

Laws of High Energy Particle Dynamics

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Abstract : Though relativity and quantum mechanics are born out of inadequacies of Newton’s laws, it is yet possible that Newtonian terms may be used, with appropriate modifications in their meaning for formulation of the dynamics of high energy- high speed micro particles. Besides three laws on the lines of Newton’s laws a Forth law is also proposed which radically differs from the aspects of Relativity and Quantum mechanics. Possibility of creation of particles even without collision like of protons in Large Hadron Collider of CERN is predicted as a consequence of this formulation.

Keywords - Evolutionary inertia, Threshold velocity, Latent energy, Angel particles, Saturation, Neutrino mass matrix

I. INTRODUCTION

Newton’s laws of particle dynamics though do not apply to the dynamics of high energy micro-particles yet they provide guidelines for formulating laws for dynamics of high energy particle in context of recent scientific and technological advancements. The terms used by Newton in his formulation are still useful by **attaching new meanings** to them. The relativistic kinetic energy T of a particle with rest mass m_0 increases enormously when u approaches c the rise thus obtained is tabulated in **Appendix** and illustrated in Fig-1. It was not possible at the time of inception of Theory of Relativity to impart such high energy to a particle so that its speed could rise more than $0.9999c$ which is now achievable in Large Hadron Collider of CERN [1].

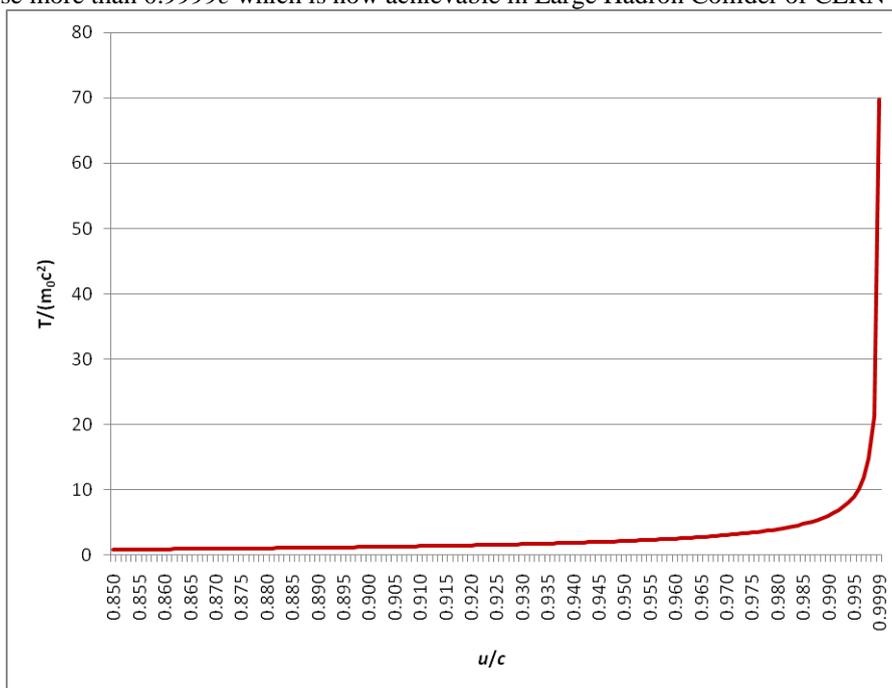


Figure 1 : Variation of Kinetic Energy with rising speed.

Data is tabulated in Appendix.

(Graphical Illustration by Dr. Neeraj Anant Pande, Yeshwant Mahavidyalaya (College), Nanded, INDIA)

$$\text{Where } T = m_0c^2 \left[\frac{1}{\sqrt{1 - \left(\frac{u}{c}\right)^2}} - 1 \right]$$

Had there been no natural barrier, for particles, having mass, to attain the speed of light; they would then have reached it; that does not happen so due to an obstacle by nature that **prevents a mass to reach speed of light** even on imposition of very high energy.

II. LHC AND INELASTIC COLLISIONS

2.1. There are certainly similarities between GEDANKEN experiment imagined for deriving $E=mc^2$ and the actual experimentation in Large Hadron Collider of CERN; but the major difference is that the **colliding particles in GEDANKEN experiment were not having any charge** while the collision experiments in LHC are being conducted with protons.

