On the Possibility of Relativistic Shock-Wave Effects in Observations of Quasar Luminosity

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A growing number of conflicts within the Standard Model call into question the fundamental interpretation of the Doppler component of the putative Hubble Expansion Law and the nature of events in spacetime associated with conventional coordinates of the line element as attached to the physical basis of the observer. Also of paramount importance is that Einstein's geometrodynamics is not a complete theory of gravity. We postulate that nonlinear effects associated with the propagation of light in an intense gravitational field produces shock waves creating 'light-booms' along boundary conditions at cosmological distances approaching the limit of observation that if correct would explain Quasi-Stellar Object (QSO) luminosity. These gravitational shock waves are considered observationally manifest in the spectrum of QSOs and Supernova as a continuous front of 'light booms' produced by superluminal boosts associated with continuous coordinate transformations relative to a distant observer. This model aligns with the view suggesting that QSOs are most likely a form of Seifert spiral galaxy with Active Galactic Nuclei (AGN) in the vicinity of the putative observational limit of the Hubble radius, H_R.

1 The Quasar Redshift-Distance Interpretation Controversy

As optical and radio telescopes continue to improve a vast amount of data continues to be accumulated on the large-scale structure of the universe. The popular view has been to interpret the data to support a hot Big Bang cosmological model; but as attested to in this chapter QSO's provide strong observational evidence that the Big Bang assumption is incorrect. From the early 1960's when the redshift of QSOs, and galaxies were compared with radio sources it became apparent that the redshift plot of QSOs contrasted with apparent brightness did not follow the usual Hubble correlation [1]. These redshift observations beginning with QSO 3C 273 in 1963 to more than 100 QSOs in 1963 still continued to show the same redshift apparent magnitude disparity when the number of sources was increased beyond 7,000 QSOs in the mid 1990's [2]. Most astrophysicists were not willing to accept that these redshift observations were not a measure of distance. Large redshift QSOs are not faint and typically have bolometric luminosities of ~ 100 times that of normal galaxies [1]. Woltjer [3] and Rees [4] found a way to interpret the QSO redshift as being wholly cosmological phenomena by considering the radiating surfaces as having relativistic motion [1].

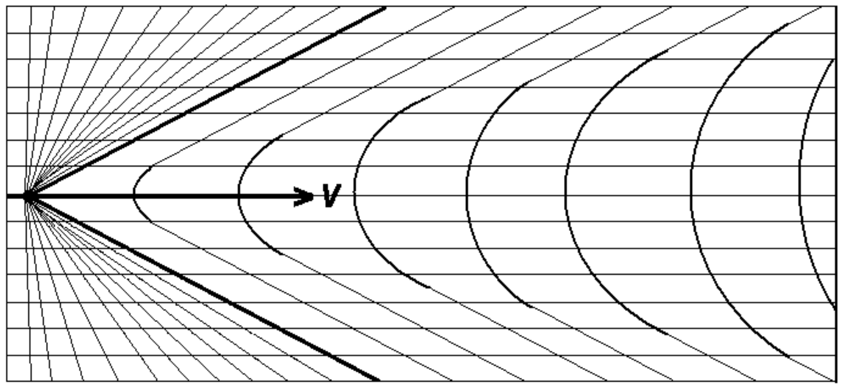

Figure 1 Wave front of a Doppler redshift for $Z = \sim .85\ c$.

Around the same time Arp comprised a catalog of unusual galaxies [5]. He noticed a physical association between radio sources, QSOs and some of the peculiar galaxies. But the observed redshift of the central galaxies was small and the redshift of the associated QSO very large suggesting that the QSO redshift could not be of cosmological origin. Arp had clearly shown with a high level of statistical accuracy that 'there was a clear association between radio QSOs with large redshifts and galaxies with very small redshifts' [1]. The linear separation between galaxy and QSO was generally the same demonstrating a clear association between the galaxy and the QSO [6-8].

> His work was greeted with astonishment and disbelief…and heavily criticized, often very unfairly. In response he began an extensive observational program…The community has remained skeptical of these results…one argument made against the reality of these associations by a leading observer was that if these results were correct, we had no explanation of the nature of the redshift! In other words, if no known theory is able to explain the observations, it is the observations that must be in error! [1]

Arp's colleagues at Mt. Wilson and Palomar were so troubled by his results that they petitioned the observatories directors to take away all of Arp's observing time. Arp protested when the recommendation was implemented and after his appeals to the trustees were turned down he retired and relocated to the Max Planck Institute in Munich [1,9].

