Introduction

We assume em waves are representations of discrete variations of a property we cannot know, and consider what we can know. We look from three fundamental directions, whether space is continuous or discrete, whether science itself is continuous or discrete, and from the reality of what the space contains, gas and plasma, the collections of discrete massive particles populating much of it at various densities. First we ask, if these discrete particles can get together and act continuously as dielectric gas and plasma for the purposes of transmission of em waves, and for Fresnel's refraction co-efficient n, what fundamental changes to science might the implications bring.

This question may come as a surprise as we know that gases do have a refractive index. Plasmas are so effective in wave particle interaction they're the latest candidate for stealth technology, a fine structure boundary layer proposed to absorb radar waves. Changes in pressure affect amplitude not frequency, and spectroscopy shows low density gases can still change em wave speed to their own local c/n. So we have our first well established axiom; **EM wave speed is controlled by n within a dielectric medium.**

As any fundamental change to science must include classic and quantum views & phenomena we briefly remind ourselves that wave particle interaction is about atomic scattering via polarisation. Advances in
optical fibre science have vastly improved knowledge, but it seems science itself can be discrete at times, not always linking to form a seamless body of knowledge. Separate disciplines are imposed by man yet all nature must be connected. Too often we say for our own clarity that a phenomena is 'not connected' to another. Only by finding connections can the complex jigsaw puzzle of nature be joined together, and ultimately the quantum and classic universes become truly continuous.

Interaction
In this case we'll look a little further at scattering. Wave oscillations can modulate particle oscillation and vice versa. Wave signals propagate through a dielectric medium such as optical fibre by interacting with and 'polarising' the particles,* which scatter or re-emit each signal. This takes a tiny amount of time, and this polarisation mode dispersion/delay (PMD)\(^3\) dictates \(n\) and chromatic dispersion.* The QED analogy is electrons absorbing photons, re-emitting them at \(c\). Whatever relative speed waves arrive at they'll be re-emitted, or scattered, at the new local \(c\) through the voids in the medium. This process changes em wave speed as required, equivalent to em waves entering or leaving water (\(n = 1.33\) eye lens \(n = 1.38\)).

But we must accentuate the 2 separate elements to the speed change. 1) To \(c/n\), speed differences within media, and  2) To the relative velocity of media, an effect on Poynting vectors well known in geometric optics. Our biggest error has been in not applying both elements elsewhere, with major implications. So we derive a 2nd, clarified, axiom; **Particles absorb signals, re-emitting them at the local \(c\).**

Medium particles and signals may be considered as waves, particles or both. By overly focussing on duality we may miss more conceptual logic.

Media
Plasma may be thought of as 'hot' energetic gas, of ions and free electrons, or highly charged particles. It is conductive and interact heavily with em fields and signals. Whether gas or plasma particles, they work most effectively in packs. The interstellar medium contains a low density of such discrete particles throughout,⁴ but not until concentrated in a continuous 'cloud' or atmosphere do they behave as a dielectric medium such as that around our planet. Air is quite dormant at \(n = 1.00030942\) (-15\(^0\)C) and helium 1.00036, but plasmas are more active, at densities up to \(10^{13}/m^3\) and varying⁵ from below \(n = 1\) upwards. But such detail is of less consequence than the effect. As we orbit the sun, light entering our ionosphere, from any source, is modulated (FM)* to propagate through it at \(c/n\) with respect to our planet. As it's slowed down it shifts slightly to the blue, (as Rayleigh scattering also turns the sky blue). EM signals from probes are also shifted to the blue if arriving from ahead of our orbital path as the signal is compressed, and to the red when arriving from behind.

But there are plasma clouds deeper into space. Our planets bow shock, at 7-12 earth radii, is a dense active
particle standing wave around our magnetosphere, at densities up to $10^4/m^3$ where it's blasted by the sun's ejected particles at over 400km/second. This is not entirely aligned with the Solar wind, our orbital motion causing aberration and eccentricity. Bow shocks are common to all celestial bodies. Jupiter's was a big shock to the Galileo probe. Pioneer, Voyager and NASA Hubble photo's of stars such as LL Orionis, (see Fig. 1) have explored the Bow Shock of our heliopause, the dense plasma 100 AU's out, ahead of our 45,000mph trajectory through the galaxy. The sun's 13 day polarity change 'wave' recorded by Voyager 2, expanded to 100+ days at the shock, which Voyager 1 is only now clearing. IBEX* data shows established views about solar winds "wrong". Quantum particles, nebula gases and supernova remains also abound. If galactic halo's are refractive zones of active dark matter particles they may easily be at the density needed to cause the flat gravitational acceleration curves found.

