Part XIV

Dark Energy

and

The Centred, Linear Equation of State

October 16, 2021

A Centered, Linear, Cosmic Equation of State

Several decades of applying the theory of compressible fluid flow to problems in physical cosmology has shown the suitability of thermodynamic equations of state to describe the main divisions of physical cosmology. Thus, we have the hyperbolic equation of state [pv = cont. = RT] to fit the field of visible, baryonic, compressed matter, the linear, tangent equation [p = Av +B] for the photons of electromagnetic radiation, and the elliptical equation of state [$p^2a^2 + v^2/b^2 = a^2b^2$] for the dark matter of the cosmos. (1,2,3,9,10,11,12). (Fig. 1).

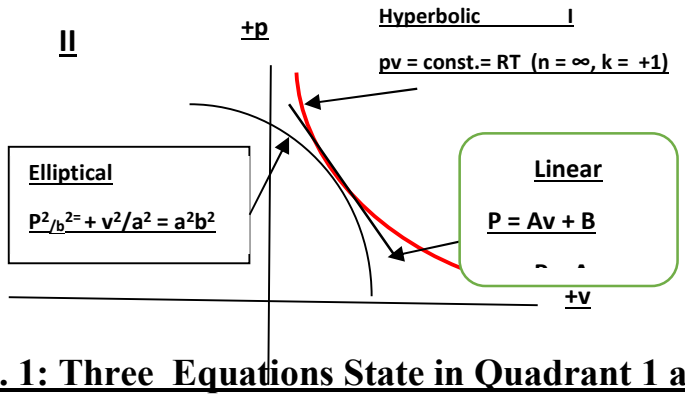


Fig. 1: Three Equations State in Quadrant 1 at a Tangent Point: Hyperbolic for Visible Matter, Elliptical for the Dark Matter, Tangent Linear for compressive Electromagnetic Photons

The hyperbolic gas law [p v = const.] describes visible matter; it supports compressible waveforms which grow to shock waves where strong compressions produce the elementary particles of matter associated with the strong force, while the associated weak shock fits the weak state and weak force particles. The numerical fit of the shock strengths to the particle mass ratios is within 1 to 2% [9].

The elliptical state [$p^2/ a^2 + v^2/b^2 = a^2b^2$] shown in Fig. 1, supports strong and weak rarefactions which we have assigned to describe proposed strong and weak **rarefied** shock particles. (**dark matter** or *celestons)*[9].

The linear, tangential equation of state Fig. 1 supports stable waves of both compression and rarefaction. Shocks are ruled out. Theses stable compression forms are assigned to the electromagnetic compression photons.

More recently, this approach has yielded the **centered**, linear, equation of state [p = ± v] Fig. 2 whose rarefaction waves appear to be the the long-sought-for gravitons (12). or quanta of gravity. We now explore this field further for its c**o**mpression waves.

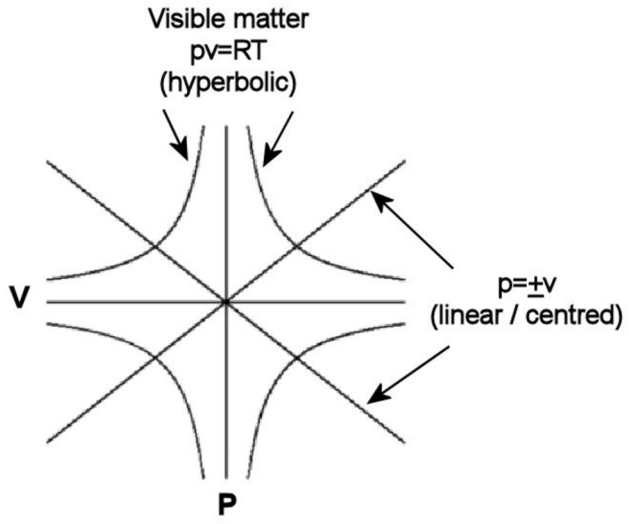
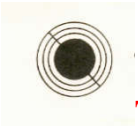


Figure 2. The Universal, Centred, Linear, State which uniquely and universally intersects with the hyperbolic, visible matter states in Quadrant 1;(Note: the universal intersctions with tbe elliptical and the tangent, linear states (Fig. 1) are similarily depictable)

The fact that this very simple basic equation of state supports waves of both compression and rarefaction leads us to assign to it the two basic cosmological entities, quantum gravity and the graviton for its rarefaction waves, and the dark energy for its compression waves.