2 QSOs an Issue of the Fundamental Basis of Geometrodynamics

Newton's formulation of the gravitational force law requires each particle to respond instantaneously to every other massive particle regardless of the distance between them which he proved; but the proof is only valid in Euclidian space. Today this would be described by the Poisson equation,

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)\varphi\left(x,y,z\right)=f\left(x,y,z\right) \qquad (1)$$

according to which, when the mass distribution of a system changes, its gravitational field instantaneously adjusts. Therefore the theory requires the speed of gravity to be infinite. Einstein's Geometrodynamics

$$G_{\mu\nu}+\Lambda g_{\mu\nu}=\frac{8\pi G}{c^4}T_{\mu\nu} \qquad (2)$$

is a classical extension of Newtonian gravitation and therefore an incomplete theory. Physical theory incorporates an upper limit on the propagation speed of an interaction, maintaining that instantaneous action-at-a-distance is impossible. However quantum entanglement between separated particles enables instantaneous correlations which led to the puzzle as to whether causality or locality must be abandoned.

The recent measurement controversy of the speed in which Gravity propagates has only addressed this semi-classical component [10-28]. The search for a Quantum Gravity (QG) is misplaced by the incorrect assumption that gravitation is quantized [29]; this is not so. The interaction between gravity and Quantum Theory (QT) occurs at the level of unitarity, not within an intermediate G-QT regime. This is because of the nature of the graviton, a quadrupole photon-graviton complex not the usual spin 2 Bose quantum-graviton with any associated properties. See Chap. 5. It is instead a condition of brane topology (according to the theory presented in this volume). We hope this chapter creates some insight into solving the conceptual; basis of this puzzle. Still in either case gravity has properties beyond the local, $v_g \simeq c$ velocity propagation. An additional instantaneous correlation as in the EPR experiment, but in unitarity where this action occurs is needed to describe gravitation. I suppose EPR in that sense provides good indicia of the incompleteness of QT. This duality of the laws of gravity are indicated in a variety of astrophysical effects such as the Titius-Bode series or QSO luminosity as addressed here. Before going into that, the aim of this chapter, a discussion of the Titus-Bode relation suggests an associated relationship to the missing components of gravitation.

Astrophysicist Silk stated, "…highly redshifted sources, most notably the radio galaxies and the quasars, reveal strong evolutionary effects. Equal volumes of space contain progressively more quasars and powerful radio galaxies at greater distances. Only by disputing the inter-pretation of quasar redshifts as a cosmological distance indicator can this conclusion be avoided" [30].

Taking an axiomatic approach we begin with a number of postulates:

- That the Hubble redshift, H_0 is non-Doppler. (No cosmological expansion or inflation)
- Redshift is due instead to photon mass, $m_\gamma \neq 0$ anisotropy, for $m_\gamma = h\nu / c^2$ with internal motion coupling periodically to the Dirac covariant polarized vacuum [31].
- Quasars (QSOs) are most likely a form of Seifert spiral galaxy with Active Galactic Nuclei (AGN) near the limit of observation at the Hubble Radius, H_R [32].
- The spectra of QSOs, the most luminous objects in the universe, can be explained in terms of Gravitational Shock Waves (GSW).
- Spacetime is asymptotically flat [33]
- The Cosmological Principle (CP) holds within reasonable limits.
- Expansion/Inflation of the universe is an observational illusion of misinterpreting of the Hubble redshift as a Doppler effect [34].
- This illusion arises from the continuous-state dimensional reduction properties of the present instant as a virtual subspace of an HD atemporal domain [35].

3 Recent Refinements of the Titius-Bode Series as an Indicator of a Possible New Gravitational Dynamic

The Titius-Bode law for planetary orbitals is in an exponential function of planetary sequence out from the sun. The law relates the semi-major axis, a of each planet in units so that the Earth's semi-major axis = 10, with $a = n + 4$ where $n = 0, 3, 6, 12, 24, 48...$ with each value of $n > 3$ twice the previous value. The resulting values can be divided by 10 converting them to astronomical units (AU). The hypothesis was discredited as a predictor of orbits after the 1846 discovery of Neptune and the discovery of Pluto in 1930. When originally published it generally satisfied by all the known planets

Mercury through Saturn. Two solar planets have a number of large moons that could have been created by a process similar to that which created the planets themselves. The four large satellites of Jupiter plus the largest inner satellite Amalthea adhere to a regular, but non-Bode, spacing with the four innermost moons in orbital periods that are each twice that of the next inner satellite. The large moons of Uranus have a regular, but non-Bode, spacing.

Results from simulations of planetary formation support the idea that a randomly chosen stable planetary system will likely satisfy a Titius–Bode law. Dubrulle and Graner [36] have shown that power-law distance rules can be a consequence of collapsing-cloud models of planetary systems possessing two symmetries: rotational invariance (the cloud and its contents are axially symmetric) and scale invariance (the cloud and its contents look the same on all length scales), the latter being a feature of many phenomena considered to play a role in planetary formation, such as turbulence. To test if a similar rule applies to extrasolar planetary systems so far only 55 Cancri, a binary star approximately 41 light-years away in the constellation Cancer, has sufficient planets to make predictions. An undiscovered planet / asteroid belt is predicted at ~2 AU.

