Part I: "Scaling" the Momentum Gap and Discovering "X"

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Step	Logical or Factual Statement	Resulting Expression	Expansion / Supporting Evidence
1	All motion is relative and therefore subject to relativistic effects. There is no such thing as a non-relativistic interaction, only interactions whose relative effects we choose to ignore. Therefore, all interactions may legitimately be expressed in a format recognizing the impact – regardless of how small – of relativistic effects. (For a discussion regarding 4-Vectors see step 22)	$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$	The Lorentz Factor (γ) approaches unity as velocity approaches zero. However, if an object is in motion it has a gamma value greater than 1 and therefore a relativistic component that can be incorporated into a relationship relating energy to mass and velocity. Validation = 100% based on established physics
2	At normal life speeds we generally express kinetic energy as follows:	$KE = \frac{1}{2} m_o v^2$	This is the classical definition of kinetic energy Validation = 100% based on established physics
3	At speeds closer to c the practice is to define kinetic energy as the difference between total energy content and the energy associated with the invariant mass.	$KE = E_{Total} - E_{\text{Invariant}}$	This equation is equally valid for all interactions regardless of the velocity of the object because all interactions have some relativistic component. Validation = 100% based on Step 1 and on established physics
4	Step 2 and 3 are generally reconciled by relating energy to mass and velocity through a Taylor expansion.	$KE = E_{Total} - E_{\text{Invariant}} \approx \frac{1}{2} mv^2 + \frac{3}{8} m v^4 / c^2 + \ldots$	This provides only an approximate relationship between kinetic energy and the object's mass and velocity because only the first term of the expansion is used with the later terms dropped as being insignificant. Validation = 100% based on established physics

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5	An absolute relationship can be expressed relating kinetic energy to mass and velocity as follows:	$\frac{E_{Total} - E_{Invariant}}{m_r v^2} = X$ or $KE = Xm_r v^2$	This simple relationship is a unique and original expression first introduced by the IWPD Research Center in 2005.* The equation is neither relativistic nor non-relativistic, but rather an absolute relationship between kinetic energy, relativistic mass (total energy content) and velocity. The relationship is valid for all velocities. * J.R. Laubenstein, "Energime, A Theory of Everything" – Yet, Almost Nothing at All, IWPD Publishing, 2005, Naperville, Illinois Validation = 100% based on established algebraic principles
6	At typical life speeds the equation from Step 5 approaches the classical equation for kinetic energy	$KE = \frac{1}{2} m_o v^2$	At typical life speeds, X approaches a value of ½ and the invariant and relativistic mass approach the same value. Validation = 100% based on established observation and measurement
7	At the speed of light the equation becomes:	$E = mc^2$	At the speed of light, X = 1 and the mass is entirely due to the energy content resulting in an invariant mass of zero. Validation = 100% based on established observation and measurement
8	Therefore, an absolute relationship exists between kinetic energy as related to mass and velocity that is valid at all speeds.	$KE = Xm_r v^2$	Where X has allowable values between ½ and 1 and varies depending upon the velocity of the object. The mass is the relativistic mass, or the combined value of invariant mass and the mass associated with kinetic energy. Validation = 100% based on the algebraic definition of X

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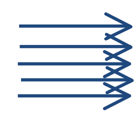
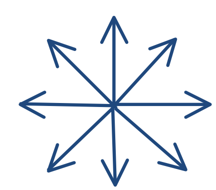
9	What is the significance of this relationship?	X	X defines the “orientation” of the transferred energy $\left(mc^2\right)$ and determines the momentum of the transferred energy to be $\left(Xmc\right)$ Validation = 100% by definition
10	“Orientation” can be shown to have a physical significance related to the speed of an object	At c: X=1 As velocity goes to zero: X approaches 1/2	At c the orientation of all of the transferred mass (energy) is along the axis of motion of the receiving object and the momentum is equal to the energy.  Orientation at c (X = 1) At lower speeds the momentum of the transferred energy is fanned out and at speeds near zero, only ½ of the transferred energy is oriented with a component of its motion in the direction of the object’s motion.  Orientation as v << c (X = ½) Validation = 100% based on the definition of orientation
11	X also plays a role in defining a number of significant relationships in physics. As an example, because the velocity of an object is dependent upon its orientation, it is possible to define the Kinetic Energy per unity mass of an object solely as a function of its X value.	$\frac{KE}{m_r}=\frac{2X-1}{X}$ $\frac{KE}{m_o}=\frac{2X-1}{1-X}$	The orientation (X) can provide you with the Kinetic Energy per Relativistic Mass or the Kinetic Energy per Invariant Mass. Validation = 100% based on the dependent relationship of velocity on X.

