check the proposed mechanism of the 'gravitational light deflection' (Sect. 8), thereby providing another check upon the intensity of the G-E field in given gravitational circumstances.

3) An attempt should be made to measure the G-E field of the Earth, at ground level, essential for any extra-polation to other bodies (Sect. 7.2). The all-pervasive nature of the gradient raises problems. Being present equally within the structure of the apparatus and of any sample, it is this which has caused it to elude discovery. Some sort of ionic drift method might be worth consideration. Rotating the chamber in a vertical plane, to modulate the signal, would remove zero-point error. But this might generate unwanted signals unless electro-magnetic screening was extremely efficient.

18. Ten Conclusions

1. Maxwell's aether, if implemented as a massless and compressible, ubiquitous continuum of negative electric charge, is inherently able, qualitatively, to fulfil its originally intended purpose, the support

and propagation of transverse electromagnetic waves of any wavelength.

2. By adopting the 150-year-old propositions of Maxwell and Thompson that fundamental particles are 'made out of aether', as vortical structures of its motion, we have been able to quantify its (minimum) stupendously high charge density, namely 10^{30} Coulomb.cm^{-3}.
3. This lifts the aether right out of the obscurity and insignificance, to which it was relegated by Relativity more than a century ago, to a status of perhaps being **the** principal agent in the Universe.
4. This new perspective has, by a wide-ranging quest for observational guidance, apparently led us to new appreciation of:-

i) the physics of gravitation, in which the Newtonian field and the Gravity-Electric (G-E) field are but facets of a single process; and there is, for a very simple stastistical reason, no development of negative gravity;

ii) the astronomically ubiquitous action of the G-E field, including central aspects of:- star formation, stellar evolution, planetary system formation, heliosphere observations, gravitational lensing, supernovae, pulsars, acceleration of cosmic rays and the dynamics of spiral galaxies. A vast range of scales.

5. These observationally integrated findings as to how the mass property is developed and the resulting gravitation really works appear completely to displace the supposed functions of the hypothetical and so-far–elusive Higgs boson. Ramping up the energies in accelerators will surely create ever-more-ephemeral particles of ever higher mass but with doubtful bearing on the way Nature does things, or has ever done in the past.
6. Fundamental particles require finite volume in which to develop their mass property and magnetic moment as dynamical constructs of aether motion. This rules out relativistic black hole models which accumulate mass without limit by supposing the presence of infinite gravitational field at the centre. In CT any such limitation of space would result in mass annihilation and energy release.
7. The aether's electrical nature and its function in generating gravitation brings gravitation, at last, into the force-family of electromagnetic ones. Its ultra-high charge density probably renders it irrotational and the link between our diverse directional devices. Since some of those are inertial in nature, this linkage makes the aether the probable site of inertia. Inertia and gravitation thereby have a 'cloned' origin, providing the long-sought reason for the strict equality of inertial and gravitational mass.
8. To sum up on more tangible matters; if the G-E field did not exist, we would have no planet to stand on, apart from an evaporating inferno only ~10 solar radii from the Sun. And the Sun would not be the same either, inside or out.
9. On the positive side, we have been able to trace a continuous linkage from the fundamental physics of G-E field generation in the Sun, all the way to the factors which constrain our human existence (water, oxygen, earthquakes) and the internal behaviour of this planet [42]. This suggests that the further pursuit of CT would be an exceptionally worthwhile matter for us all.
10. Fundamentally, with the reality of the G-E field now secured by the multiple evidence for its action, presented here, there is now a functional requirement to meet as the basis on which, as recently favoured [66], to explore the modelling of non-zero-sized particle interiors (especially the electron and positron), of which Figure 2 is no more than a very simple conceptual starting-point. The 'infinitesimal singularity' view of particles, rejected here as absurd (Sect. 3), has for a century caused this to be treated as an illegitimate enterprise, so [67], a late discovery by me, may be the only contemporary comparison.

Acknowledgements

In 1959, Peter R. Wyke (deceased) was impressed by the physical significance of my work on the observed sky brightness distribution, noted in the Introduction. CT's foundations were the outcome of his prescience in organizing funding at once for me to pursue it for nearly a year, separately from the project. From that moment to this, continuance of my work on CT and its diverse ramifications has uniquely been made possible by the steadfast support of my wife, Margaret.

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