Recent new calculations have shown that the Titius-Bode Law can be accurately demonstrated by the Euler-LaGrange equation for the free energy variations of the plasma initially forming the sun and solar system [37-39]. Using a 1st order Bessel function scaled to the geometry of the solar system, Wells has shown that the Titius-Bode numbers correspond to extrema of the roots and make exact predictions for the outer planets where the Titius-Bode series originally failed [40]. These new insights stem from the seminal work of Chandrasekhar [41] on the equilibrium properties of the boundary conditions of a volume of plasma.

TITIUS-BODE LAW - SOL				
Planet	k	Mass (M_E)	Bode Distance	Actual Distance- AU
Mercury	0	0.05527	0.4	0.39
Venus	1	0.81500	0.7	0.72
Earth	2	1.0000	1.0	1.00
Mars	4	0.10745	1.6	1.52
(Ceres)	8	0.00016	2.8	2.77
Jupiter	16	317.83	5.2	5.20
Saturn	32	95.159	10.0	9.54
Uranus	64	14.500	19.6	19.2
Neptune	128	17.204	38.8	30.06

Table 1 Titius-Bode Law for planets orbiting Sol [42]

TITIUS-BODE LAW - 55 CANCRI				
Planet	K	Mass (M_J)	Bode Distance	Actual Distance-AU
55 CANCRI -e	0	>0.034	0.039	0.038
55 CANCRI -b	1	>0.824	0.104	0:115
55 CANCRI -c	2	>0.169	0.283	0:240
55 CANCRI -f	4	>0.144	0.768	0:781
55 CANCRI -5	8	-	2.08	(not discovered)
55 CANCRI -d	16	>3.835	5.643	5:77
55 CANCRI -7	32	-	15.3	(not discovered)

Table .2 Titius-Bode Law for exoplanets orbiting 55 Cancri [43,44].

This “hints at other phenomena associated with the morphology of the system” [37]; we postulate this might reveal a feedback mechanism between the two modes of operation for gravity that could be responsible for destruction of a planet that should have formed in the asteroid belt. It is sometimes suggested that the gravitational force from Jupiter disrupted the planets formation. Our idea is that this feedback mechanism might arise from a harmonic oscillation between the effects of classical gravitation operating at the speed of light, c and the operation of the as yet undiscovered effect of quantum/unitary gravitation operating instantaneously. This effect if true provides indicia for our model of gravitational shock waves which also have oscillatory parameters.

4 Critique of Hubble's Law as Applied to Doppler Expansion

Redshift refers generally to motion of a source relative to an observer; with blueshift for motion toward the observer, $Z < 0$ and redshift for velocity away from the observer, $Z > 0$ for an object not in the line of sight the relativistic form of the Doppler effect is

$$1 + Z = \frac{1 + v\cos(\theta)/c}{\sqrt{1 - v^2/c^2}}\,. \tag{3}$$

When the motion of the source is in the line of sight, $\theta = 0$ the equation reduces to the general formula

$$1 + Z = \sqrt{\frac{1 + v/c}{1 - v/c}} \tag{4}$$

where one can tabulate *Z*:

V	Z
.5c	.73
~.6c	1
.75c	1.64
.8c	2.00
.85c	2.51
.95c	5.24
.96c	~6
.99c	13.11

Table 3 Tabulation of *Z* compared to velocity approaching *c*.

The largest *Z* currently known is for the most distant QSO CFHQS J2329-0301 with $Z \simeq 6.43$ [45]. A QSO with $Z > 10$ has been observed but is still unconfirmed. Hubble's redshift law is considered quite variable; and interpretation depends on a number of factors like the specific cosmological model utilized or if Λ is 0, + or -. The best indirect evidence supporting our thesis is that QSO's are the most luminous objects in the known universe and that an object, especially one as massive as a QSO is supposed to be, receding at ~c would indicate ~ infinite mass.

5 The Observer and the Cosmological Principle

In summarizing the *Cosmological Principle* (that the universe is homogeneous and isotropic on average in the large-scale) [46] events are idealized instants in spacetime defined by arbitrary time and position coordinates *t, x, y, z*, written collectively as x^i where *i* runs from 0 to 3. The standard line element is

$$ds^2 = \sum_{ij} g_{ij} dx^i dx^j = g_{ij} dx^i dx^j, \qquad (5)$$

where the metric tensor

$$g_{ij}(x) = g_{ji}(x) \qquad (6)$$

is symmetric [46]. In local Minkowski form all first derivatives of g_{ij} vanish at the event and equation (5) takes the form

$$ds^2 = dt^2 - dx^2 - dy^2 - dz^2. \qquad (7)$$

The Cosmological Principle generally suggests that the clocks of all observers are synchronized throughout all space because of the inherent homogeneity and isotropy. Because of this synchronization of clocks for the same world time *t*, for commoving observers the line element in (7) becomes