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12	A ratio of the two equations from step 11 provide a ratio of relativistic mass to invariant mass providing a definition of the Lorentz Factor as a function of the orientation value X.	$\dfrac{KE/m_o}{KE/m_r} = \dfrac{\left(\frac{2X-1}{1-X}\right)}{\left(\frac{2X-1}{X}\right)} = \dfrac{X}{1-X} = \gamma$	The Lorentz Factor (γ) may be defined solely as a function of (X) and is equal to $\dfrac{X}{1-X}$ Validation = 100% based on the relationship $\dfrac{m_r}{m_o} = \gamma$
13	X can also be used to express the relationship between Energy and Momentum:	$\dfrac{Energy}{Momentum} = \sqrt{2X-1}$	In this case we see that for the speed of light (X = 1) the energy and momentum are the same magnitude. As velocity decreases, energy and momentum diverge such that as the velocity goes to zero (X = ½) the momentum of the object becomes infinitely larger in magnitude than the corresponding momentum associated with its energy. Validation = 100% based on established observation and measurement
14	We believe that Step 13 uncovers a "momentum gap" that exists in any elastic collision. The momentum gained by an object in a collision is much greater than the momentum associated with the transferred energy. This momentum gap exists with either 3-Vector or 4-Vector analysis. (See steps 15 - 22 for details)	$Energy = mass \times c^2$ $Energy = momentum \times c$	All pure energy has a mass equivalency All pure energy has a momentum equivalency Validation = 100% based on established physics
15	Pure energy, moving at the speed of light, exhibits a momentum that is equal in magnitude to its energy content.	$mc^2 = mc$	Pure energy is defined as energy with no invariant mass. Under this condition, the energy content and momentum have the same value. (Assuming the speed of light is defined as unity.) Validation = 100% based on established physics and Step 13

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16	All momentum must have a mass component and any change in momentum must be accompanied by a change in the object's mass. Any resulting change in velocity is completely dependent upon the change in mass.	$Momentum = \sqrt{m_r^2 - m_i^2}$	This is often overlooked because of the classical definition of momentum as *mass x velocity*. While this is a valid definition, it fails to properly define a dynamical situation involving a change in momentum. *Mass x velocity* implies that a change in velocity can occur without a change in mass. (A practice often used at so called "non-relativistic" speeds.) In reality, any momentum change must involve a change in relativistic mass (energy content). Any resulting change in velocity is directly dependent upon the change in mass. This is equally true at low speeds as it is for speeds approaching c. Validation = 100% based on the established physics of relativity and the complete definition of momentum as $\sqrt{m_r^2 - m_i^2}$ which works equally well at normal life speeds.
17	Therefore the change in an object's momentum before and after an elastic collision should be accounted for within the energy transferred during the interaction	$Energy_{transferred} = m_{transferred}c^2$ $Momentum_{\text{transferred}} \le m_{\text{transferred}}c = Xm_{\text{transferred}}c$	Since all momentum has a mass component and the mass gain involved in any elastic collision is purely due to the transfer of energy, it follows that the change in momentum (momentum transferred) should be no greater than the total momentum of the energy transferred. Validation = 100% as a purely logical statement

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18	If we allow c to be expressed as unity	$Energy_{transferred} = m_{transferred}$ $Momentum_{transferred} = Xm_{transferred}$	This suggests a new relationship between Energy and Momentum: • Kinetic Energy is equal to the mass (energy) transferred during a collision. • Momentum is the "orientation" of that same transferred mass (energy). Validation = 100% when "orientation" is mathematically defined as X
19	This creates a momentum problem for elastic collisions at typical life speeds. In the case of an object initially at rest that receives energy and momentum through an elastic collision, it follows that the momentum change for this object is far greater than the maximum momentum of the transferred energy.	$m_{relativistic} v >> m_{transferred} c$	There is insufficient momentum in the transferred energy to account for the change in momentum of the object receiving the energy. If any other source were responsible for the momentum it would certainly contain a mass component that would add to the mass gain of the object. Since this does not occur, all of the momentum must be from the transferred energy; yet, there is clearly a momentum gap. Validation = 100% based on established observation and measurement