The combined body formed after collision in LHC is an **immense unstable fireball** that dissipates into particles. This fireball contains much more high energy than what would have been obtained by converting entire mass of colliding particles into energy. In actual collisions only a certain fraction of the energy is available for conversion into the **immense fireballs from which very heavy and unstable particles can be born** [2].

The GEDANKEN experiment, of Einstein's era is re-thought in terms of a collision of two identical masses having no charge at speed comparable with the speed of light.

In the modified GEDANKEN experiment, proposed in this paper in context with the findings of LHC, a combined body [3] is expected to be formed, same as the "heavy and unstable fireballs" observed, immediately after **inelastic** collision in case of collision of protons in LHC.

2.2. Kinetic Energy of the bodies remains constant in elastic collisions while in **inelastic** collisions all the kinetic energy disappears on collision. In its place, after the collision, there appears **some form of internal energy**, such as heat energy or excitation energy. Founders of relativity expressed views about conversion of excess of energy into forms, other than kinetic energy [4], [5], [6], [7].

We now see that this **extra internal energy results in rest mass (inertia) of the combined body** being greater than the total rest mass (inertia) of the two separate bodies. **Thus the rest mass is equivalent to energy (rest-mass energy) and must be included in applying the conservation of energy principle.** This result follows from Lorentz transformation and the conservation of momentum principle which were used in arriving at it [8].

Some type of internal-inertial energy and a force responsible for not allowing masses **to reach the speed of light** has been conceived since the very inception of the Special Theory of Relativity. There was, however, no role of its effect at that time when artificially achievable velocities of objects were much less than c .

III. HYPOTHESIS

3.1. Basis of hypothesis are the objections raised after Einstein's Special Theory of Relativity about quantitative value of speed of light irrespective of **its central role** in physics. Recent observations on reminiscent of Big Bang and primordial radiations are tending to conclude that the properties of free space would also have been different in remote past, so that the value of c would be changing during the course of cosmological evolution [9]. It was probably **very high in inflationary stage of expansion** of the universe which is now decreased to its present value. In view of strong dependence and close **relation between velocity of light and stage of evolution** of the universe, " c " is assumed to be a "**Stage Constant**" [10] related to evolution meaning that **magnitude of c would change, maintaining its central role**, during evolution.

3.2. It would be relevant to use the terms from Newtonian mechanics, in different context for high energy particles. A new term "**evolutionary inertia**" is introduced here which means a property of matter which tries to maintain its stage of evolution. This postulation allows a conservative force that prevents masses to cross the barrier of c .

3.3 Nature of "evolutionary inertia" hypothesised here can be further explained on the background of recent developments, like creation of bosons after certain threshold; so that the **evolutionary inertia would be effectively operative after attaining this threshold speed** by the particle.

3.4. The masses which are accelerated to high velocities, approaching speed of light, in proposed (modified) GEDANKEN experiment; though may be able to acquire very high energy and speed, yet instead of overtaking the speed of light, they **store the energy in a latent form which is converted into particles after attaining threshold limit or by collision.** This latent form of energy resembles the strain energy accumulated in rocks ahead of rupture which causes earthquake [11].

3.5. Momentum of any matter-particle is not allowed, by nature, to exceed a certain limit so that its speed should not increase above c . It is for that matter essential that the particle would itself start **creating new particles**, so that the velocity of any of the individual particle should not exceed c . similar to the composite particles constituted by clamping of quarks and gluons in LHC [12].

3.6. The force responsible thus for breaking of the particle need not only be an external force but it could also be an **internal property** of matter. This is due to a **different mode of utilization of energy** in high energy particle physics rather than its simple utilization for accelerating the particle.

3.7. The creation of new particles can also be visualized in context of Newton’s third law, identifying work done against evolutionary inertia as an **“action”** by the force which tries to accelerate it beyond speed of light that is **opposed by a reaction by creating new particles**. Newly created individual particles have velocities, may even be less than the threshold so as to conserve momentum and energy.

3.8. There is, however, **no analogue** for the variety in newly created particles. It is suggested that this variety is due to an internal or **in-built programme of evolution** from within the matter that would lead to an addition of **“programme carrying particles”** like the so called “Force Carriers” γ, g, z, W in Murray Gell Mann’s **Standard Model** of particles.

