The Optical Breakdown Density Limit Gamma giving the Lorentz Transformation Mechanism

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Abstract.

The maximum possible density of conjugate ionized pairs produced by photo-ionization is defined as the optical breakdown (OB) density, which may be considered in terms of minimum wavelength (λ) as gamma. Applying Raman atomic scattering to the shocks and transition zones treated as two-fluid plasmas we identify the effects of approaching gamma on the absorption and re-emission process. We theoretically describe how the maximum density and related minimum wavelength limit produce the increasing resistance to electromagnetic (EM) wave permeability at propagation velocities approaching c. The increased ionization with increase speed through the quantum vacuum is found analogous to the Unruh effect and not in conflict with the postulates of Einstein's Special Theory of Relativity. (SR) Heat and sound is produced as density and resistance increases to the ion density limit $10^{21}/cm^{-3}$. The effect at OB provides a mechanism to implement the Lorentz Transformation (LT) by producing the 'gamma' curve as a resistance curve to matter in motion at increasing speeds in the quantum vacuum due to the bow shock photo-ionisation.

Axioms.

There are a number of different ways of understanding optical breakdown (OB). None have yet identified the connection and relationship with the curve of the function gamma as applicable to the Lorentz Transformation (LT). The LT both mathematically and geometrically describes the limit to propagation speed of light c, and the physical effects of transformation between inertial systems. The poorly understood effects grouped under the term 'Non-linear Optics' (some considered 'bizarre') are certainly anomalous, violate Snell's Law of refraction, and remain testament to the incompleteness of theoretical interpretation. We address the key effect when density approaches the OB limit or 'mode' in any circumstance, including at astrophysical shocks and Maxwell's Near/Far field Transition Zone (TZ). We propose a mechanism capable of producing all observed effects and working within both the postulates of Special Theory of Relativity (SR) and Quantum Mechanics (QM). We first axiomise;

1) Inertial systems as particle systems in a group state of motion, so forming a physically limited local scattering rest frame. We refer to such systems as 'virial kinetic entities (VKE's).

2) All fermion pairs, ions and scattering particles scatter EM energy (light) at c in the particle system of VKE frame. It should be noted that if the system is moving through a medium towards the source the 'closing velocity before interaction is arbitrary. All emission is however at c, thus implementing the wavelength (λ) change familiar as Doppler shift at a refractive plane (medium change).

The Unruh Effect.

Never verified as a purely accelerative effect, the Unruh effect[i], (Unruh 1976) can be characterised as an attempt to explain the increasing ionization rates of matter accelerating through the quantum vacuum (QV). In an attempt to also retain consistency with current '*interpretation'* of SR the Unruh effect was first attributed to 'acceleration'. None the less the ionized particle and heat build up exists, which we attribute directly to motion through the QV. The propagation forms the ubiquitous surface charge at smaller scales and planetary and solar Bow Shocks at larger scale. The process may be may be considered in conventional terms as fermion conjugate pair production, condensed momentarily from the vacuum. This propagation has been stated as confirming that "*the particle content of a field theory is observer dependent*." by Crispino et al. (2008)[i] who give a full mathematical derivation, not repeated here. Mean proper lifetimes of Protons and Neutrons (<~900 seconds) are also Modelled by Crispino. Considerable heat is produced, which we identify as increasing with density and emitted frequency on a power curve towards OB mode.

Optical Breakdown

Considered as a effect in diffuse dielectric media 'Optical Breakdown' has been familiar since the 1950's as the peak density or 'mode' of maximum plasma frequency ahead of a moving body where EM signals emitted from the body can no longer penetrate the medium. In a free space (near) vacuum the effect occurs as speed reaches c. In diffuse gas such as air and using Lasers the effect is considered as ionization of the air molecules.[ii] A loud 'crack is heard and heat and a bright blue light emitted which we characterise as momentary Cerenkov radiation emissions. The non-linear optics effect is also often considered in terms of photons undergoing spectral compression, i.e. Lavoi et al (2013)[iii]. It is agreed universally that optical breakdown ion density occurs at approaching 10^{20} electrons/cm^3 and steepens increasingly to an absolute limit at ~10^{22} electrons/cm^3, whereon all additional EM energy is absorbed and emitted as 'heat'. (Gamma >10^{19} Hertz, and minimum wavelength ~10 picometres).

