ENERGY FUNCTIONS DESCRIBING KINEMATICAL TRANSFORMATIONS OF MOVING MECHANICAL SYSTEMS

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ABSTRACT

Kinematical transformations are expressed as time independent and time dependent functions of work and energy to be employed in motions of mechanical systems. Relations between the kinematical parameters of moving mechanical systems and energy transformations occurring in them are also considered.

Keywords: Analytical Mechanics, Kinematics, Theoretical Physics

1. INTRODUCTION AND RATIONALE

“Kinematics is the study of the geometry of motion” [1] using vectorial concepts such as points, vectors, planes and volumes. “Formally it is a branch of mechanics analyzing the motion in terms of the change in position” [2] independent of other mechanical properties of the moving body such as mass and the causes of the motion such as force and work. [2] On the other hand, another branch of mechanics, the analytical mechanics measures the motion by using “two scalar properties of motion, the kinetic and potential energies, instead of vector forces.” [3] However, we can’t make a sharp distinction between the structure of mechanical systems and the output of motion it expresses due an input of energy in daily life mechanical systems, especially when there is transformation of energy in the mechanical system due its structural design or probability of energy transformations due its own structure and nature of work. *Thus it may prove to be useful to express changes in kinematical properties as functions of changing energy and work.* Time-independent functions for motions involving change at one step; and time-dependent functions for motions involving continuous changes with respect to time are equated with this notion. As a result, relativity between different frames of two different mechanical systems becomes a *measurement function* written in some interval, where a variable in a frame is measured from another frame; and Galilean transformation of translating mechanical systems (i.e. not classical Galilean transformation of points and vectors) turn out to be a special solution of these functions of energy.

2. TIME-INDEPENDENT ANALYSIS BETWEEN TWO STATES OF MOTION

2.1. General Functions

Assume an object of mass m, with initial non-zero velocity $u = u_1$, initial translational kinetic energy $K = K_1$. Assume it is accelerated to a constant velocity $(u + \Delta u) = u_2$ and kinetic energy $K + \Delta K = K_2$ at one step.

$$\Delta K = K_2 - K_1 = \frac{1}{2} m u_2^{\,2} - \frac{1}{2} m u_1^{\,2} \tag{1}$$

$$u_2 = \frac{u_1}{\sqrt{1 - \frac{2\Delta K}{m u_2^{\,2}}}} = \frac{u_1}{\sqrt{1 - \frac{\Delta K}{K_2}}} \tag{2}$$

$$u_2 = \gamma u_1 \Rightarrow \gamma = \frac{1}{\sqrt{1 - \frac{\Delta K}{K_2}}} = \sqrt{\frac{K_2}{K_1}} \tag{3}$$

Now that, this gamma factor being *a function of energy* can be used to correlate changes of kinematical parameters and their relations within the context of work-energy theorem.

$$\gamma = \frac{u_2}{u_1} = \frac{p_2}{p_1} = 1 + \frac{\Delta u}{u} = 1 + \frac{\Delta p}{p} \tag{4}$$

$$\Delta u = u_1(\gamma - 1) = u_2(1 - \gamma^{-1}) \tag{5}$$

The ratio of change in energy to change in momentum equals to average velocity.

$$\frac{\Delta K}{\Delta p} = \frac{u_1 + u_2}{2} = \sqrt{u_1 u_2 + \frac{(\Delta u)^2}{4}} \Rightarrow (\Delta K)^2 = (\Delta p)^2 u_1 u_2 + \frac{(\Delta p)^2 (\Delta u)^2}{4} \tag{6}$$

If we replace the above u values according to Equation 5, we employ γ into function relating changes in energy, momentum and velocity all together.

$$(\Delta K)^2 = (\Delta p)^2 (\Delta u)^2 \left(\frac{\gamma}{(\gamma - 1)^2} \right) + \frac{(\Delta p)^2 (\Delta u)^2}{4} \Rightarrow \Delta K = \frac{1}{2} \Delta p \Delta u \left(\frac{\gamma + 1}{\gamma - 1} \right) \tag{7}$$

2.2. Velocity addition as a function of energy

2.2.1 Collisions

$$\Delta K = \frac{1}{2} m' V^2 \Rightarrow \gamma = \frac{1}{\sqrt{1 - \frac{V^2}{u_2^{\,2}} \left(\frac{m'}{m} \right)}} = \frac{1}{\sqrt{1 - \frac{V^2}{(u + \Delta u)^2} \left(\frac{m'}{m} \right)}} \tag{8}$$

$$\lim_{\Delta u \to 0} \gamma = \frac{1}{\sqrt{1 - \frac{V^2}{u^2} \left(\frac{m'}{m} \right)}} \tag{9}$$

2.2.2 Galilean transformation as a function of energy

Assume the one step change in the above object's velocity is due motion of its frame with constant velocity V, where V//u. Assume a stationary observer in another frame.