$$ds^2 = dt^2 + g_{\alpha\beta} dx^\alpha dx^\beta = dt^2 - dl^2, \qquad (8)$$

where dl^2 represents spatial separation of events at the same world time, *t*. This spatial component of the event dl^2 can be represented as an Einstein 3-sphere (compatible with the dual 6D Calabi-Yau 3-toris)

$$dl^2 = dx^2 + dy^2 + dz^2 + dw^2 \qquad (9)$$

which is represented by the set of points (*x, y, z, w*) at a fixed distance *R* from the origin:

$$R^2 = x^2 + y^2 + z^2 + w^2 \qquad (10)$$

where

$$w^2 = R^2 - r^2 \text{ and } r^2 = x^2 + y^2 + z^2 \qquad (11)$$

so finally we may write the line element of the Einstein 3-sphere from equation (9) as

$$dl^2 = dx^2 + dy^2 + dz^2 + \frac{r^2 dr^2}{R^2 - r^2}. \text{ [46]} \qquad (12)$$

By imbedding an Einstein 3-sphere in a flat HD space, specifically as a subspace of a new complex 12D superspace, [34,47,48] new theoretical interpretations of standard cosmological principles are feasible. This is the line element we feel is most compatible with the oscillatory spacetime boundary parameters required by our model of gravitational shock waves in QSO luminosity.

6 Some Fundamental Insights on Shock Waves

In general a shock wave is defined as an abrupt, discontinuous, nonlinear change in the characteristics of a medium that travels at a velocity higher than an ordinary wave often through a vortex fanning out from the source of the shock. Shock energy dissipates in a short distance and the accompanying expansion wave merges with the shock wave, partially canceling it. So our putative gravitational light-boom results from the degradation and merging of the shock wave and the expansion wave produced by the oscillating spacetime boundary conditions. To get a shock wave something has to be traveling faster than the local wave speed. In this regard some segments of the light around the vortex fan are traveling at the normal speed of light, so that the waves leaving the QSO pile up on each other and a shock wave, the pressure increases, and spreads out sideways. Because of this 'constructive interference' effect, shocks are intense like an explosion.

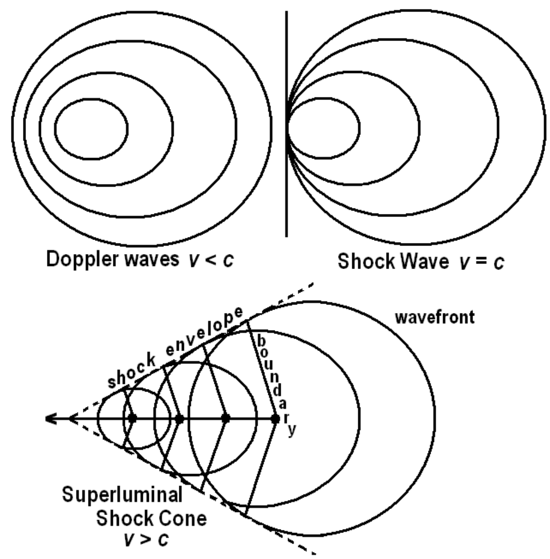

Figure 2 Simplistically considering a shock as originating from a point source in two dimensions the disturbance forms circular wavefronts centered at successive positions of the QSO's harmonic gravitational image source as illustrated at the bottom of the Figure. The wavefronts overlap and form the shock envelope. In 2D the shock envelope is a wedge, and in 3D it forms a cone. In aircraft nomenclature the semi vertical angle of the cone is the Mach angle μM = arc sin (1/M), where M is the ratio of source speed to sound speed and is called the Mach number. All sound is contained in the shock envelope where for the first approximation the envelope is the location of the sonic boom [60]. Analogous phenomena exist in disciplines besides fluid mechanics. In nuclear physics particles accelerated beyond the speed of light in a refractive medium create a visible phenomenon known as Čerenkov radiation emitted when a charged particle like an electron passes through an insulator at a speed greater than the speed of light in that medium. The characteristic 'blue glow' of nuclear reactors is Čerenkov radiation [61].

Shock/vortex interactions and superluminal vortex breakdown occur when a superluminal vortex stream encounters a shock wave, the discontinuous pressure rise of the shock wave can be sufficient to burst the vortex with an oscillation of light booms depending upon the structure of the vortex [49-55]. The structure of shock/vortex interactions has been investigated in a series of Soviet studies using various flow visualization methods [56-58]. These studies show that shock/vortex interactions result in highly unsteady flow patterns in which the shock wave bulges forward in the upstream direction showing a decrease to minimum value on the vortex axis. The cause of this action - the Ranque-Hilsch effect is currently unknown. But Crocco's theorem [59] (Eq. 13) suggests a steady flow gradient's total enthalpy relates to entropy gradients and vorticity, both of which are present in a vortex core. For an over expanded nozzle flow a strong interaction is distinguished from a weak interaction by the formation of a secondary recompression shock downstream of the bubble shock suggesting that the strong interaction corresponds to supersonic vortex breakdown. Finally Delery et al show that the strength of a shock required to burst a supersonic stream-wise vortex is inversely related to the vortex strength [51].