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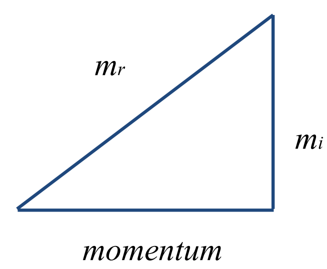
20	This momentum gap problem is an area that the IWPD Research Center believes is worth pursuing and that provides valuable insight not only to this problem but to many other current challenges within physics. While we can mathematically account for the momentum through an orthogonal relationship $\sqrt{m_r^2 - m_i^2}$ it is difficult to provide a physical significance as to why the momentum equivalence of the energy transferred is not sufficient to account for the momentum change of an object receiving the energy.		While we know that this mathematical relationship will provide the correct answer it does not address the physical significance of why an object with invariant mass has so much more momentum associated with it as compared to the momentum equivalency of the energy that is responsible for the object's motion. Validation = 100% based on established observation and measurement
21	Therefore, we have a scaling problem with momentum. One way to address this is to adjust the momentum with a mathematical scaling factor in order to "scale it up" to the full momentum required.	$f(X) = \sqrt{2X^3 - X^2}$	The appropriate scaling factor that brings the momentum of the transferred energy into agreement with the observed and measured momentum of the receiving object is yet another relationship that is solely defined as a function of the orientation value (X). Validation = 100% based on established observation and measurement
22	This same problem exists in 4-Vector analysis. Consider an interaction in which 0.0050378 MeV of energy are absorbed by a 1.0 MeV object at rest. The interaction is elastic with the resulting velocity of the object being 0.1 c. If we look only at the kinetic energy and the object receiving the energy, it becomes clear that the momentum associated with the kinetic energy is not equal to the momentum of the object after the interaction. This holds true when analyzed in either 3 momentum or 4 momentum.		

The 4 momentum case

Properties of the object after the interaction:

$$Mass_{\text{Invariant}} = 1.0MeV$$
$$Mass_{Rel} = 1.0050378MeV$$
$$Velocity_{Observed} = 0.1c$$
$$X = \frac{E_k}{M_{\text{Re}l} \times V_{Observed}^2} = 0.50125$$

Prior to Interaction

Assuming the motion is defined along the x axis only, the total 4 momentum prior to the interaction is the sum of the 4 vectors for the energy and the object at rest.

$$\begin{bmatrix} E_{Trans} \\ p_{Trans}c \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} E_I \\ 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} E_{Trans} + E_I \\ p_{Trans}c + 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 1.0050387MeV \\ (0.50125)(0.0050378)MeV \\ 0 \\ 0 \end{bmatrix}$$

The resulting 4 momentum is:

$$\sqrt{E^2 - p \cdot pc^2} = \sqrt{(1.0050387)^2 - (0.0025251)^2} = 1.0050355MeV$$

After the Interaction

$$\begin{bmatrix} E_{Rel} \\ p_{observed}c \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 1.0050387MeV \\ 0.10050387c^2MeV \\ 0 \\ 0 \end{bmatrix}$$

With the resulting 4 momentum of:

$$\sqrt{E^2 - p \cdot pc^2} = \sqrt{(1.0050387)^2 - (0.10050387)^2} = 1.0000000MeV$$

Just as in 3 momentum calculations, there is a discrepancy between the 4 momentum of the transferred energy and the 4 momentum of the object after the interaction.

In 4 vector analysis the 4 momentum should be equal to the invariant mass of the system.
This is true for the case after the interaction. However prior to the interaction, the 4 momentum should also be equal to 1.0 MeV.

This can be achieved by introducing the IWPD Scale Metric of $\sqrt{2x^3 - x^2}$ into the calculation.

$$\sqrt{E^2 - p \cdot pc^2} = \sqrt{(1.0050387)^2 - \frac{(0.0025251)^2}{\sqrt{2x^3 - x^2}^{\,2}}} = 1.0000000MeV$$

Therefore, the IWPD Scale Metric appears to have an equally valid application in both the 3 momentum and 4 momentum analysis.