The observer observes that;

$$V = \Delta u \Rightarrow \Delta p = m\Delta u = mV \tag{10}$$

Equations 7 and 10 together give;

$$\Delta K = \frac{1}{2}mV^2\left(\frac{\gamma+1}{\gamma-1}\right) = \frac{1}{2}mV^2 + \frac{mV^2}{\gamma-1} \tag{11}$$

$$\gamma = \frac{1}{\sqrt{1-\dfrac{\Delta K}{K_2}}} = \frac{1}{\sqrt{1-\dfrac{V^2}{u_2^{\,2}}-\dfrac{2V^2}{u_2^{\,2}(\gamma-1)}}} \tag{12}$$

This indeed requires writing gamma as a *series expansion*, which will be provided in Section 3. However, for now, since the motion is altered at one step, we can replace the γ in the denominator with ratio of final and initial velocity values and Equation 12 simplifies to;

$$\gamma = \frac{1}{\sqrt{1-\dfrac{V^2}{u_2^{\,2}}-\Delta u\left(\dfrac{2u_1}{u_2^{\,2}}\right)}} \tag{13}$$

Thus the relative velocity (u_{REL}) is observed as:

$$u_{REL} = \frac{u}{\sqrt{1-\dfrac{V^2-2u\Delta u}{(u+\Delta u)^2}}} \quad \textit{(Where } \Delta u \textit{ is a function of work and structure)} \tag{14}$$

Briefly, in terms of work-energy theorem, Galilean relativity resulting from motion of frame with constant velocity V is a special solution of work being done *in one step*, which adds to *only* translational kinetic energy. However, the work done on a mechanical system needn't be always equal to change in translational kinetic energy and thus we need a comprehensive function relating general work and translational velocity to be employed in kinematics.

2.2.3 Work function and gamma factor

Change in velocity and change in *translational* kinetic energy due work done on mechanical systems depend on many physical (i.e. mechanical and non-mechanical) parameters resulting from conditions and the structural properties of the translating system and those of the energy source and the nature of the work. Moreover the event gets more complex if there is a *probability of energy transformations (or if the system is designed to be so)*, such as transformation of *translational* kinetic energy into *internal* energy as it is the case in nonelastic collisions; also into other types of *kinetic* energy such as vibration energy, spin energy, spring-potential energy and oscillation energy as well as other types of *non-kinetic* energy such as electrical energy, electromagnetic energy, due engineering and structural design of the system. This probability of energy transformations can lead to Δu=0 or Δu→0 though there is work done which is supposed to be adding more translational energy, even by collision or frame acceleration; depending on *non-translational characteristics* of the object. Briefly, the physically important point is that the energy added to accelerate the system surely does a type of work; whether the system accelerates as it is intended or not. Even in the case of non-acceleration of particles at relativistic speeds though work is done with the intention of acceleration; non-acceleration due to the increasing relative mass is a concept that is reducible to a concept of work being done via consumption of the added energy.

2.2.3.1 General relation of gamma factor with non-translational energy types of the system

Assume an object which possesses *translational* kinetic energy K and other types of energy which gives a sum of βK. Assume its total energy is E.

$$E = K + \beta K \Rightarrow W = K_2(\beta_2 + 1) - K_1(\beta_1 + 1) \tag{15}$$

$$\frac{1}{2}mu_1^{\,2}(\beta_1 + 1) = \frac{1}{2}mu_2^{\,2}(\beta_2 + 1) - W \tag{16}$$

$$\gamma = \frac{1}{\sqrt{\frac{\beta_2 + 1}{\beta_1 + 1}\left(1 - \frac{W}{E_2}\right)}} \tag{17}$$