So it's clear that space contains dielectric media. If the laws of physics are consistent, and in accordance with the postulates of the Special Theory of Relativity, (SR) light travels through such gas and plasma shock clouds at $c/n$ with respect to the shock and the massive body it belongs to, as it does through the Earth's ionosphere. The spectroscopic absorption lines would seem to be a perfect record of the history of light, evidencing the many changes in speed necessary to always stay at 'c' locally.

Discrete Spaces
This gives us a 3rd logical axiom, but now also raises the more fundamental question of whether space itself is discrete or continuous. Albert Einstein considered that there was not just one 'space' but that all mass is 'spatially extended' saying; "Physical objects are not in space, but these objects are spatially extended. In this way the concept "empty space" loses its meaning." Indeed, when considering SR, Minkowski first introduced the concept of discrete spaces in 1909 "Then from here on, we would no longer have space in the world, but endlessly many spaces;"

Einstein embraced this for his field based General Relativity (GR), but, it appears never evaluated it in terms of SR. Considering unified fields he said in 1952;
“The concept of space as something existing objectively and independent of things belongs to pre-scientific thought, but not so the idea of the existence of an infinite number of spaces in motion relatively to each other.”

We view Cartesian co-ordinates as a frame, and refer to inertial frame, yet Einstein referred to a body, or a co-ordinate system rigidly connected to a body. In Ch.3 of “Space and Time in Classical Mechanics,” He wrote of: “co-ordinates rigidly attached to the carriage” and referred to, “a particular body of reference.”

Using the logic of Einstein and data from space exploration we may view space not as a continuous absolute void but consider the local parts around “ponderable mass” as discrete regions in relative motion by virtue of the dielectric properties of the ionosphere. The medium boundaries, the plasma shocks around magnetic fields, will define some of the infinitely many regions of space centred on mass, within which light travels at 'c'. All such regions of space would then represent inertial frames. So our 3rd axiom is:

**A massive body in motion is surrounded by a discrete area of space bounded by a plasma shock of n=?**

We must be clear that this does not require ‘ether’, that there is no ‘absolute’ space, and that the Principle of Relativity & postulates of SR all apply;

*The laws of physics are the same in all inertial frames* and the measured propagation speed of light is always c.

SR was created to explain constancy of 'c' with respect to all observers. Apparent contradictions, paradoxes, and inconsistency with QM have been well aired. Yet we seem to have just confirmed the postulates of SR by a known Quantum Mechanism, and also shown how all observers may measure light at c. This surely can’t be correct as physics isn’t that simple. We must now falsify it by studying nature and SR more closely to expose inconsistencies.

**Thought Gedanken**

Einstein’s light box may help falsify the theory. A glass box with mirror floor and ceiling is in uniform motion with respect to an external observer O. A light pulse reflects, vertically with respect to the box, which represents an inertial frame. But as it moves, O must observe the pulse at more than c on a diagonal track, so time must dilate to slow the pulse down, or the box contract so lateral distance reduces. Thus O never sees it moving at more than c.
Now we use atomic scattering and c/n; If the light is not visible to O the issue never arises. To be visible it must interact with air, gas or plasma within the box. The particles emit (scatter) em waves laterally towards us through the glass of the box walls. They do so at c. A signal passing through the glass walls is slowed (say n = 1.5) It then speeds up again, crosses the space at just below c if in air,* or in a vacuum (n = 1) it returns to c. It does not exceed 'c', either in the box or approaching O, nor does the pulse itself exceed c. It changes speed again at the fine structure of his eye (and his lens n = 1.38), so he registers the light at well below 'c'. The glass lens of his detector ensures that it reads similarly, the quantum process of the act of measurement instrumental in the result (QM). If O is in motion approaching or receding from the emitter the refractive indices are unaltered so the reading will remain c. We can measure light speed both via regular interval pulses, as in fibre optic signals, and via d/t,* yet we get different results, by approximately observer velocity v. This is now logically explained. Niels Bohr taught a young Heisenberg that knowing how instruments work was crucial. It still is today, and the reason for CSL for all observers may be self evident.