3.9. Stem cell, which is capable of transforming itself into various types of cells leading ultimately to a **programme** for formation of different tissues & organs, happens to be well-known **biological analogue** of the proposed variety of particles.

Some process like throwing a stone from sling or firing a bullet from gun could be happening on large scale in the distant celestial bodies, say during supernova explosions, so as to accelerate and **emit even uncharged particles nearly to the speed of light** of that era. Postulates of Special Theory of Relativity are thus modified in the context of results obtained from Large Hydron Collider. Though **technology for accelerating uncharged particles** to high velocities, conceived in GEDANKEN experiment, is **not yet developed**, we are now able to detect **high speed uncharged particles** like neutrinos. They appear to be on the verge of crossing the limit of speed of light [13].

IV. CREATION OF MATTER OUT OF ENERGY

All the work done by the force F_1 acting upon a particle, according to Special Theory of Relativity, **goes into Kinetic Energy** and is utilized for accelerating the particle, which increases its velocity to u so that

$$\int_{u=0}^{u=u} F_1 dx = \int \frac{d}{dt} (mu) dx = \int d(mu) \frac{dx}{dt} = \int (mudu + u^2 dm)$$

from which we obtain relation for **variation of mass** with energy as $m = \frac{m_0}{\sqrt{1 - \left(\frac{u}{c}\right)^2}}$, Yielding to Relativistic

Kinetic Energy as $m_0 c^2 \left[\frac{1}{\sqrt{1 - \left(\frac{u}{c}\right)^2}} - 1 \right]$ and Total Energy $E = mc^2$.

These relations, according to the hypothesis of the present paper, are **valid up to the threshold** speed u_T .

The **threshold speed**, which might be characteristic of the object under consideration, is also hypothecated as a limit, after crossing of which the external force imposed upon the accelerated particle, instead of contributing totally to acceleration, is utilized **partially for creating new particles** of matter for which energy is stored in it in a latent form, that is utilized for creation of matter out of energy.

The Einsteinian equivalence

Total Energy = Relativistic kinetic energy (T) + Rest mass energy

is **valid only upto the threshold limit** of speed, which may be represented as

$$E_{u < u_T} = m_0 c^2 \left[\frac{1}{\sqrt{1 - \left(\frac{u_T}{c}\right)^2}} - 1 \right] + m_0 c^2 = mc^2, \text{ where } u_T \text{ is the threshold speed.}$$

In view of variation of Kinetic Energy T with increase in speed, the threshold may be anticipated to be somewhere above $0.9c$.

Unlike in the Special Theory of Relativity, the particle, after having had achieved a threshold velocity, would **start experiencing the hypothesised “Evolutionary Inertia”** so that all the energy imposed upon the particle would **not be fully utilized to accelerate** it but a part of it is accumulated in a **latent form** which is utilized thereafter for creation of new particles. It is further assumed that the accelerating force is capable to increase the velocity of particle up to a **saturation limit** u_s . The accelerating energy, which is predominant

before achieving threshold, ultimately tends to zero while all the excess of imparted energy becomes creative, which is represented as

total energy imparted	=	kinetic energy used for raising + velocity upto u_T	work done against evolutionary inertia to raise the velocity beyond u_T upto u_s	work done in conversion of excess of energy into particles
		$E = T_{u_T} + \int_{u_T}^{u_s} F_2 du + \sum_j \left[\frac{d}{dt} p \right]_j$		

Where $p_1=v_1m_1, p_2=v_2m_2, p_3=v_3m_3, \dots$ are the momenta of newly created particles of which velocities are individually $< c$ or more often $< u_T$. The particle, in this case, is allowed to be accelerated to saturation limit.