If the work is equal to change in only translational kinetic energy, then;

$$W = \Delta E = \Delta K \Rightarrow (K_2 + \beta_2 K_2) - (K_1 + \beta_1 K_1) = K_2 - K_1 \Rightarrow \frac{K_2}{K_1} = \frac{\beta_1}{\beta_2} \tag{18}$$

$$\gamma = \sqrt{\frac{\beta_1}{\beta_2}} \tag{19}$$

If the energy is transformed within the system though there is no *external* work is done;

$$K_2(\beta_2 + 1) = K_1(\beta_1 + 1) = E \Rightarrow \gamma = \sqrt{\frac{\beta_1 + 1}{\beta_2 + 1}} = \sqrt{\frac{K_2}{K_1}} \tag{20}$$

2.2.3.2 Equipartition of energy

If the equipartition of energy holds for the translating object which possesses J types of energy one of which is its translational kinetic energy,

$$E = JK = K + \beta K \Rightarrow \beta = J - 1 \tag{21}$$

If the added energy ΔE distributes equally on all types of energy;

$$\Delta K = \frac{\Delta E}{J} \Rightarrow \frac{1}{2}mu_2^{\ 2} = \frac{1}{2}mu_1^{\ 2} + \frac{\Delta E}{J} \tag{22}$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{2\Delta E}{J(mu_2^{\ 2})}}} \tag{23}$$

$$W = \frac{J}{2}mV^2\left(\frac{\gamma + 1}{\gamma - 1}\right) \tag{24}$$

2.2.3.3 Non-acceleration and work

$$\Delta u = 0 \Rightarrow W = \Delta E = K\Delta\beta \tag{25}$$

$$\frac{E_1}{E_2} = \frac{\beta_1 + 1}{\beta_2 + 1} \tag{26}$$

2.2.3.4 Negligible acceleration, fluctuation around a constant speed and work

If after work is done on system, $\Delta u \neq 0$ but $\Delta u \to 0$ due any of the previously mentioned energy transformations or any external reason *so that velocity fluctuates near a constant C*, Equation 13 simplifies to;

$$\gamma = \frac{1}{\sqrt{1 - \frac{V^2}{C^2}}} \tag{27}$$

Thus, for any reference path ΔX on which the observer observes the motion before and after energy addition;

$$\Delta \mathrm{X} = u(\Delta t) = u_{REL}(\Delta t)_{REL} \tag{28}$$

$$(\Delta t) = \frac{(\Delta t)_{REL}}{\sqrt{1 - \frac{V^2}{C^2}}} \tag{29}$$

$$p_{REL} = \frac{P}{\sqrt{1 - \frac{V^2}{C^2}}} \tag{30}$$

Equation 30 is particularly important because, if the observer can't detect the change in velocity though a force is applied and additional momentum is given to the object by any means, she can measure the change in momentum *if the mass is large enough*. Similarly, it is known that "there are large amounts of mass moving at close to the speed of light" [4] namely the momentum change is detectable though velocity change is difficult to detect at such high speeds. Thus for the observer to define the event without detecting an acceleration, we have to write a general function for measurement of change in momentum and work *independent of changing velocity*.

Assume change in velocity is not detected, $c'-c=\Delta u\to 0$ (31)

Assume change in momentum is detected, $\Delta p\neq 0$ (32)

$$\lim_{\Delta u\to 0}\Delta p=\lim_{\Delta u\to 0}\gamma.p-p=\frac{mc}{\sqrt{1-\frac{V^2}{c^2}}}-mc \tag{33}$$

Since p is observed to be variable, but u is not; it is more convenient for the observer to write work as a function of changing momentum.

$$K=\frac{p^2}{2m}\Rightarrow \lim_{\Delta u\to 0}\Delta K=\lim_{\Delta u\to 0}\frac{2p\Delta p}{2m}=c\left(\lim_{\Delta u\to 0}\Delta p\right)=\frac{mc^2}{\sqrt{1-\frac{V^2}{c^2}}}-mc^2 \tag{34}$$

$$W=\gamma mc^2-mc^2 \tag{35}$$

In general, if an object starts to translation from an initially stationary state, then the work equals to its whole energy. Thus;

$$W^2=E^2=p^2c^2+(mc^2)^2(2\gamma-\gamma^2) \tag{36}$$

$$\lim_{\Delta K\to 0}\gamma=1\Rightarrow E^2=p^2c^2+(mc^2)^2 \tag{37}$$

2.2.3.5 Unique formulation of this motion based on this unique observation

$$c=\lim_{\Delta u\to 0}\frac{\Delta E}{\Delta p}=\frac{\Delta x}{\Delta t} \tag{38}$$