Other physical approaches are possible, of course, such as relativity theory for gravitation, since in uniform flow the path lines on a space time (x,t) presentation are straight while in an accelerated flow they are curved. All waves are basically quantised in these two fields so quantum theory applies. The exploitation of the possibilities of applying these two new fields to other existing theoretical approaches to cosmology are left for their specialists.



The Quantum Gravity Field

A satisfactory theory of quantum gravity has been a main goal of current cosmology. Here, we have approached this complicated task by proposing the centered, rarefied, linear equation as the sought for **quantised gravitational equation of state**. We have shown that it is universal, is intrinsically quantised **and that its quantum wave particle qualifies as the graviton**.*[Ref. 12. Part XIII: Gravitons and a Centered Linear Equation of State .Posted August 2021].*

. We may summarise the main features of the field as follows:

1.**Derivation:** The basic equation of state for the baryonic/Hubble universe is usually some form of the ideal gas equation pv = constant = RT. If we now express this in the adiabatic gas form, pv^k = const. where k = c_p/c_v, the ratio of the specific heats, then the relationship of the two equation of states, becomes for k = - 1, just pv^{-1} = p/v = const, or **p = ±v, which is the proposed quantum gravity equation of state.**

2. **Quantisation:** Both linear fields , photon and graviton, are intrinsically quantised as can be argued in several ways.:

(1) The compressible flow wave speed c is given in the energy equation as: $c^2 = k\, p/\rho$, where c is the phase wave speed, k is the adiabatic exponent [$k = c_p/c_v$, the ratio of specific heats). Here $k = (n+2) / n = (-1 +2)/ -1 = +1/-1 = - i$. Going back to the energy equation and inserting this negative value for k , we have: $c^2 = k\, (p/\rho)$;so

$c = \sqrt{-1}\, (p//\rho)^{1/2} = \boldsymbol{i}\, (p//\rho)^{1/2}$ **which is complex and quantised.**

(2) The complex nature of the wave forms in this new linear field leads to a view of its quantum wave/particles (photons and gravitons) as being quasi- point energy concentrations surrounded by very sharply attenuating energy fields.

3. **Quantum Spin:** For the photon, the number of degrees of energy freedom n is +3, and so $S = (n - 1)/2 = (3 - 1)/2 = 2/2 = 1.$

For the graviton, taking n equal to -3 we have Spin $S = (-3 -1)/2 = -4/2 = -2$

4. **Relativity:** A Basic current theory of gravitational force is that of general relativity which requires a spin 2 for the graviton. We have just derived Spin -2 which agrees (in magnitude) .

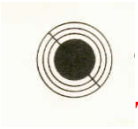
Also, conceptually, compressible flow physics postulates that all its flows V must be **relative** and so it basically fits special and general relativity. For example, uniform flows plot on the flow space- time coordinate diagram (x,t) as straight lines, corresponding to special relativity, while accelerated flows plot as curved space time trajectories corresponding to general relativity. The corresponding force is that of gravity. It seems clear that our compressible, quantum field $p = \pm v$ can accommodate both relativities.

5. **Universality:** An essential requirement is that the desired gravitational theory **must apply universally.** Our candidate field equation uniquely meets this requirement (Fig. 2).

6. Force: The photon is the carrier or messenger particle for the E/M force. Symmetrically then , the graviton is the carrier of the gravitational force.

The **exclusively attractive** nature of the gravitational force is also possibly explainable from parallel and anti-parallel spin considerations, but this matter is left for specialists in quantum spin physics. Another mechanism to consider in explaining this attractive nature of gravity is the effect of the rarefaction nature of the graviton in the interaction of a graviton and a mass energy particle. The net lower pressure of a mass particle and its interacting graviton would seem to result in a net pressure lowering and hence of attraction. towards the gravitating source This approach would essentially be a pressure gradient field approach.