Work done by the force F_2 acting upon a particle **partially goes into Kinetic Energy** and partially stored into it, in latent form which thereafter, **is used for creating new particles**. This **qualitative change in mode of utilization of imposed energy** is hypothesized due to evolutionary inertia and represented by \sum instead of \int as **integration, by definition, is a limit of sum**. The above expression is analogues to the process in which a quantum mechanical function has a range of **both continuous and discrete** eigenvalues [14] [15]. Integration part of it represents utilization of energy for accelerating the particle while summation indicates creation of new particles. Proton in Large Hadron Collider, however, does not appear to be accelerated to the limiting speed u_s but it is **intercepted by collision** with the other proton at a speed u' so as to be fragmented into debris. In case *if* the **saturation limit is achieved before collision**, then the proton would have had started acting as a **perfect converter** of supplied excess energy into particles.

$$E'_{\text{inelastic \& premature collision}} = T_{u_T} + \int_{u_T}^{u'} F_2 du + \left[\begin{matrix} \text{composit} \\ \text{unstable} \\ \text{matter} \end{matrix} \right] = \sum_j \left[\frac{d}{dt} p \right]_j$$

Where $u_T < u' < u_s$.

Collision in LHC may also be conceived as a **premature trigger**.

V. SEISMOLOGICAL ANALOGY AND FLUX OF NEUTRINOS

The latent energy proposed to be accumulated in the particle, is analogous to the strain accumulated in hard material of tectonic plates of earth. The limit of u_T is similar to the elastic limit beyond which strain is **not directly proportional** to stress. The name “**Angel particles**” is proposed by the author for those entities which are coming out from within the earth before major earthquakes. They are expected to perturb animals, birds and fishes. These angels resemble neutrinos in their capacity to penetrate hard rock [16].

There is yet another similarity between process of emission of Angel particles ahead of earthquake and the neutrinos apparently moving at or even more than the speed of light, found in experiments with Large Hadron Collider. It is the resemblance between seismological **stress matrix** [17] with the **neutrino mass matrix** [18]. Neutrinos may leak through LHC by quantum tunnelling [19], [20] like the flux of Angel particles through hard crust of earth.

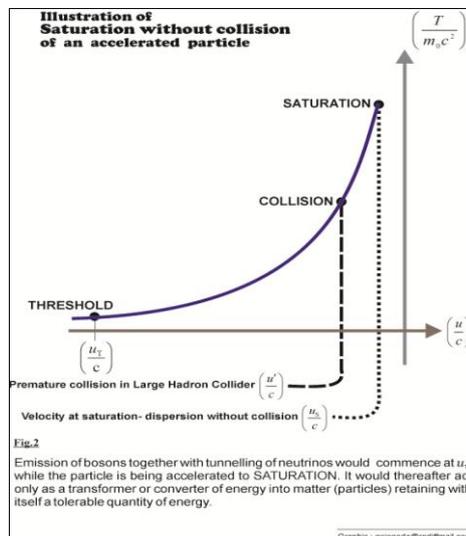


Fig- 2 Particle Creation Scenario at High Energies

VI. DISCUSSION

6.1 Interaction of bodies is the most frequently observed phenomenon in nature. Direct physical contact, like that of billiard balls is not always necessary for their interaction. Round trip passage of **comet** through solar system [21] or interaction of proton with nucleus are also treated as **types of collisions** in which the other forces such as gravity, Coulomb's repulsive force, strong sub-nuclear forces are predominant. The **evolutionary inertia** is conceived here to be most **predominant in the range of velocity approaching the speed of light**.

6.2 Any mechanism, as per the theories about generating elementary particles, must become active above certain energy level, such as two 3.5 TeV for proton beams colliding in LHC [22] for producing Higgs particles. This inference is in **support of the proposed threshold speed** for activation of evolutionary inertia. This is the energy threshold observed in case of proton in LHC, the other particles may have different thresholds. The chain begins from formation of Quarks. **Quarks make nucleons, and the nucleons make nuclei. Nuclei and electrons make atoms, molecules and all the known non-living and living matter.** [2 3]

6.3 The ideas of threshold velocity and evolutionary inertia are suggested as most probable valid reasons for creation of new matter. The scope of this paper is **limited to the cause of creation** of new particles. Classification and types of created particles, their properties and positions in **Standard Model** of particles etc. [24] [25] are beyond the scope of this paper.

6.4 Conversion of excess of energy, into a latent form as the cause of creation of new matter appears to be more **rational** explanation than the so called omnipresent Higgs mechanism imparting masses to **various forms of existences** and that all known elementary particles **remain as mass-less (existences) unless they interact with Higgs field** [26].