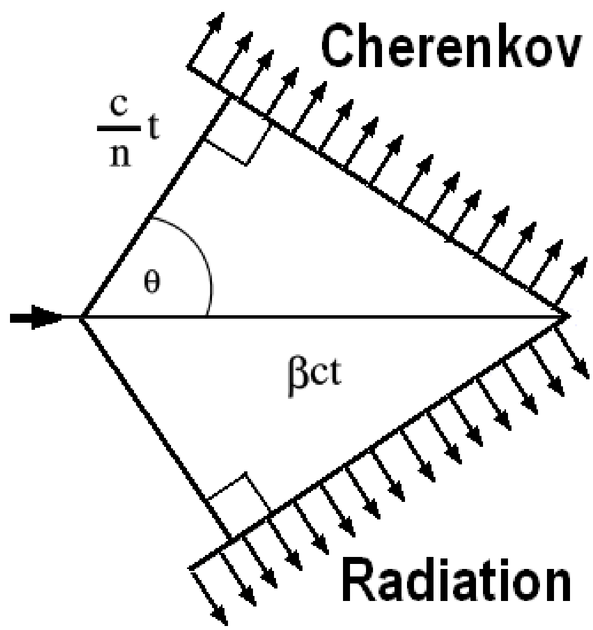

Figure 3 Geometry of Cherenkov radiation. In the figure, *v* is the velocity of the particle (arrow), β is *v/c* and *n* is the refractive index of the medium. The arrows are the direction of Cherenkov radiation so that $\cos\theta = 1/n\beta$.

In line with our postulate that all shock phenomena have similar characteristics Lyman & Morgenstern [52] have garnered three geometric insights into aircraft shock suppression that could also shed light on spacetime characteristics of gravitational shock waves: 1) A relation between lift force and airfoil area, 2) A volumetric shock cancellation phenomena that could give indicia to our postulate of constructive and destructive interference in the gravitational wave light cone, and 3) A directionality control by non-planar shaping that reduces centerline off-track signals.

7 New Cosmological Gravitational Shock Parameters

The nature of the universe has remained an open question. Kant attempted to solve the debate between Newton and Leibniz concerning whether the universe was open or closed by suggesting the antinomy [62] that the universe is both open and closed, i.e closed and finite in the semi-classical limit within the observed temporal boundaries of the observed Hubble radius, H_R; and open and infinite into a HD atemporal holographic multiverse domain beyond, H_R . Our model is cast in such a Multiverse with a potential for an infinite number of nested Hubble Spheres in causal separation each with their own fine-tuned laws of physics. This is pertinent here in passing because the cosmology in balancing the cosmological constant, Λ gives a backcloth that predicts asymptotically flat spacetime and an interpretation for dark energy as arising from the rest of the multiverse.

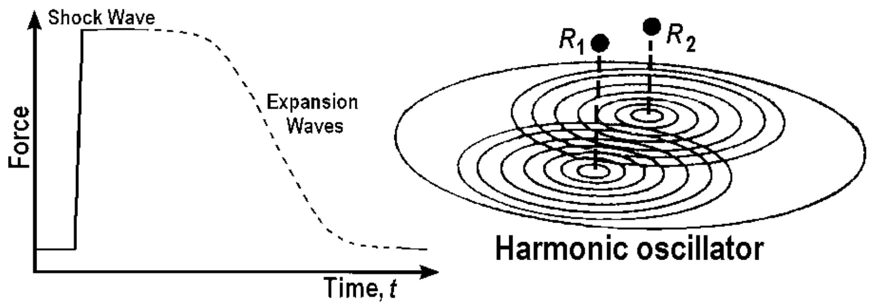

Figure 4 a) General shape of a simple shock wave. b) If shocks oscillate harmonically they may undergo constructive and destructive interference.

The Einstein gravitational potential oscillates the tidal gravitational field associated with the curvature of spacetime and predicts gravitational waves that propagate with a velocity of $v \simeq c$ .We postulate a new cosmological principle related to the action of gravitational wave shock fronts [63]. This action arise form a duality in the nature of gravity, whereas classical general relativity propagates according to $v \simeq c$ the eventual discovery of the completed form of quantum/unitary gravitation will show an additional quantum component with similarities to the EPR condition with instantaneous nonlocal synchronicity. Our postulate here is that this action at cosmological distances and for massive objects such as AGN QSOs creates a spacetime oscillatory shock fronts in the line of sight gravitational light cones leading to an apparent 'light boom' in QSO luminosity.

8 Hypersonic Shock Waves

We proceed for preliminary delineation under the assumption that the equations of state for hypersonic shock waves apply generally to any compressible media with shocks such as sonic booms or gravitational shock waves on the Dirac superfluid of spacetime especially those of secondary shock waves [60] that we postulate could be extended to support our theory that QSO luminosity can be explained by gravitational shock waves arising from an oscillatory interference of boundary conditions in propagation between of the dual modes of gravity, i.e. classical and quantum-unitary.