7. Quantum Gravity Infinities and Renormalization: These are specialities, but the proposed quantum field may be of assistance in visualizing them physically. For example, the assumption of initial small physical size plus internal reflections and interactions and a speed of light wave speed necessarily generates quasi -infinities of quanta, thus perhaps explaining the necessity for renormalization.



The Universal, Dark Energy Field

The questions of the existence and nature of the dark energy of the cosmos are central in cosmology. This mysterious energy is needed to account for the observed acceleration in the expansion of the observable universe. It also makes up by far the largest portion of the theoretical mass/energy of the entire universe (visible matter 4.9 %, dark matter 24%, and dark matter 69%).

Because the new centred equation [$p = \pm v$] is linear, it supports stable wave particles of **both compression and rarefaction**. We have already above assigned the rarefaction wave/particles to the gravitons**. Now we assign the compression wave states to the dark energy field of the cosmos.**

Since visible matter is graphed as an hyperbolic state equation, dark mater as an elliptical state, and now dark energy as a centred linear equation (Figs 2), let us examine the relative pv- energy **areas** at some arbitrary common pressure p . We see in Fig. 3 that pv areas corresponding to visible matter , dark matter and dark energy **are in roughly the same ratios as the observed relative cosmic masess of 4.9%, 26% and 68% cited above.**

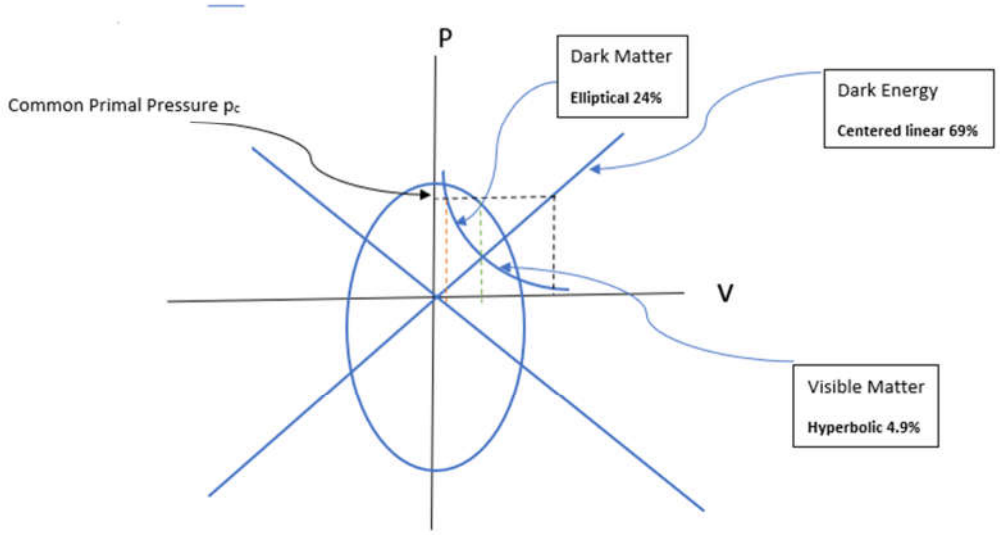


Figure 3. The Three Basic Equations of State Compared as to Energy (i.e. pv areas) at a Common Pressure p_0: Evidence for Compressible Flow States Underlying the Observed Cosmic Energy Ratios of 4.5%, 24% and 69% Respectively

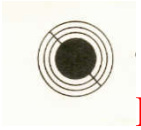
One explanation for the above ratios is that they arise out of an initial very high input of dark energy which is needed to actuate the Big Bang shock and start the cosmological process. Given that initial very high value from the dark energy and the relative geometry of the hyperbolic and elliptical state curves on the pv energy graph, then the relative pv energy ratios are roughly determined.

It is interesting that in the dark energy state the law of conservation of energy seems not to apply, since as p increases v increases and the energy (pv) increase and vice versa.

6 Basic Field Energy: The field energy of this basic linear, centered field ($p = \pm v$) constitutes a vacuum energy density. In this field waves are stable and quantised with the fundamental field form being described by the quantum wave function $\Psi = c \pm iV$, where c is the wave speed and V is the relative pulse speed.