So far the model has only made things simpler, but what about dilation and contraction? The box is always, moving either towards or away from O. As the box approaches, the signal moves through it horizontally at c (or c/n of any medium within it), blue shifting at the refractive plane to pass through the glass at c/1.33, then red shifting most of the way back at the next layer of free boundary interface particles to pass through the void or air at c or c/1.0003. When we 'open up' a sample of the light to check it's records we find the spectral absorption line evidence. The signal has contracted proportionally to the relative speed of the emitter and receiver. A wave train or (Wolf) string of photons, electrons or protons would do the same. This is a simple length contraction from $c = \frac{f\lambda}{c}$, equivalent to Doppler shift.

But we must apply both elements of contraction, that due to n and that due to the relative motion. Even if the medium n inside and outside the box are the same, the wavelength (and f) are still Doppler shifted due to the relative motion. Once the box/emitter has passed O and is retreating, the shift due to medium c/n doesn't change, but the shift due to motion is now to the red. This works both ways, the light or particle 'string' from O being contracted as they close but also stretched as they move apart, via absorption and scattering at the transition between frames, and always subject to relative vector. Thus a simple Galilean transformation may be both $x' = x - vt$ and $x' = x + vt$, but is also always modified by c/n.

Before we leave the box, now, for the first time, if we take the walls away and just move the mirrors; the pulse is left to fly off into space. Could nature really be intuitive?

So perhaps contraction can be logically derived, but what about Time Dilation? Let us give O, and 2nd observer B inside the box, clocks, analogue or digital, coordinated when at rest. As the box approaches O the clocks all hit 1pm. At that moment each sees the others clocks reading slightly late due simply to the light travel time. One second later the distance, therefore the travel time, is halved. Each will see the others
clocks have caught up by half the original delay. To each observer the moving clocks therefore appear to run faster. Momentarily when B passes O they will all appear to read the same. But then as the box recedes, the distance increases with time so the signals take progressively longer to arrive. This increases the time interval so the moving clocks appear to run slower. But, as the light signal arrived at c in both cases this appeared to raise a paradox. Fresnel's ubiquitous n now shows that, if space is in Einstein's 'infinitely many' discrete parts, there is no paradox.

**Lorentz Transformation**

So time dilation, can be demonstrated, but at the heart of SR is the mystical exponential transformation Hendrik Lorentz derived by using Larmor's 't' factor with Fresnel's original equation and Fitzgerald's length contraction. This was all constructed to explain CSL for moving observers, but if constancy can be explained with consistent logic by a quantum mechanism what place for the Lorentz Transformation? (LT). Even if Occam's razor can be wielded to trim dilation and contraction down to palatable size, if it means cutting out LT surely SR would wither and die. It does not. In this model of discrete 'inertial fields' the LT has an essential role to play, but not quite the role we have so far understood.

For the LT we return to consider our string or bunch of electrons or protons, moving through the box as it approaches observer O at velocity v. As they leave the box towards O, entering the 'local background' inertial frame of O they are 'accelerated' (decelerated) and the group is compressed. Their inertial energy and local speed would be massively increased if c + v applied. As c cannot be exceeded in the new inertial field, but the law of conservation of energy applies, they must slow down and the excess energy must go somewhere! The compression concentrates it by reducing wavelength, (or increasing frequency, subject to observer frame, also explaining the photoelectric effect) but at any relativistic v this is overwhelmed.