6.5 Phenomenon of neutrinos moving at speed of light or appearing to move even **faster than that of light**, detected by ICARUS from CERN [27] was an international news on **23rd September 2011**. It could be "leakage" of neutrinos probably due to **quantum tunnelling**. Stream of such neutrinos could also emerge out of supernova explosion from the matter in an ancient stage of evolution. **Antonio Ereditato** claimed that ancient neutrinos from supernova explosion, which was first **noticed in 1987** preceded light by few hours in reaching the earth [28]. Such neutrinos can thus be believed to have tunnelled [29] across **the then speed limit** (of light) that could be higher than its present value.

6.6 Flux of superluminal neutrinos from supernova itself is yet another evidence for higher value of c in remote past. This is what is defined as **Relativity of stages of evolution** [30] by the author.

The supernova might have naturally accelerated charge-less particles to a velocity very near to the then speed of light.

6.7. Spontaneous **breaking of** an underlying **symmetry** according to presently accepted theories, is said to be the cause of birth of massive particles [31], [32]. It does not, however, provide any answer as to 'where from', 'how' and 'why' this spontaneity comes? It is suggested that the spontaneity is an outcome of an internal **urge of matter for evolution**.

VII. CONCLUSION

Inference from experiments of Collision in Large Hadron Collider means only that a new particle is found. Its identity with predicted Higgs boson does **not justify the Higgs mechanism**. An alternative mode, as suggested by the author in this paper can also be the cause of creation of new particle. There is every possibility that the hypothesis of this paper would be verified by observing **creation of particles** together with dissipation of energy into particles **before collision** in LHC.

Certain laws for **dynamics of high energy particles** are formulated on the basis of above, which are as under:

1st Law of High Energy Particle Dynamics :- Every moving particle continues in its stage of evolution, so far as it be accelerated to a limit of velocity by an external-impressed force due to a type of inertia defined as **evolutionary inertia**.

2nd Law of High Energy Particle Dynamics :- A natural force becomes effective, after crossing a limit of speed that constraints the momentum of moving particle so as not to cross the speed of light. The force, thereafter, yield a new type of energy which generates matter-particles out of energy.

3rd Law of High Energy Particle Dynamics:- The action of imposed force on the particle to accelerate it is countered by a reaction which after a certain limit results into creation of particles.

4th Law of High Energy Particle Dynamics :- The energy, in itself, contains an in-built programme of evolution that imparts variety into created particles of matter, during collision or dissipation.

The programme is analogous to **primitive form of molecular mechanism of inheritance**. It may be narrated in a Sanskrit verse as **Eko' hambahusyām** [33] meaning "I am one, would like to be many".

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APPENDIX

$\frac{u}{c}$	$\frac{T}{m_0 c^2} = \frac{1}{\sqrt{1 - \left(\frac{u}{c}\right)^2}} - 1$
0.866	0.99982402
0.867	1.00679043
0.880	1.10537980
0.891	1.20262714
0.900	1.29415734

$\frac{u}{c}$	$\frac{T}{m_0c^2} = \frac{1}{\sqrt{1-\left(\frac{u}{c}\right)^2}} - 1$
0.901	1.30510835
0.910	1.41191535
0.917	1.50697439
0.923	1.59875295
0.924	1.61511427
0.929	1.70212050
0.935	1.81969956
0.939	1.90767711
0.943	2.00487335
0.959	2.52850595
0.969	3.04758796
0.979	3.90532126
0.980	4.02518908
0.987	5.22199117
0.990	6.08881205
0.993	7.46637168
0.994	8.14243324
0.995	9.01252349
0.996	10.19153703
0.997	11.91963785
0.998	14.81929993
0.999	21.36627204
0.9999	69.71244595
0.99999	222.60735677
0.999999	706.10695807
0.9999999	2,235.06803643
0.99999999	7,070.06793148
0.999999999	22,359.68257373
0.9999999999	70,709.75369809

$\frac{u}{c}$	$\frac{T}{m_0c^2} = \frac{1}{\sqrt{1-\left(\frac{u}{c}\right)^2}} - 1$
0.9999999999	223,608.27107451
0.9999999999	707,192.12283025
0.9999999999	2,238,204.92666454
0.9999999999	7,153,827.93930562
0.9999999999	25,364,765.41600790