The quantum wave energy is $\Psi^2 = (c \pm iV)^2 = c^2 + 2icV - V^2$.

The very high energy levels assigned to the quantum field in quantum field theory can possibly be physical understood as a consequence of the enormous number of internal reflections in an initial extremely small sized physical field when the wave/particle speed is c, the speed of light.



Discussion

To repeat, a very simple, basic linear equation of state ($p = \pm v$) is proposed to explain both (1) the long-sought-for graviton and (2) the basc dark energy of the cosmos; this basic stste's interaction with other cosmic states sets off processes which form the matter and radiation of the cosmos.

This linear, centered equation is automatically quantisied, and supports stable waves of both compression and of rarefaction. We have already proposed that the compression wave/ particle is the quantum of gravity or graviton; we now propose that the rarefaction waves are in this mysterious **dark energy** field which alsom causes the observed acceleration in the expansion of the visible cosmos.

If the Big Bang is seen as an ultra-strong compression shock, then we propose that the primordial compression field for the formation of this primal shock is this dark energy field. The cosmological question of 'what preceeded the Big Bang' then would be answered that it was this dark energy state, which may well also be primal.

The fields of both quantum gravity and of dark energy have been the subject of immense specialised research. No attempt will be made here to examine how the new proposed equation of state may relate helpfully to these various detailed specialty approaches.

If the dark energy is assigned a single definite specific volume v (or alternatively a single pressure v) then the dark energy becomes a tangent linear equation ($p = \pm Av$) Figure 2, which is orthogonal to the centered linear state. This orthogonality sets up the condition for Maxwell's Electromagnetic Equations ( ) **and so the possibility for electromagnetic radiation emerges .**

Compressible Cosmology :

A dark energy pulse initiates the Big Bang in the hyperbolic state t\o form the baryonic particles,, and then participates in the inflationary spherical expansion in which the weak shock interaction forms the leptons: it also activates the elliptical state's rarefaction shock to form the rarefied dark matter..

Compressibility cosmology thus describes a basic, energy (dark energy) state ($p = \pm v$; 69% of the total mass energy of the cosmos) which **interacts** (a) with the tangent linear states to form radiation (b) with the elliptical state (to form the rarefied dark matter; 24% of the mass energy of the universe) and (c) with the hyperbolic state (pv= constsnt = RT,) to form the Big Bang shock and the observable ordinary matter, protons, atoms molecules; (4.9% of the total mass energy.).

Iimmediately following the Big Bang compression, an inflationary, super-expansion state activated the elliptical state (Figure 2), triggering rarefaction shocks and forming the rarefied dark matter. The weak shock option in the hyperbolic state also triggers the formation of the leptons.

To repeat:

1. The Initial Event was a Compression or Surge in the Dark Enegy Field ($p = \pm v$).which interacted with the tangent linear state ($p = \pm Av$) to form radiation.

2. This dark energy surge and interaction next triggered a super- strong compression shock in the hyperbolic field (pv = constant) in which strong shock or Big Bang there formed the baryon elementary particles (quarks, protons, neutrons mesons, Appendix A) .

3. Almost immediately then the super inflation which folllowed the Big Bang also activated elliptical dark matter rarefaction shocks in which was formed the rarefied dark matter of the universe which today makes up about 24% of the total mass energy of the cosmos. In the hyperbolic state the interaction set off weak shocks which formed the leptons, photons and various electroweak interactions. (Appendix A). The total observable hyperbolic matter and radiation make up about 4.9% of the mass-energy of the universe.

Held together by gravity, the cosmos is now a quasi- spherical, expanding, dark energy field (69%) , enclosing sub- fields of co-expanding, interacting. hyperbolic compressed visible forms (particles, atoms molecules photons, leptons), (4.9%) and non-detecible, weakly interacting (10%), elliptic, rarefied dark matter forms (celestons) (24%).

To repeat, a very simple, basic linear equation of state ($p = \pm v$) is proposed to explain both (1) the long-sought-for graviton and (2) the basc dark energy of the cosmos who's interaction with other cosmic states sets off processes which form the matter and radiation of the cosmos.