This is a unique result for the observer, because it implies that *the change in energy is observed to be completely compensated by the change in momentum as an individual entity independent from velocity, so that no acceleration is observed though there is a change in momentum with respect to time (i.e. force observed, momentum change observed but acceleration not observed).* Namely though the initial force applied on the object adds energy and changes momentum with a factor of γ, the increase in energy is not with a factor of γ^2 as conventionally expected, but of γ only, so that; $W\neq mc^2(\gamma^2-1)$ but $W=\gamma mc^2-mc^2$ and thus W/ΔP=c. This observance may be described by the observer by a unique relation between action and velocity such that; there is action and there is change in energy over time as well as there is change in momentum during translation, but there is no change in velocity. Briefly, though there is no change in velocity still the force adds to momentum and energy.

$$V(i,\Pi)=\frac{di/dt}{di/dx}\Leftrightarrow\int di=\int pdx=\int Edt \tag{39}$$

(Where “i” is a function of action, and V is velocity as a function of action and structural function, “Π” is the structural function that allows energy transformations)

The complete set of general relations of change of the motion parameters observed by the observer to be independent of change in velocity in the existence of a constant force is written as follows.

Assume “I” is a parameter such that $\int dI = \int idt$ (40)

Assume “B” is a parameter such that $\int pdt = \int dB$ (41)

Then;

$$\int dI = \iint pdxdt = \int Bdx \tag{42}$$

$$\int di = F\iint dtdx \tag{43}$$

The factor I given above becomes a function of moment of inertia. Namely, above relations *employ moment of inertia instead of mass* because the observer doesn’t detect acceleration. Thus the notion of the observer is that the most comprehensive signal of motion with respect to a point is a change in moment of inertia with respect to that point, whether there is acceleration or not. This notion of motion is not only independent of acceleration, but also independent of time. However the parameter “i” is the time rate of this change in moment of inertia with respect to a point. Even if an object is completely stationary in space (i.e. I=constant), the parameter “i=I/t” decreases since time elapses for every object whether stationary or not. That is there is always a decreasing action function on an object which is stationary or has a constant velocity, and acceleration starts if this decrease is altered. This notion provides a *measurable* value to be employed in Newton’s first rule; *there must be continuously decreasing action as a rule of the constancy of velocity of an object, even if the velocity is zero; and there must be additional action for the change of motion state. However, increasing energy in time and acceleration requires a time dependent analysis, which is provided in the following section.*

3. TIME-DEPENDENT ANALYSIS

If there is continuous acceleration (i.e. the change in motion state is not done in one step), γ changes with respect to time as velocity increases. Since instantaneous gamma is a ratio of two instantaneous velocities following each other, it is more convenient to write it as a series expansion.

$$\gamma_n = \frac{u_n}{u_{n-1}} \tag{44}$$

$$u_n = u_0 + at_n \tag{45}$$

$$\gamma_2.\gamma_3........\gamma_n = \frac{u_2}{u_1}.\frac{u_3}{u_2}.........\frac{u_n}{u_{n-1}} = \frac{u_n}{u_1} \Rightarrow u_n = u_1\prod_{i=2}^{i=n}\gamma_i = (u_0 + at_1)\prod_{i=2}^{i=n}\gamma_i \tag{46}$$

In order to include time, which is a *continuously* increasing parameter, in this series expansion; assume the measurement is done periodically, such that;

$$t_n = t_{n-1} + T \Leftrightarrow t_n = \sum_{i=1}^{i=n} T_i = nT \ \ ; \ \ n \in N^+ \tag{47}$$

Namely the *measurement function* of time is a quantized function, though time itself is essentially continuous. Then time dependent analysis of kinematical and mechanical parameters is done easily in the form of series expansion.

$$u_n = u_0 + anT \tag{48}$$

$$\gamma_n = \frac{u_n}{u_{n-1}} = \frac{u_0 + at_n}{u_0 + at_{n-1}} = 1 + \frac{1}{\frac{u_0}{aT} + n - 1} \tag{49}$$

$$\lim_{n\to\infty}\gamma = \lim_{n\to\infty} 1 + \frac{1}{\frac{u_0}{aT} + n - 1} = \lim_{n\to\infty} 1 + \frac{1}{\infty} = 1 \Rightarrow u_n = u_{n-1} \tag{50}$$