If we then consider the case of a particle system, which may be a body or VKE, in motion through the QV at close to relativistic speeds, a dense bow shock will be propagated forming the ubiquitous ionospheric shock as found in Earth's 'plasmasphere' at the magnetospheric boundaries. A less dense but larger magnetotail forms, also of charged particles. In a dense ambient medium the shock density at any speed will increase. The dense and hot plasma shock of space probes on atmospheric re-entry is considered as a similar ionization effect reaching OB mode also in which EM signal penetration is not possible. The braking' effect of the ion propagation is considerable, and relied on for probe deceleration into the rotating planetary 'system' (VKE) inertial frame.

Comets

Past theoretical interpretation of an 'empty' medium in space has lead to an inconsistent theory of comet coma's as simply ice and rocks forming a group around the body. This assumption does not however extend to explaining the typical 'bow shock' and tail form of the coma. Diffraction has also been found through the coma consistent with a moving ionosphere. What is clearly not a co-incidence is the fact that below a certain velocity through the QV a body has no bow shock and is classified an asteroid, but above that narrow velocity transition zone a coma and tail is always present so the body is designated as a comet. Again ambient medium density has a direct effect, so we see the transition from the features of an asteroid to those of a comet as bodies approach the sun and the coma grows.

The term meteor is often coined for asteroids growing coma's, but the incomplete theoretical assumption of a violation of SR has been too great to allow full recognition of the simple mechanism. Assumedly the realisation that ice would immediately melt in such heat has discouraged any link being drawn. A local VKE of QV particles must always act as the 'background frame' for such motion, but is not itself not in any *absolute* state of motion so no violation of SR occurs. All bodies in motion through the local QV frame are found to have similar 'non-collisional' shocks. The bow shock of the star LL Orionis and companion stars are highly visible where in motion through the nebula gas.

Two-Fluid Plasma

A popular model of plasma dynamics is as an ion/electron fluid with two distinct states of motion and magnetohydrodynamic (MHD) turbulent mixing between. The two-fluid model has proved successful in accurately representing the appropriate physical processes and is relevant in laboratory conditions as well as across astrophysical shocks . Shumlak et al. (2004)[iv] write; "*The plasma is described by distribution functions in physical space, velocity space, and time, f(x, v, t). The evolution of the plasma is then "modelled by the (seven dimensional in the kinetic model) Boltzmann equation*."

The two-fluid structure forms a transition zone, and the shock electrons (or fermions pairs) on each side of the turbulent zone absorb em radiation at arbitrary closing speeds but always re-emit at c in their own medium rest frame. The new re-emission frame was as first discovered by Chandrasekhara Raman in the 1920's. For his 1930 Nobel prize. The result is that the propagation speed of EM emissions is then maintained at c in both frames on meeting and coupling with matter. The temporal evolution of the interaction as the refractive plane moves between wave peak (or 'photon') arrivals naturally effects the Doppler shift across the transition zone.

The four probe NASA Cluster mission 'frequency' findings are consistent with the two-fluid model In Figure 1 the top part 'A' shows the change in speed and wavelength across the bow shock as predicted by the two fluid model, part 'B' (bottom) shows the comparable cluster findings. Due to the apparent theoretical inconsistencies the data is described as showing magnetic field strength and electron 'temperature' rather than change to lambda (Dl) and propagation speed (local c), but are described as *“poorly understood and controversial.” (S. Schwartz. 2011).*[v] Earth's orbital motion is ~300km/sec. Higher relative frame speeds would propagate a more dense and wider shock to effect the steeper gradient.