This linear, centered equation is automatically quantisied, and supports stable waves of both compression and of rarefaction. We propose that the compression wave/ particle is the quantum of gravity or graviton, while the rarefaction waves are the missing dark energy which causes the observed acceleration in the expansion of the visible cosmos.

If the Big Bang is seen as an ultra-strong compression shock, then the primordial compression field for the formation of this primal shock is this linear centred equation of state. The cosmological question of 'what preceeded the Big Bang' then would be answered that it was this dark enegy state.

The fields of both quantum gravity and of dark energy have been the subject of immense specialised research. No attempt will be made here to examine how the new proposed equations of state may relate helpfully to these various detailed specialtIes.

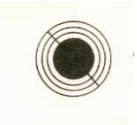
In general, the approach of applying thermodynamic equations of state to physical cosmology has been remarkably fruitful (Fig 2) by showing physical unity and differences between visible compressed matter, invisible dark matter and electromagnetic radiation, (Fig. 1,) The new centered, linear equation of state, it is hoped, will emerge as the supporting state for universal quantum gravitation and for the dark energy and so to help complete the cosmological state system.

The general compressibility explanations have pertained to wave types and wave functions, to quantification, to compressed physical matter, to rarefied physical matter, to E/M radiation and now to gravitational quanta or gravitons and dark energy. Compressible flow theory also provides a general physical base for special

and general relativity, as well as for all the quantum wave/particles and wave functions.

This centered energy equation is apparently **a basic universal** field interacting with all other compressible fields. Since it is also basically complex, as shown above, we may speculate that it is also a basic quantum field. If this is so, then the designation of it as the graviton quantum field constitutes it as the sought-for link between gravity and quantum physics and with relativity in a more general way.

Since this quantum equation of state sems to be basic and universal, it is hoped that it may be helpful to quantum physicists with some of their intricate and difficult fundamental problems such as **quantum infinities,** with **self-interaction** and with **renormalization, etc.**



Relevant Further Questions

1. Does the new field offer any insight or help with the **problem of infinities** in quantum calculations which leads to the necessity for renormalization?

2. Develop the approach leading to a solution for the problem of gravitational **attractive force.**

3. Explore the linear, centered field in Quadrants II, III and IV(Fig. 2)

4.What does the new field have to offer to the problem of **vacuum density** Of the **cosmological constant**?

5. What is the relevance of the proposed energy field to the "**flatness problem**?-

6. Pursue the application of the new energy field to the problem of the **rate of cosmic expansion**?

7. Examine the problems of **quantum action at- a distance** and of **collapse of the quantum wave function** in the new field.

7. For the new centred linear equation of state, examine any problem sed by a physical vacuum and consequent absolute discontinuity in symmetry found at the graphical origin point where p and v are both zero. (Note: A separate "Part XV" on this problem of scientific /numerical limits that have been encountered with applying thermodynamic equations of state is under study).

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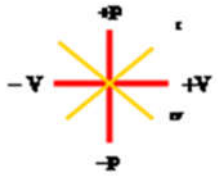
10.---------- *Part XI: Interactions and Transformations (Page posted November, 2020).*

11. ---------- *Part XII: Visible – to – Dark Matter Transformations*. Page posted June 2021.

12. ----------*Part XIII: Gravitons and a Centered Linear Equation of State. Posted August 2021*



“What is real is that which can be intelligently grasped and reasonably affirmed ……. “.

Bernard Lonergan, S.J. in his treatise

“Insight: A Study of Human Understanding”

“Insight is Joyous” ……. Richard Feynman

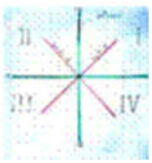
APPENDIX A

Formation of Visible, Hadronic and Leptonic Matter in a Hyperbolic Compressible Shockwave

Evidence for the Origin of Baryonic Matter by Energy Compressibility in Shock Wave Condensations, as occurs in Linear Accelerators

We have earlier proposed .[1,2,3]. that **: All elementary particles of matter (with the possible exception of the neutrino) are condensed energy forms produced under hyperbolic equations of state by compression shocks**

The forms are given in terms of a simple, integral number **n** (n = degrees of freedom of the compressible energy flow, which is roughly the number of ways the energy of the system is divided). The experimental values of the ratio of the masses to one another are then related to the maximum theoretical compression ratio for each compression shock. (Eq. 16 below). The observed fit is to within 1%.