If the initial velocity is zero, this decrease in gamma factor is more obvious, because γ is independent of acceleration and only depends on n, thus *gamma factor is only a ratio of measure of time.*

$$\gamma_n = \frac{u_n}{u_{n-1}} = \frac{0 + aTn}{0 + aT(n-1)} = \frac{n}{(n-1)} = \frac{t_n}{t_{n-1}} = 1 + \frac{T}{t_{n-1}} \tag{51}$$

At low speeds;

$$W \propto \gamma^2 \tag{52}$$

$$\gamma_n = \sqrt{\frac{\mathrm{E_n}}{\mathrm{E_n} - 1}} \Rightarrow \frac{\sqrt{E_n}}{\mathrm{n}} = \mathrm{Constant} \tag{53}$$

$$\frac{\sqrt{E_n}}{\mathrm{t_n}} = \mathrm{Constant} \tag{54}$$

Since $\Delta u \to 0$ when energy is added to objects with high speeds;

$$W \propto \gamma \tag{55}$$

$$\frac{E_n}{E_n - 1} = \gamma_n \Rightarrow \frac{E_n}{n} = \text{Constant} \tag{56}$$

$$\frac{p_n}{p_n - 1} = \gamma_n \Rightarrow \frac{p_n}{n} = \text{Constant} \tag{57}$$

Also note that when time measurement is done with increments of one second, n becomes like a frequency of observance. Briefly $\gamma = (1 + \Delta u/u)$ is a decreasing function with respect to any reference time and its growth is to 1; and Δu is a decreasing measurement function whose growth is to zero. *In other words, velocity, which is defined by the observer to be a time dependent function in terms of local time of the observer, "must" have a maximum value with respect to her own frame. In fact, there is always the "cause" of acceleration, but acceleration is a decreasing function; it is a measurement function with respect to time which is an always increasing function (t=nT). As a result, eventually no function can grow faster than the function of time. The relation between two values of n in different frames when* $\Delta u \to 0^+$ *is as follows;*

$$\left(T' = \frac{T}{\sqrt{1 - \frac{V^2}{C^2}}} \Leftrightarrow n = \frac{n'}{\sqrt{1 - \frac{V^2}{C^2}}} \right) \Leftrightarrow t_1 = t_2 \tag{58}$$

This approach makes the Lorentzian transformation of local times in different frames observed in nature [5] compatible with work-energy theorem. Any clock (i.e. observer) measures the time with respect to a frequency of detection or frequency of observance (i.e. "n") and period of observance (such as Δt=T) in the frame of the clock. Time, being a continuous function in essence is measured by quantized amounts of period of observance in a frame, where each period is indeed a continuous amount of time (i.e. T is continuous, n is a number, t is continuous). This continuity of time being core to Calculus and its measurement function being quantized seems to be very useful in both quantum physics and astronomical measurements. *If the reference T, and thus λ were chosen smaller, the acceleration would be detectable for more number of increments of unit time (n), namely changing of velocity would last for a longer time of observance where time is the observer's local time, or equivalently any acceleration in high speed particles such as cosmic particles is more detectable if they come from longer distances, thus have high values of n,* because the change in velocity is observed as change in λ when acceleration is measured by the constant reference time T of the observer, or constant *frequency of observance (proof is given below). This may provide a* *basis for the explanation of the observations of superluminality by Hubble telescope on the Galaxy M87* [6] *, and perhaps for active galaxies.* [7]

Assume X_n is the displacement from time t=0 to t=t_n in the existence of an acceleration.

$$X_n = \frac{1}{2}at_n{}^2 = n^2\left(\frac{1}{2}aT^2\right) = n^2 X_1 \tag{59}$$

Assume λ_n is the displacement between t=t_{n-1} and t=t_n (i.e. Δt=T).

$$\lambda_n = X_n - X_{n-1} \tag{60}$$

$$\lambda_1 = X_1 - 0 = \frac{1}{2}aT^2 \tag{61}$$

$$X_n = n^2\lambda_1 \tag{62}$$

$$\lambda_n = n^2\lambda_1 - (n-1)^2\lambda_1 = (2n-1)\lambda_1 \tag{63}$$

Acceleration, as long as it is measured with respect to a constant reference time T, determines the amount of λ_1 assigned by the observer and the rest of unit displacements in time Δt=T increase with the general rule above like that of *"free falling motion"* (i.e. λ_1 ,$3\lambda_1$, $5\lambda_1$, $7\lambda_1$ … and λ_1=$aT^2/2$). Briefly shift in velocity is a shift in λ but not a shift in T which is a constant set by the observer for the measurement function of time. Thus a low acceleration which is not detected in short distances will be more detectable as a shift in λ *only after long distances are translated*, thus n is greater and t is greater, since T is constant.