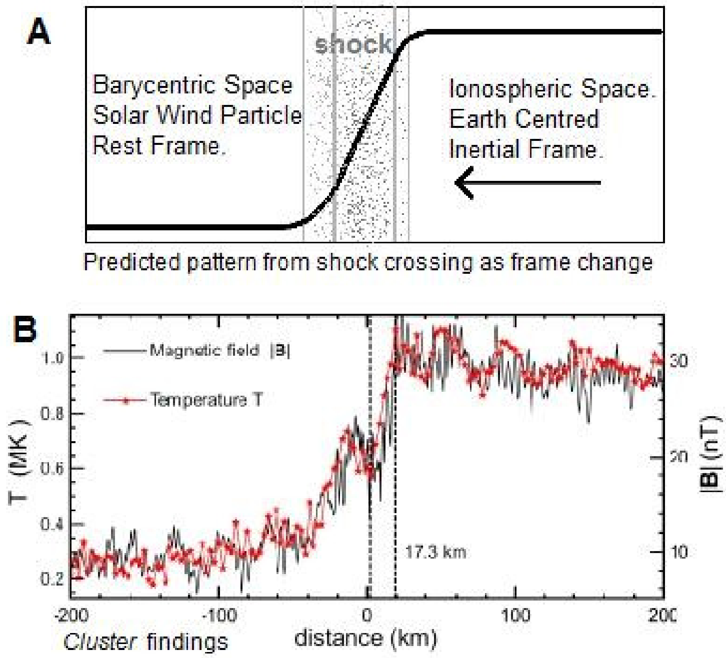

Figure. 1: Prediction of the two-fluid plasma model (A) as a kinetic change to propagations speed and wavelength across Earth's Bow Shock, scattered to maintain local c. And actual 'Cluster' mission data (B) NASA. S Schwartz Imperial College London.

The two-fluid hydrodynamics may be described as a linear version of the torque converter in a car's automatic gearbox. The particles on one side are in one rest frame and those on the other side in the other frame, with turbulent mixing between. In the plasma case, the pairs are likely to be produced and annihilated over a very short time slot. The mechanism of angular momentum transfer from 'light' to matter has been and quantified by Higuchi et al (2013)[vi] and described in terms of the 'coherent scattering' of EM waves from non-uniform irregularly moving plasma. The process is closely related to Surface enhanced Raman scattering at surfaces and is termed; *“Impulsive stimulated Raman scattering (ISRS)... expressed as a linear response to the instantaneous Stokes parameters (ISPs) of the laser pulse.”* (Higuchi 2013). The scattered wavelength/frequency spectrum has long been *“shown to be a transform of the plasma motion statistical characteristics”* (Gressilon et al 1985)[vii].

The speed modulation described at frame domain boundaries allows the recovery of Snells' Law of Refraction at the transition zone (TZ) between Maxwell's near and far field terms, which will describe the identical process across the surface plasmon transition zone, and the physical mechanism for implementing Maxwell's equations and 'partial time derivative on frame transition. At optical l the TZ is within 1 micron of the surface. The mechanism at surfaces including mirrors was discussed and resolved in detail by Jackson and Minkowski (2012)[viii]. The interaction regime was found to behave in a way consistent with this mechanism by Lamothe et al (2007)[ix]. At present Fresnel Refraction is lost at the TZ to be replaced with the mystical 'Fraunhofer refraction and only 'virtual' electrons. All such non-linear effects are rationalised by an acceleration of the observer into each local inertial 'frame' or system rest frame (VKE).

Lorentz Factor gamma curve

We have shown that two-fluid plasma density increases with the velocity of a body through the quantum vacuum. The plasma refractive index has long been established as ~n = 1 or slightly lower, giving plasma a near zero EM cross section, so near zero observability [x]. As no evidence of scattering at any velocity other than c in the new particle medium (VKE) frame can be found, the scattering velocity is axiomised at c in accordance with Einstein's 2nd postulate of SR. The Lorentz Factor then emerges to implement the gamma curve of velocity transformation between frames as a direct function of the plasma wavelength and, inversely, plasma frequency. Figure 2 shows the mathematically derived Lorentz curve. As we already know to the first order that plasma frequency increases to a good approximation of gamma then the mechanism for EM wave transition becomes self apparent. The wavelength limit relates to the Plank length ~1.6162 x 10^{-35}m. The resistance curve for matter at varying velocities may not appear so obvious, but the curve is directly related to the ionization rate and density.

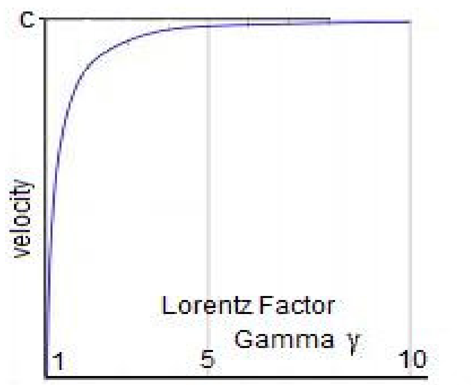

Figure. 2: Mathematically derived Lorentz Factor Gamma curve. PJ.