From Crocco's equation for smooth flow in an ideal gas [49,59]

$$\Delta h_0 = -\frac{\partial \mu}{\partial t} + T\Delta S + \vec{\mu} \times \vec{\omega} \qquad (13)$$

then following Kaouri [60] we develop a circulation theorem for a flow with shocks to eventually apply to the oscillation of boundary conditions for gravitational duality because the circulation theorem can be applied to parallel and perpendicular vorticity. For the closed curve,

$$C = \sum_{i=1}^{n} C_i \qquad (14)$$

in Fig. 4 where C_i is the domain from P_i to $P_i + 1$ and the circulation around C is

$$\Gamma = \sum_{i=1}^{n} \int_{C_i} u \cdot dx = \sum_{i=\Gamma}^{n} \Gamma_i \;. \qquad (15)$$

To construct the circulation theorem one needs to evaluate

$$\frac{d\Gamma}{dt} = \sum_{i=1}^{n} \frac{d}{dt}\left(\int_{C_i} u \cdot dx \right) = \sum_{i=1}^{n} \frac{d\Gamma_i}{dt}. \qquad (16)$$

For each C_i the expression $\frac{d\Gamma_i}{dt} = \int_{C_i} u \cdot dx$ needs to be evaluated. Applying Crocco's equation (13) and summing all the C_i contributions we arrive at

$$\begin{aligned} \frac{d\Gamma}{dt} &= \sum_i \int_{P_i^+}^{P_{i+1}^-} TdS + \sum_i \left[H \right]_i + \\ &\sum_i \left(u\left(P_{i+1}^-\right) \cdot \dot{P}_{i+1} - u\left(P_i^+\right) \cdot \dot{P}_i \right) \end{aligned} \qquad (17)$$

where the 2nd term on the right is the sum of $\left[H \right]_i$, the total jump at the *i*th shock [60].

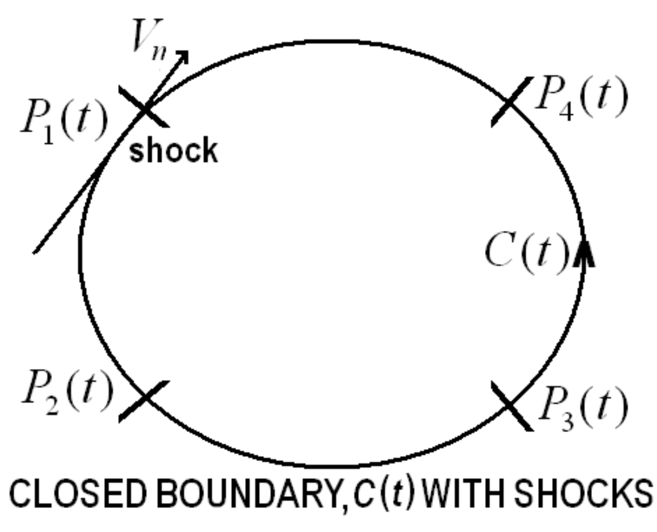

Figure 5 A closed curve boundary, $C(t)$ impinged arbitrarily by 4 gravitational shocks at positions $P_i(t)$ here with $1 \le i \le 4$ creating an entropic jump or constructive interference summation of gravity shock waves. Figure redrawn from [60].

Recent new work by Kaouri [60] on the dynamics of secondary sonic boom shock waves appears to provide insight into our idea of the dual nature of gravitational wave propagation.

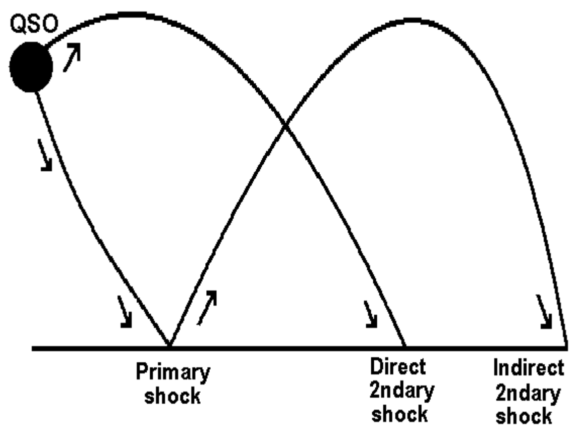

Figure 6 A conceptualization of a direct and indirect secondary boom. Figure redrawn from [60].

If Figs. 4 and 5 were combined one might end up with a conceptual view like that diagrammed in Fig. 6 but with a QSO at the center. If the physical case for a QSO contained a 2nd set of cusps in the bottom quadrant, the harmonic (Fig, 8) constructive and destructive interference of gravitational pressure waves could be a factor in producing 'light booms' in a manner dynamically similar to those producing Cerenkov radiation [61].