4. ROTATIONAL KINEMATICS

Role of gamma factor, a parameter of changing energy, is essentially same in rotational kinematics with its role in translational kinematics. Assume K is *rotational* kinetic energy.

$$\gamma = \frac{1}{\sqrt{1-\frac{\Delta K}{K_2}}} \tag{64}$$

4.1. Centripetal Force

The energy of a rotating frame is proportional to the centripetal force to the center of mass of the system. The centripetal force on a rotating body is given by;

$$F = \frac{m}{R}V^2 \tag{65}$$

Namely, *at normal speeds* and when m and R are constants, the increase in centripetal force by a factor of γ^2 is equivalent to an increase in energy by a factor of γ^2 and in linear momentum of the points on the object by a factor of γ, and increase in velocity by a factor of γ, and increase in angular momentum by a factor of γ.

4.2. Constant angular momentum and constant tangential velocity in a rotation are not contradictory concepts

According to Equation 35 when we do work on an object with a tangential velocity which remains at or fluctuates near a constant C and *can not be accelerated more by the increase in centripetal force by a factor of* γ^2, the energy doesn't increase with a factor of γ^2, but increases with a factor of γ accompanying the increase in momentum by a factor of γ. All these conditions are satisfied in the following table; which means that when velocity is not variable, the increase in force can be compensated only by the increase in (m/R) by a factor γ^2 *by the increase in mass (↑γ) and contraction of dimensions (↓γ)* of the object, which results in an *always but always constant (↑↓) angular momentum*, and in *a direct proportionality between energy and frequency to the first power*.

W	**E**	**Vtg=c**	**R**	**m**	**L**	**ω**	**T**	**i_0 = ET**	**F**	**P**
↑(γ-1)	↑γ	↑↓	↓γ	↑γ	↑↓	↑γ	↓γ	↑↓	↑γ^2	↑γ

Table. Change in rotational parameters when $\Delta u \to 0$ after addition of energy.

Thus relativity and rotation with constant angular momentum are not contradicting concepts, oppositely they are interlinked.

As work is done;

$$m' = \gamma m \tag{66}$$

The mass increases

$$R' = R/\gamma \tag{67}$$

The dimensions contract.

$$T' = T/\gamma \tag{68}$$

The period dilates; and *observed number of events per reference time increase.*

$$t = nT = n'T' \Rightarrow n' = \gamma n \tag{69}$$

These relativistic relations are also explainable with Newtonian notion such that the decrease in dimensions is due the fact that the centripetal force pulls the mass to its center of mass and does work, and the tangential velocity can not increase in accordance with the force to escape, thus a new equilibrium is formed after an amount of energy is lost by the pulling of force of the object with a distance ΔR. This collapse of the object into itself and its increasing mass increases the density with a factor of γ^4 in three dimensional objects, which may limit the collapse and the increase in frequency to a maximum value. This would also be consistent with current astronomical knowledge and strings phenomenology, when we assume that there can be some space in the object into which it can collapse as it rotates faster, however this case has got limits and the collapse can not be infinite. The need to experimental verification of this issue will be discussed in the discussion section.

4.3 Relation of shape factor and gamma factor may support string phenomenology

Additionally, shape of rotating mechanical systems is also effective in gamma factor.

$$\alpha = \frac{I_{CM}}{mR^2} \tag{70}$$

$$\frac{1}{2} I\omega_2^{\ 2} = \frac{1}{2} I\omega_1^{\ 2} + W \tag{71}$$

$$\gamma = \frac{1}{\sqrt{1-\frac{V^2}{\alpha C^2}}} = \frac{\omega_2}{\omega_1} \tag{72}$$

$$W = \frac{1}{2} mV^2 \Rightarrow V = \sqrt{\alpha (Vtg_2^{\ 2} - Vtg_1^{\ 2})} = R\sqrt{\alpha\left(\omega_2^{\ 2} - \omega_1^{\ 2}\right)} = R\Delta\omega\sqrt{\alpha\left(\frac{\gamma+1}{\gamma-1}\right)} \tag{73}$$