Validation = 100% based on the mathematics of 4-Vectors

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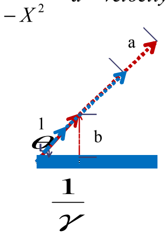
23	The scaling factor (defined in step 21) takes on increased significance when you realize that a linear relationship incorporating a scaling factor is equivalent to an orthogonal relationship. This has significance when comparing the 4-Velocity of a worldline to the observed 3-Velocity.	$\sqrt{1-\left(\frac{1}{\gamma}\right)^2} = b = velocity$ $\left(1-\frac{1}{\gamma}\right)\frac{1}{\sqrt{2X^3-X^2}} = a = velocity$  $a = b$	An orthogonal relationship may be equally expressed in a linear fashion by applying a mathematical scaling factor. The factor required is exactly equal to the scaling factor required to account for the momentum gap. Validation = 100% based on algebraic principles, observation and measurement
24	This is only of interest if the scaling factor required to convert the orthogonal 4-Vector analysis to a linear relationship has some physical significance.	$f(X)=\sqrt{2X^3-X^2}$	The scaling factor required is solely a function of X and is the same scaling factor required to address the "momentum gap." Validation = 100% based on observation and measurement

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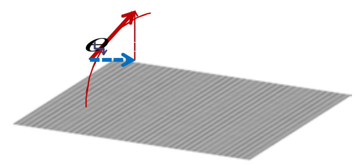
25	Step 24 is of significance because if the curve of a worldline is caused by gravitation, then it follows that the scaling factor may have a contribution to play in understanding gravitation.		The simplest case of a uniform spherical non rotating mass with no charge requires the Schwarzschild solution in order to determine the curve of the worldline and the value of the angle (θ) at any given point on the worldline $ds^2 = \left(1 - \frac{2GM}{c^2 r}\right)^{-1} dr^2 + r^2\left(d\theta^2 + \sin^2\theta d\phi^2\right) - c^2\left(1 - \frac{2Gm}{c^2 r}\right)dt^2$ This is significantly simplified using a linear relationship in conjunction with a mathematical scalar as compared to the case for an orthogonal relationship Validation = 100% -- Based on Step 26 - 30
26	The IWPD Research Center has developed an equation for gravitation based on the strength of a Local Field (LEF) to that of a Background Field (BEF) defined as unity.	$LEF = \frac{BEF}{BEF + \frac{GM}{d}} = \frac{1}{1 + \frac{GM}{d}}$	Where G is the gravitational constant, M is the mass of a gravitating body and d is the distance between the mass and a test particle. Validation = 100% based on observation and measurement
27	The LEF may also be expressed solely as a function of X as $\left(\frac{1-X}{X}\right)$ and can be applied in a manner very similar to the 4-Vector analysis; or, in a way consistent with a linear relationship in conjunction with a mathematical scalar. (See step 28)	$v^2 = 1 - LEF^2$ $V_{3-Vector}^2 = V_{4-Vector}^2 - \left(\frac{1}{\gamma}\right)^2$	Since 4-Velocity is defined as unity it is equivalent to the BEF and the LEF is equivalent to $\left(\frac{1}{\gamma}\right)$ Validation = 100% based on step 12

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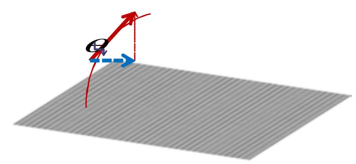
28	The observed velocity can also be determined by the difference between the BEF and the LEF (which represents the kinetic energy of the object) times a mathematical scalar.	$(BEF - LEF)\sqrt{2X^3 - X^2}$	The mathematical scalar is again exactly equal to the scalar required to address the "momentum gap". Validation = 100% based on observation and measurement
29	So, are there benefits in expressing gravitation through a linear as opposed to orthogonal relationship?		One significant benefit is the ease of determining the angle (θ) at any point along a worldline which is also solely a function of the orientation value (X) $\sin\theta = \frac{1}{X} - 1$ Validation = 100% based on observation and measurement
30	An additional benefit is in the ease of determining $\left(\frac{1}{\gamma}\right)$ for the mass and distance from a gravitating mass	$LEF = \frac{1}{\gamma} = \frac{1}{1 + \frac{GM}{d}}$	This provides a significantly easier approach than through the application of the Schwarzschild solution $ds^2 = \left(1 - \frac{2GM}{c^2 r}\right)^{-1} dr^2 + r^2\left(d\theta^2 + \sin^2\theta d\phi^2\right) - c^2\left(1 - \frac{2Gm}{c^2 r}\right)dt^2$ Validation = 100% -- Based on Step 26 - 30