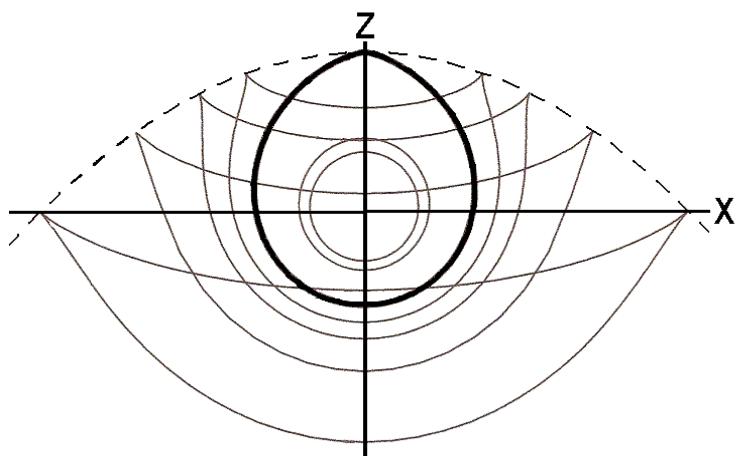

Figure 7 Select wave-fronts, a caustic, locus of cusps, when $Z = 1 - x^2 / 4$ plotted on the dashed line of a wave envelope. Figure adapted from [60].

The nonlinear nature of compressed fluid flow is the primary element of shock formation. If we consider a sinusoidinal gravitational influence of sufficient intensity where the curvature fluctuation across the wave is propagating adiabatically a disparity occurs in the velocity, *c* of propagation of light. The 'compressed' portion of the 'wave' will steepen to form a 'vertical' pressure front or shock as in Fig. 1b. The shock wave propagates because of a 'shift' in momentum transfer among flow regions of variable velocity. Shocks, being waves, only form in hyperbolic flow. The characteristic lines of flow are linear and merge into an envelope creating the shocks. Also as generally known parametric conditions can create triple shocks.

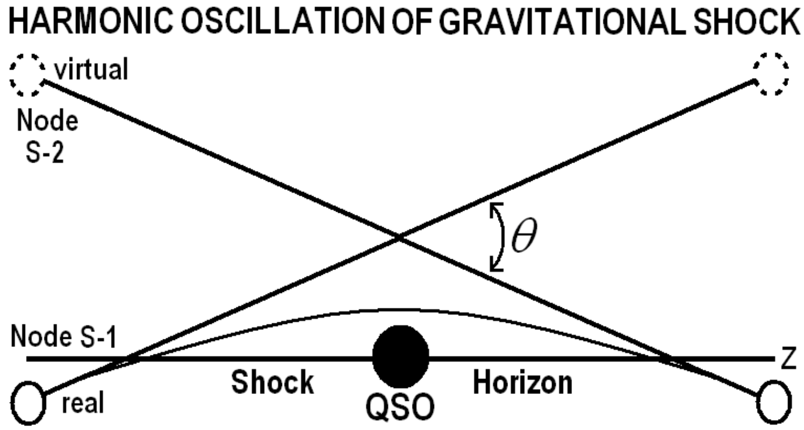

Figure 8 Schema of the primary postulate for a gravitational 'light boom'.

If the putative dual nature of gravitational propagation is physically real, than at cosmological distances for narrow axis large masses such as AND QSO's the coupling and uncoupling of the two principles could lead to a harmonic oscillation of the boundary conditions of the gravitational horizon such that a constructive/destructive interference occurs where at the summation nodes 'light booms' occur.

The nonlinear *x* component of gravitational shock nodes summating at collective shock fronts along $R_{E\text{-}Q}$ Adv + $R_{E\text{-}Q}$ Ret as seen by an Earth observer is shown in Fig. 9. The actual 'light boom' is the harmonic summation of shock nodes from the x, y & z axes and nonlinear assets arising from the interaction of the dual coupling of gravitational wave propagation.

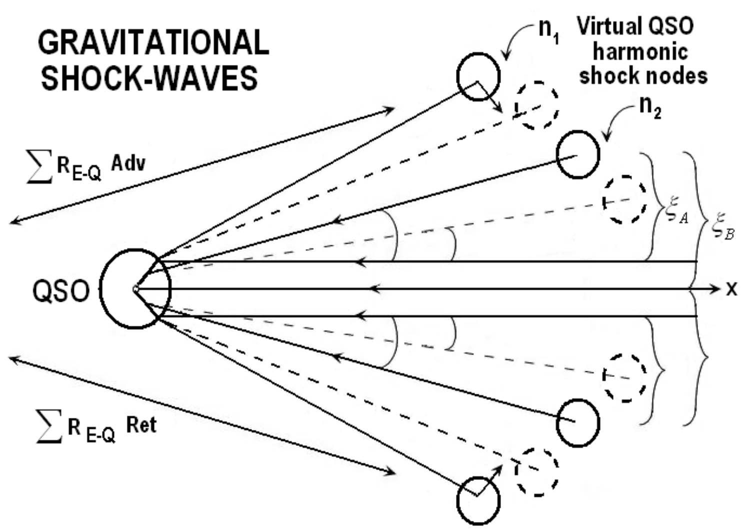

Figure 9 Elaboration of one quadrant of Fig. 8 showing a more detailed association of the oscillatory nature of the boundary conditions.