However, when R decreases such that the object becomes point-like due change in energy without acceleration the shape effect disappears and the inertia becomes $I=mR^2$ since points do not have shape by definition. However, the alternative shapes of strings theory other than cylinder (of whose $I=mR^2$) causes tiny fluctuations from classical Lorentzian transformation; which may be helpful to remove “the headlong collision between relativity and quantum in superstrings theory” [8].

4.4. Systems with both rotational energy and translational energy and with constant velocity and constant angular momentum

If the object possesses two different types of kinetic energy (i.e. rotational and translational kinetic energy), then J=2.

$$E = \frac{1}{2} I_{CM}\omega^2 + \frac{1}{2} mc^2 \tag{74}$$

$$\left(k \in R; c = k\omega R\right) \Rightarrow \beta = \frac{\frac{1}{2} I_{CM}\omega^2}{\frac{1}{2} mc^2} = \frac{\alpha}{k^2} \tag{75}$$

$$E = mc^2\left(\frac{1+\beta}{2}\right) = I_{CM}\omega^2\left(\frac{1+\beta^{-1}}{2}\right) \tag{76}$$

We can measure the translated distance and time elapsed as a series expansion with respect to the number of increments of rotation period in the frame of the object, rather than the observer's frame.

$$n = 1 \Rightarrow (t_n, X_n) = (T, \lambda) \tag{77}$$

$$\frac{\lambda}{2\pi R} = \frac{cT}{2\pi R} = \frac{k\omega RT}{2\pi R} = k\frac{2\pi R}{2\pi R} = k \tag{78}$$

Thus; $\frac{k_1}{k_2} = \frac{\lambda_1}{\lambda_2} = \frac{T_1}{T_2}$ (79)

Since velocity is constant $p = \frac{i_0}{\lambda} = mc$ (80)

$$L = I\omega = \alpha m R^2 \omega = mc\frac{\lambda}{2\pi}\frac{\alpha}{k^2} = \frac{p\lambda}{2\pi}\beta \tag{81}$$

Thus, $i_0 = 2\pi L\beta^{-1}$ = Constant (82)

Namely i_0 being a translational parameter is practically analogous to angular momentum.

$$E = mc^2\left(\frac{k^2+\alpha}{2k^2}\right) = I_{CM}\omega^2\left(\frac{k^2+\alpha}{2\alpha}\right) \tag{83}$$

$$E = pc\left(\frac{k^2+\alpha}{2k^2}\right) = L\omega\left(\frac{k^2+\alpha}{2k^2}\right) \tag{84}$$

Now that if equipartition of energy holds for the object, *no matter its shape and size are*; then

$$\beta = J - 1 = 2 - 1 = 1 \tag{85}$$

$i_0 = p\lambda = 2\pi L = ET$ = constant (86)

$$E = mc^2 = I_{CM}\omega^2 = \frac{J}{2}mc^2 \tag{87}$$

Also when the change in parameters are observed with respect to a reference time t;

$$t = n_1 T_1 = n_2 T_2 \Rightarrow \gamma^{-1} = \frac{n_1}{n_2} = \frac{E_1}{E_2} = \frac{p_1}{p_2} = \frac{\nu_1}{\nu_2} = \frac{T_2}{T_1} = \frac{m_1}{m_2} = \frac{\lambda_2}{\lambda_1} = \frac{R_2}{R_1} = \frac{I_2}{I_1} \tag{88}$$

$$1 = \frac{L_1}{L_2} = \frac{Vtg_1}{Vtg_2} = \frac{Vtr_1}{Vtr_2} \tag{89}$$

$$\Delta E \Delta T = \Delta p \Delta \lambda = -i_0 \frac{(\gamma - 1)^2}{\gamma} = i_0 \left(2 - \frac{n_2}{n_1} - \frac{n_1}{n_2} \right) \tag{90}$$