To keep the new local v to below c, for momentum p = mv, the only place for the energy is in m (mass). This predicts a very strange phenomena. As individual protons can't physically increase in size the proton bunch would have to propagate, or condense, a surrounding plasma 'cloud' of temporary or 'virtual' particles to hold the mass. This would have a density and frequency subject to relative motion through the field. As no massive particle would ever quite be able to reach the new local c, this propagation would follow the Lorentz exponential curve. The power requirement for acceleration of mass towards c follows a similar curve. At the larger scale this 'power' curve would be needed to accelerate the light box in the first place, requiring infinite power as c is approached. Larger still, the cloud is consistent with & equivalent to the 'hot' charged particle plasma shocks and halo's of planets and larger collections of matter we initially considered, emitting the same em synchrotron radiation, from a boundary zone where the bodies em fields cease to dominate. If this were true such localised concentrations must cause asymmetries in the CMB. Both WMAP and Planck showed consistent quadrupolar and bipolar asymmetries\(^4\). NASA's Laser Lunar Ranging results are also consistent with a discrete space inside the shock.\(^{15,16}\)
As the relative speed of our bunch of protons reduces, the virtual particles would decrease oscillation rate and eventually evaporate but retain a fine structure ground state, of perhaps 1/137th of the mass at rest. As both inertial frames contribute to the boundary 'cloud', this may be expected to be at relative rest on each side of the boundary layer. This is what we find where the earth's bow shock interacts with the inertial frame of the solar wind, and at galactic Halo's, now shown consistent with this theory by IBEX.* Conceptually this means the Lorentz transformation is indeed the acceleration curve at the frame transition. The model simply allows removal of the unnecessary additional requirement that an apparent rate of change of position may not be \( v + c \) viewed from another frame. This highlights the importance of applying observer frame corrections to perceived subjective reality and allows logical explanation of all apparent superluminal phenomena.\(^\text{17}\)

A test of this prediction for bunches of protons moving through a vacuum may be carried out in particle accelerators. Most are busy searching for the Higgs Boson and dark matter but hampered by parasitic 'photo-electron' clouds growing round the particles, needing exponential power to approach \( c \).* Discovery is often spin off from other experiments so it's hoped that by 2020 CERN may help find out if laser beams passed through these clouds are refracted. If so, the problematic assumption that it's only possible to discern velocity in a vacuum relative to another body, not required in discrete fields, could be confirmed as redundant. If we study the evidence for relativity we find good empirical support for GR and the postulates of SR, however, most cited evidence against SR is only falsifies that assumption, which was not a postulate. Discrete spaces also can't be falsified by interferometer results or GPS\(^\text{16}\) as it's consistent with all, and the Sagnac effect. So we must now resort to the big gun with a curved trajectory to falsify our model; GR.

**Space-Time**

Considering our 'model of discretion' within GR, a possible insight into the Principle of Equivalence (PoE) is immediately apparent (Gravitational Mass = Inertial Mass). How can the gravitational attraction of a body increase with it's speed through the vacuum? We don't have any idea. Yet, in this model, actual mass is indeed increased in proportion to speed, by the 'cloud' particles. When the bunch slams into another it does prove to hold that energy. Taking this to a logical conclusion; Gravity depends on acceleration and speed (via mass) through a condensate/potential, so vice versa. So, with speed, (which brings in rate of change \( t \)) equivalent to inertial energy, \( p=mv \), increasing mass increases the energy needed to 'keep time'. Time must then run slower near greater mass. Condensate energy potential is 'canted' towards it to maintain equilibrium. This works via em field generation; Increased em particle oscillation, via speed, increases the two way interaction between oscillators, i.e. gravity, directly with inertial mass. Matter would condense due to field incompressibility. An allowed field would in turn allow entanglement, and modulate em wave speed via scattering. Einsteins intuitive 'wave bundle', if not conserved, would be confirmed as a superposed oscillating 'gyroscopic' corpuscle of inertial mass/energy.

This is disproved by Gravity Wells, caustics in space-time explaining excessive galactic mass estimates from 'Einstein Lensing' light delays of up to 3 years.\(^\text{18}\) Yet we know light moves at \( c \) both across deep space and
through galaxies irrespective of their motion. Logically a receding 'discrete' galaxy will delay light compared to that lensed around it, and an approaching galaxy will advance it. Far longer delays are now predicted.

Rainbows show that refraction in gas curves light. Our model of discretion uses curved light paths, explaining stellar aberration. Refraction at the suns plasma halo is equivalent to Eddington’s results. If mass/charge 'polarises' the quantum vacuum, inertial charge would create curved space-time itself. Points of gravitational equilibrium would then be Lagrangian not infinities. We find this emerges as a fresh view on Stochastic theory, possibly via a less rocky path. So GR is unable to falsify the theory, but importantly it could remove all 'field attribute' differences between GR and SR.