Maximum Compression Ratio

$$m_b/m_q = V_{max}/c^* = [n+1]^{1/2} \qquad (16)$$

where m_b is the mass of any hadron particle, m_q is a quark mass, $V_{max} = c_o\, n^{1/2}$ is the escape speed to a vacuum; that is, it is the maximum possible relative flow velocity in an energy flow for a given value of n, the number of degrees of freedom of the energy form, this is a non-isentropic relationship which **corresponds physically to the maximum possible strong shock.**

Experimental verification values for this hadron mass- ratio formula is given in Table A below. (See Appendix B: The Production of Visible Matter at a Strong Condensation Shock in a Linear Accelerator)

Table A) Hadrons (Baryons and Heavy Mesons)

n	n +1	$[n+1]^{1/2}$	Particle	Mass (m_b) (MeV)	Ratio to quark mass
0	1	1	quark	undefined	1
1	1	(s)	quark (s)	505	1
2	3	**1.73**	eta (η)	548.8	**1.73**
5	6	**2.45**	rho (ρ)	776	2.00
8	9	**3.00**	proton (p)	938.28	**3.03** (1)
			Λ (uds)	1115.6	**2.97** (2)
			Ξ^o (uss)	1314.19	**2.99** (3)
9	10	**3.16**	Σ^+ (uus)	1189.36	**3.17** (2)
10	11	**3.32**	Ω^- (sss)	1672.2	**3.31** (4)

Note: Average quark mass is 310 MeV; (2) Average quark mass is (u + d+ s)/3 = 375 MeV (3) Average quark mass is (u+s+s)/3 = 440 MeV; (4) Average quark mass is 505 Mev.

Comparing column three, the maximum shock compression $[n+1]^{1/2}$], to the final column "Ratio to quark mass" we see that they closely agree, so that the

proposed origin of hadrons by strong shock compression theory expressed in Equation 16 is verified.

B. Origin of Leptons, Pion and Kaon

$$m_L/m_e^- = k/\alpha^2 = [(n+2)/n]/\alpha^2 = \{(n+2)/n] \times 137 \quad (17)$$

where $\alpha = 1/11.703 = [1/137]^{1/2}$ is the fine structure constant of the atom , and k is the adiabatic exponent or ratio of specific heats, $k = c_p/c_v = [(n+2)/n]$.

Because of the presence of k, this equation for the mass of the leptons is thermodynamic and quasi-isentropic.

We propose that the leptons are formed via the weak shock option (i.e. they involve the reduction in strength of the fine structure constant $[1/137]^{1/2}$

The experimental verification for the lepton mass ratio formula of Eqn. 17 is given in Table B below.

Table B) Leptons, Pion and Kaon a

N	k = (n+2)/n	Particle	Mass (MeV)	Ratio to Electron	Ratio x 1/137
1/3	**7**	Kaon $K^{\pm}$	493.67	966.32	**7.05**
2	**2**	Pion $\pi^{\pm}$	139.57	273.15	**1.99**
4	**1.5**	Muon μ	105.66	206.77	**1.51**
-	-	Electron	0.511	1	

Clearly, column 2 values for $k \approx m_l/m_e$ (1/137) closely match column 6 for the mass ratio reduced by 1/137, thus verifying Equation 17 and the theory that the leptons are formed by weak shock condensation. .

Summary

The problem of the origin of the observed mass-ratios of the elementary particles of matter to one another has here been explained by the compressible flow expressions to within about 1% of the experimentally observed values. This grounds the creation of matter in the strong compressible shock for the baryons, and in the weak shock option for the electron and leptons.

The principle of the compressibility of energy flow, therefore, would seem to underlie the emergence of material particles in the visible universe from some underlying energy field or continuum such as a modified general relativity field.

The above data are those of the standard model of elementary particle formation as verified in high energy accelerators. We now propose that this shock compression process for particle formation in accelerators may fit into the existing Big Bang model as well.

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