5. IMPLICATIONS, PREDICTIONS, EXPERIMENTAL DESIGN AND DISCUSSION

In order to reach a more practical and physically meaningful definition of motion which allows us to employ analytical mechanical parameters in kinematical functions, and also considering the motions in which the structure of the body has a role in the output of motion after an input of work, the conventional geometric definition of motion as "displacement in space" is enlarged to a physically more comprehensive definition as "displacement of a momentum in space". This can equivalently be read as displacement of energy in time. If the displaced momentum or energy is constant then there is no net force on the system, and force is the reason of change in momentum and energy, but not necessarily change in velocity in some cases. Because velocity is defined to be a *measurement function with some finite interval;* where this measurement is done with respect to number of increments of the reference time in the frame of a clock; thus velocity is a parameter which is always relative as it is a measurement function between two frames. A rationale for the observance of eventual constancy of velocity function is introduced by this definition; any measurement function is a local concept and its interval is finite. Displacement with respect to a point is a decrease in inertia with respect to that point, which can be measured by parallel axis theorem. This definition frees the *signal* of spatial displacement from time, acceleration and the effect of shape.

Observations of relativistic time gains have been well documented in atomic clocks since as old as 1972 [5]. There is an obvious consistency and similarity between the equations reached in this article for objects with translational and rotational energy and those reached by Theory of Relativity, which requires a special discussion and experimental clarification. Though the mathematical equations describing "relative motion with a velocity which is constant in all frames no matter energy content is" same between these equations, the modeled phenomena are significantly different. Lorentzian transformation describes the motion of a translating frame; or in terms of analytical mechanics it describes an object with only translational energy, thus without an angular momentum which is a non-translational parameter. However the model here includes a probability of energy transformations and it describes the motion of a body possessing a changeable translational energy with an always constant translational velocity; and changeable rotational energy with an always constant angular momentum; and this model gives the classical Lorentzian transformation only for particles for which equipartition of energy is applicable. This is further consistent with Planck's statistical approach on blackbody radiation from a radiating bulk, *but this model also covers isolated particles with a different phenomenology, which is very helpful in order to resolve issues with theory of relativity in the quantum scale.* If equipartition of energy is not applicable, there are some little variations from classical Lorentzian transformation which can be helpful to remove "the headlong collision between relativity and quantum in superstrings theory" [8].

Considering the very fact that particles possess a non-translational energy namely *spin energy (even if not a kinetic energy of a classical spin motion, still $J=2$ and $\beta=1$)*; any positive correlation between "the greatness of the velocity of motion of frame" and "the probability of transformation of translational kinetic energy that the objects gain by this motion of the frame into other types of kinetic or non-kinetic energy" must be tested experimentally, in order to clarify this similarity. In such an experiment, it is expected by this model that if the translational velocity of the frame is high (i.e. relativistic speeds), translating objects gain vibrational and/or rotational energy due internal and/or external reasons; and after a maximum value of rotational velocity is reached, energy transformation to mass and dilation of coordinates makes *the angular momentum constant*. Constant angular momentum in the existence of increasing energy (with a factor of γ) and frequency (with a factor of γ) though tangential velocity is constant (c) is explained by the increase in centripetal force (with a factor of γ^2); such that the dimensions contract (with a factor of γ) and the mass increases (with a factor of γ). Here, it must also be noted that an early astronomic study of "period-activity correlation in RS CVn-type binary systems" [9] also includes direct proportionality between high energy (i.e. luminosity) and low radius; and between high energy and high mass.

For an isolated particle possessing rotational energy and translational energy, γ depends on shape and the velocity may change after energy addition if the work causes a shape change or a shape change occurs spontaneously due to a restriction in the medium; which is a case that may provide a basis for famous *superluminal signaling* experiments by photonic tunneling [10]. Nimtz may have discovered a method to force the geometry of the quanta to some shapes by photonic tunneling.

To sum up, when this model is applied on light it reaches to the mathematics of relativity independently, but also allows violations of relativity with the same mathematics based on the shape and strings phenomenology and it fits to Bohr's interpretation of constant angular momentum, and may be helpful in some astronomical observances. It results in a modification to classical corpuscular theory of Ibnal Haytham or that of Newton by using three additional assumptions based on Bohr's interpretations, Nimtz's experiments and shape phenomenon so that it becomes *"light consists of quanta which rotate with constant angular momentum due indirect proportionality between frequency and radius; and translate with constant velocity, provided that their geometry is not altered"*. Thus, superluminality may have been provided a theoretical *basis without a wave comprehension of light.*

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