**Specification**

We now specify Discrete Spaces in more detail to expose inconsistencies. Mathematically only the Doppler formula is used, so we focus on reality and logical and empirical consistency: A space surrounds and moves with all mass in relative motion within any surrounding space, as a local extension of the mass. This applies from single accelerated particles to galaxies, nebula, super clusters or greater. It's defined by boundaries, which define discrete inertial frames, but only exist if in relative motion. There are infinitely many spaces, the boundary zones have the properties removed from the 'ether' for the purposes of SR and are real physical zones of condensed plasma or gas of n = 1<. Light travels through each zone at c/n, and respects the SR postulates. EM energy is conserved at each boundary by Doppler shifted f or λ subject to observer frame. Each observer in relative motion has an inertial field so all observation is at c, and of subjective (‘Parry’) reality. 'Lensing' delays mean Schrödinger spheres and light cones already have very uneven surfaces. Discrete fields explain how this does not affect causality. Yet with adequate spectroscopic and light path information original concrete realities can always be calculated.

The effect? The fine structure of all mass converts em wave speed to c/n locally before it's measured. It combines locality, reality and a known Quantum Mechanism using intuitive logic.

We apply an analogy; Consider a fluid in motion and a law that no molecule can move at over 1m/sec. In a fast flowing stream, an observer at rest beside it may see the centre moving at 10m/s. Will he deny it? If he observes any point in the stream, he'll find no molecule is moving at more than 1m/s with respect to it's neighbours, it knows nothing of other molecules elsewhere, it just keeps to the speed limit where it is. A molecule 100 from the edge may do 100 m/s from the observers frame but only 1m/s in it's own, as defined locally. The observer may see the centre of the
stream doing any speed as it is in a different inertial frame. The LT is not required as the light signal from the centre of the stream only does c. This explains the scores of quasar gas jets found, some apparently moving at over 7c from our frame. The stream of active particles ejected only do c locally in the stream they're ejected into, the next do c within the stream of the previous ones, and so on, forming 'incentric' discrete inertial fields.

A final strange prediction is that space has inertia and angular momentum. If a massive body were to suddenly stop dead, the field itself continues. Bizarrely this is what is found, the momentum of 'charge'. The field instantly regenerates at c from the mass outwards. Again this is consistent with a continuous sub matter condensate of energy potential as now allowed by the model, perhaps even below the Planck matter domain, but locally discrete around mass. This field regeneration also again shows a dynamic balanced tensor relationship of em potential with gravity and enables continuous connections between SR and the GR fields.

A 3rd way

Until now we've had two theories of light; Absolute Ether, then SR, never quite fitting with QM. A discrete field model (DFM) is a new 3rd way, with no problem of absolute space yet allowing a quantum field with a role in em wave propagation. It would change our understanding of SR, but really only clarify it and make it extra special by simplification, showing nature is continuous and by revealing the link with QM. It shows that at Solvay in 1927 Einstein was right to fight for reality, but also that QM was soundly based. Recent research shows we need to find a less self centric view of nature to gain 20-20 vision of how it works, to step back and detach ourselves to not confuse personal view and experience with a concrete reality that only maths can describe, but perhaps not ask maths to replace our conceptual thinking and visualisation skills.

If this theory is correct, it's value would be in the progress allowed across physics and all science, from energy, gravity and space travel to physiology. But would any paradigm adjustment be possible by 2020? and would discretion be the only part of valour needed? Certainly more falsification than can be given here is needed, but is possible.


Refraction & Extinction

Refractive Index is only found by experiment as knowledge of its material cause is limited. It's expressed as the ratio of the speed of light in a vacuum. For glass at $n = 1.5$, light travels $1.5$ times faster in a vacuum. This gives the angle of refraction between media via Snell's Law, varying with frequency, or wavelength subject to media and observer inertial frames. *Co-efficient of Extinction* arises as a measure of absorption $v$ wavelength, relating to scattering delays, Chromatic Dispersion and refracted light path. Motion can result in scattering to higher (or lower) frequencies.

New Concepts and suggested new terms.

New concepts arise requiring new words. The motion of multiple tubes or bodies 'sliding' within others, as gas jets; *Incentric*’ motion. Gravitation cross sectional of a collection of matter with a Lagrangian point at its centre of mass; *J-Ring*. The Discrete Field notion of space around mass as infinitely many 'nested' spaces of fields in relative motion with their local backgrounds; *Co-centric* motion or space. No body or em wave can move to another field without a balanced +or- transformation of frequency $f$ & wavelength $\lambda$ to maintain $c$. ($c = f \lambda$), $d$ is a transformation function of $\lambda$.