9 Gravitational Shock Waves

According to Misner, Thorne & Wheeler junction conditions may act as generators of gravitational shocks. They suggest that the dynamics of spacetime geometry for a 3-surface, Σ which includes the intrinsic Riemann scalar curvature invariant, *R* for example, also includes an extrinsic curvature tensor, K_{ij}. When imbedded in an enveloping 4-geometry hypersurface it can be applied to the change (shrinkage and deformation) in the vector, *n* parallel transported as junction conditions applicable to the gravitational field (spacetime curvature) and the stress-energy generating it. A discontinuity in K_{ij} across a null surface without stress-energy producing it is a geometric manifestation of a gravitational shock-wave generated by a different embedding in spacetime 'above' Σ than 'below' Σ [64].

Dray and 't Hooft [65] developed the fundamental conditions for introducing a gravitational shock wave in a particular class of vacuum solutions to Einstein's field equations by way of a coordinate shift. They outlined a model for generalizing gravitational shock waves for a massless particle moving in flat Minkowski space [66] formulated as two Schwarzschild black holes of equal masses glued together at the horizon. For a spherical shell of unequal masses moving along $u = u_0 \neq 0$ their solution [67] represents two Schwarzschild black holes glued together at $u = u_0$. By infinitely boosting the Dray-'t Hooft solutions various forms of gravitational shock waves have been found [68-73]. Sfetsos [74] extends these results to the case with matter fields and a non-vanishing cosmological constant. Using the d-dimensional spacetime metric

$$ds^2 = 2A(u,v)\,du\,dv + g(u,v)\,h_{ij}(x)\,dx^i dx^j \qquad (18)$$

with $(i, j = 1, 2, \ldots, d-2)$ he considers a string based dilatonic black hole gravitational solution [75,76] from the perspective of a conformal background field theory of coset $SL(2,\mathbb{R})/\mathbb{R}\otimes\mathbb{R}^2$ to achieve a differential shift factor

$$\left(\frac{d^2}{d\rho^2} + \frac{1}{\rho}\frac{d}{d\rho} - \varepsilon\right) f(\rho) = -16\varepsilon\rho\frac{1}{p}\delta(\rho) \qquad (19)$$

where $\rho^2 = x^2 + y^2$ and for the black hole singularity case with $\varepsilon = 1$ Eq. 19) is a modified Bessel equation. When $\varepsilon = -1$ Eq. 19 is interpreted as an expanding universe [74].

Spitkovsky [77] has developed a simulation for a relativistic Fermi emission shock process that could provide and alternative to or component process for our gravitational shock work. His simulations on relativistic collisionless shocks propagating in initially unmagnetized electron-positron pair plasmas showed natural production of accelerated particles as part of a shock evolution. He studied the mechanism that populates the suprathermal tail for particles gaining the most energy. The simulation showed the main acceleration occurs near the shock where for each reflection these particles gain energy, $\Delta E \sim E$ as is expected in relativistic shocks [78-80].

10 Conclusions

Newton's theory of gravitation required instantaneous action at a distance or the conservation of angular momentum would be violated. According to Einstein's theory of general relativity an instantaneous influence would violate causality and the special theory of relativity and so must be mediated by a field. This is the dual nature of gravity that we have put as the basis for our model.

Shock phenomena remain a relatively little explored area of science both within and transdisciplinary. We have tried to show that it is possible with further study to relate shock phenomena to gravitational waves especially for narrow axis massive cosmological objects such as AGN QSOs that readily lend themselves to ‘light-boom’ effects that could therefore be used to explain QSO luminosity as further evidence of the insurmountable shortcomings of Big Bang cosmology.

Our model would appear to work best by contrasting both modes of the dual nature of gravity because a nonlinear jump in flow occurs with a discontinuity. From the 2nd Law of Thermodynamics entropy can only increase when a particle crosses a shock. The duality of the propagation of the gravitational influence is evident in the idea of Birkhoff's theorem [81] in that a spherically symmetric gravitational field is produced by a massive object such as a QSO at the origin; if there were another concentration of mass-energy somewhere else, this would disturb the spherical symmetry. This effect could occur if interference occurs between the usual modes of the gravitational influence by shock parameters.

More work needs to be done developing this model. We have only outlined what we perceive as an appealing avenue. At the close of writing we found an interesting 2009 article by Crawford suggesting new supernova data consistent with a static universe [82]. Also several more high redshift QSO’s have been discovered that seem to support our shock theory for QSO luminosity [83-86].

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