In particle accelerators such as the Large Hadron Collider (LHC) a 'virtual electron' cloud grows around the proton bunch in the bunch frame with increased velocity through the vacuum field, and also around each magnet in the pipe rest frame, creating the two-fluid mode. This cloud, originally termed 'photo-electrons' (from photo-ionization), is considered the source of the 'parasitic' drag of the bunch, stopping the bunch speed reaching c. The plasma emits synchrotron radiation as shown in Figure 3. The power input and synchrotron output curves closely approximate the Lorentz factor gamma curve as the bunch speed approaches c in the vacuum frame. Note the tailing off in figure 3, which is after OB mode has been reached.

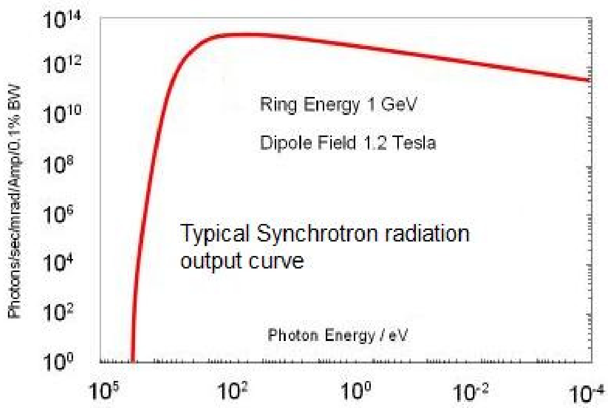

Figure. 3: Typical experimentally found particle accelerator radiation emission curve. CERN.

Halo Propagation

For consistency at all scales, the galactic halo would propagate conjugate pairs with the high coupling potential of plasma in proportion to rotational velocity in the 'Local Group' rest frame as identified in the original WMAP data and Smoot's 2004 Nobel prize winning analysis[xi]. There would then be a frame transition across the extended halo's 'two-fluid' plasma dynamics and structure. Rates of annihilation and birefringence in diffuse media will correspond to density and harmonics as well established theory. When considered in the frame of the local background medium the unexplained rotational velocity pattern of galaxies resolves to a very similar profile to the Lorentz gamma curve (see Figure 4). In the case of such Haloes and considering angular momentum the Yukawa or 'screened Coulomb' potential[xii] may prove to be required as a second order adjustment to the gamma formula.

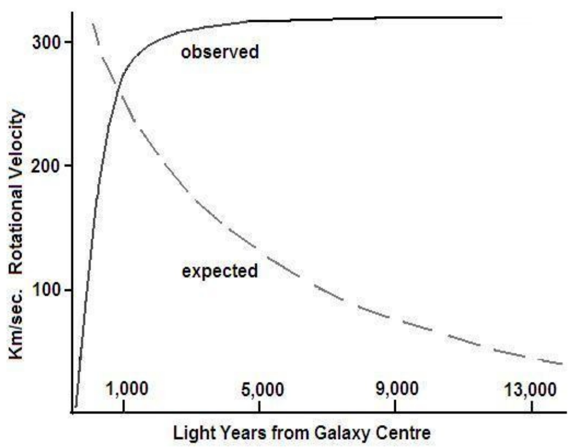

Figure. 4: Local velocity through ambient medium plotted against distance from the galactic centre. Gen.

Conclusions

We have shown that a theory of light speed modulated to c in all cases by local scattering to c corresponds to observation without the paradox and anomaly of other theory. The mechanism identified simply underlies present conceptual and mathematical descriptions. The postulates of the Special Theory of Relativity emerge from the quantum mechanism of Raman scattering in the local frame in all cases. The Lorentz factor emerges as a result of photo-ionization rates increasing with velocity through the local (not absolute) background frame. The CMB 'domain boundaries' implied by the WMAP and Planck data arise from the theory as the 'surfaces last scattered' implied by the data but not previously identified. At smaller scales the process is described by the Maxwell equations and field transition, and at large scales by Galactic Haloes.

The conjugate fermion pair production has almost zero EM cross section so may play the role of 'dark matter' propagated there by QV compression, condensed to fulfil the purpose of scattering to c, with the gravitational potential it represents being incidental. A hierarchical nested sequence of inertial systems assigned as virial kinetic entities VKE's then forms a 'discrete field' model (DFM) of 'regions of space' formed by particles as dielectric media. The maximum 'Optical Breakdown' plasma density and frequency gamma implements the Lorentz Transformation and limit c, dictated by the minimum wavelength of EM radiation. Theoretically problematic no-linear optical effects are resolved and Snell's Law recovered at Maxwell's near/far field transition zone.

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