Consistent Definition of $d = vt$

Distance from Velocity $\times$ Time is only a 'definition', from $v = d/t$. As there is no absolute space in SR there is no absolute velocity. Distance Calculation is based on 'c', independent of motion of emitter or receiver, but with no absolute space it is a local quantity. Thus the $v$ in $d$ is only locally, so between inertial frames, is a variable. In $v = d/t$, if $d$ contains the variable $v$ it fails logic to treat $d$ as non-variable. This is consistent with curved space-time and the variable $v$ in $p = mv$. For logical consistency a small addition to $d = vt$ is needed for SR to add *locality*; $d = v_{l}t$. 'Local' means only directly applicable within the same inertial frame. Video of frame transition; [http://www.youtube.com/watch?v=b9KIzLuJIR0](http://www.youtube.com/watch?v=b9KIzLuJIR0)

Polarisation Mode Delay/Dispersion (PMD) & Birefringence

PMD is a term used mainly in Optical Fibre Technology describing the limitation of transmission speed due to the (partial superposed) particle charging or polarisation element of the atomic scattering process. *Birefringence* is an effect that demonstrates the relevance of particle polarisation on transmission time, birefringent materials having multiple refractive indices, therefore transmission speeds, subject only to polarisation of the incident light.

Lagrangian Points

Points of gravitational equilibrium. 5 are in the Sun/Earth/Moon system at the combined centre of mass. If physics is consistent the DFM suggests one exists at the centre of the earth, and at singularities.
**Particle Accelerators**

Accelerating particles in a vacuum propagates a 'cloud' of photo or virtual electrons (heat). Density extent & frequency are subject to speed, which is subject to power input. They can fill the pipe, and are considered 'parasitic', causing drag. Particles radiation is consistent with that from fast moving bodies in space, showing it is possible to discern local speed. Photoelectron or 'virtual electron' Clouds in accelerators. Wang et al. 2002. [http://conf-ecloud02.web.cern.ch/conf-ecloud02/papers/allpdf/wang.pdf](http://conf-ecloud02.web.cern.ch/conf-ecloud02/papers/allpdf/wang.pdf) 3Dsim, Harkay, K.C. et al. CERN Simulations of electron cloud build-up and saturation in the APS. [http://conf-ecloud02.web.cern.ch/conf-ecloud02/talks/harkay-ecloud02.pdf](http://conf-ecloud02.web.cern.ch/conf-ecloud02/talks/harkay-ecloud02.pdf) (2002).

**Other Anomalies.**

The model is consistent with the below and the anomalous activity and 'drag' on Pioneer and Voyagers and the Flyby anomaly. 'Upstream' shock activity, is not explained without an orbital component (see Fig. 2). Entanglement is explained by the oscillation connection through the combined em field for QG (see 'Space Time'). See text for; Flat Gravity Curves, CMB, Superluminal Motion, Infinities and Lensing Delays (also Ref)\[18\] and see Laser Lunar Ranging Ref's.\[15\][16\] 'Schrödinger spheres' are formed by the the spherical wavefronts emitted from an event in space, light cones result from adding a time dimension.

**IBEX Mission**


**Cassini Mission.** (quote).

"..the heliosphere appears to be bubble-shaped according to data from Cassini's Ion and Neutral Camera . Rather than being dominated by the collisions between the solar wind and the interstellar medium, the .. maps suggest that the interaction is controlled more by particle pressure and magnetic field energy density." Johns Hopkins University (Oct. 18, 2009). New View Of The Heliosphere: Cassini Helps Redraw Shape Of Solar System. [http://www.sciencedaily.com/releases/2009/10/091016101807.htm](http://www.sciencedaily.com/releases/2009/10/091016101807.htm).

**Field boundary distance etc.**

Field boundary positions appear to relate to mass distribution, relative velocity, magnetic field strength and orientation. The moon and Venus have weak magnetosphere's & little discernible shock. Venus's ionosphere generates a shock, significantly smaller than Earths. Comet shocks form around their gas clouds. Voyager 1 has now left the high particle activity zone (June 2010, at 17bn km.)