Where Do the Laws of Physics Come From?

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In 2012 I formulated the Scale Principle or Scale Law which was published electronically in May this year. This paper proposes a theory to answer an old question: Where do the laws of physics come from?

***Keywords**: Planck scale, Planck's constant, Planck mass, Planck length, entropy, relativistic energy, fine structure constant, Schwazschild radius, Bohr Postulate, Friedmann equation, Schrödinger equation.*

1. Introduction

The Scale Law [1] is a fundamental Law from which a number of physical laws were spawned. This includes but is not limited to the following laws and fundamental constants:

- The Heisenberg uncertainty principle,
- The black hole entropy,
- The fine structure constant,
- Einstein's relativistic energy equation,
- Newton's law of universal gravitation,
- The Friedmann equation,
- The formula for the Schwazschild radius,
- The Bohr Postulate,
- The De Broglie wavelength-momentum relationship,
- The Schrödinger equation,

  and possibly more

2. How Nature Made the Laws of Physics

Before starting this topic I need to define what I mean with Meta Law.

Definition

A Meta Law is a Law that has spawned, formed or created other specific or conventional physical laws and fundamental constants (classical, quantum mechanical and relativistic laws).

A Meta Law is like a model nature has used to create other specific laws. This concept has nothing to do with metaphysics.

I shall use the following conventions.

Conventions

a) If the first letters of the law's name are written with uppercase the name indicates a Meta Law. Examples: the **Scale Law**. The **Laws** of physics, refers to all Meta Laws (at the moment we have discovered only one).

b) If the first letters of the law's name are written in lowercase the name indicates a normal, conventional or specific physical law (scientist's surnames are not included in this convention since they should always be written in uppercase). Examples of conventional laws: **black hole radius equation**, **relativistic energy equation**, **Einstein's relativistic energy equation**, **Bohr's postulate**, **Schrodinger equation**, etc. The **laws** of physics refer to all the conventional laws of physics.

So far we have discovered one Meta Law only: the Scale Law or Scale Principle. But why would there be only one Meta Law? Common sense indicates that there must be other Meta Laws which we haven't been able to discover yet.

Thus each law of physics must obey one and only one Meta Law and one Meta Law governs a number of normal laws. The answer to the question "Where do the laws of physics come from?" is: They come from Meta Laws.

I shall introduce the following postulates

Postulates

1) All Meta Laws "were created before" the big bang.

2) Meta Laws are the most fundamental Laws nature has created.

3) Each law of physics must obey one and only one Meta Law and one Meta Law governs a number of normal laws.

3. How Was the Scale Law Discovered?

Principles are not subject to derivation. For example the principle of conservation of energy (in modern physics: the conservation of energy and mass) cannot be derived. It was initially inferred from experiments. The Scale Principle or Scale Law is therefore not subject to derivation either. However, nature gives us at least three signs of the existence of more fundamental Laws than the normal laws of physics we are familiar with. All we need to do is to look at the right place. Let us have a look at these signs.

3.1. Sign 1: Layers of Creation

Meta Laws might sound unreasonable or even crazy but let us consider the way nature builds the stuff around us including us - *nature builds stuff in layers.*

The first layer, as far as we know, are the fundamental particles (such as electrons, quarks, etc.) and bosons (photon, W-, W+, Zo particles, etc.) , the second layer are the compound particles such as mesons and baryons which are made of quarks and gluons, the third layer are the atoms which are made of both fundamental particles and compound particles, the fourth layer are the molecules which are made of atoms, and so on until we get to the upper layers of nature comprising life forms and all the other stuff around us (minerals, planets, stars, galaxies and clusters of galaxies, etc). Then why wouldn't nature use the same mechanism to build the normal laws of physics?

Thus I proposed that there are only two layers of physical laws: the first layer is made of the Meta Laws such as the Scale Law and the second layer is made of all the normal physical laws we are familiar with.

3.2. Sign 2: Similarities in Spatial and Temporal Relationships

One of the central questions in science is: Why? Now I am in the position of answering one of the most fundamental questions in quantum mechanics that the standard model is unable to answer, or in other words, I can turn the previous sentence into a question:

What is the fundamental question that the standard model didn't even bother to ask? This is the question:

Fundamental Question

Why are the *spatial version of the Heisenberg uncertainty principle* and the *Planck's spatial equation* so similar, despite the fact that the HUP is an inequation and the Planck's equation is an equation?

Let us consider the following table

Spatial version of Heisenberg uncertainty principle	Planck's spatial equation	Temporal version of Heisenberg uncertainty principle	Planck's temporal equation
$\Delta p \Delta x \geq \frac{\hbar}{2}$	$M_P c L_P = \hbar$	$\Delta E \Delta t \geq \frac{\hbar}{2}$	$E_P T_P = \hbar$
Inequation	Equation	Inequation	Equation
Δp	$M_P c$	ΔE	E_P
Δx	L_P	Δt	T_P
Scale factor = ½	Scale factor = 1	Scale factor = ½	Scale factor = 1

Table 1: *Table of scale factors. The similarity among these relationships suggests that a common more fundamental law governs them.*

If we look at Table 1 we see a similarity among the relationships shown in the second row. This similarity suggests that a common more fundamental law is behind them. Then the Scale Law comes to the rescue us

Answer to the above Fundamental Question

The answer to the above fundamental question is that these relationships are similar because all of them were created or spawned by the same Meta Law (the Scale Law) with different scale factors and different relationship types (inequation vs. equation). As Table 1 shows the scale factor for both *Heisenberg uncertainty principles* is ½, while the scale factor for both *Planck's equations* is one.

3.3. Sign 3: Similarities in Equation Shape Among Other Equations

There are also similarities in equation shape among apparently very different laws as shown on Table 2, Section 5. Then it is natural to ask: Who dictates the similarity among the laws of physics shown on Table 2? Again, the answer is the Scale Law.

4. What is the Structure of a Meta Law?

So far we know Meta Laws deal with dimensionless quantities and not with specific quantities. For example (and this is the only example we have) the Scale Law is

(1)

Scale Principle or *Scale Law*
$D_1^n \left[< \mid \leq \mid = \mid \geq \mid > \right] S \;\; D_2^m$

Where

D_1 = dimensionless number 1
D_2 = dimensionless number 2
S = scale factor
n and m = exponents
(a more detailed explanation is given later on in this section)

The three quantities D_1, D_2 and S are dimensionless numbers. Thus I arrive to the first property of Meta Laws:

Meta Laws are dimensionless relationships.

Either "before" the big bang or very soon after it, this Law generated an unknown number of normal laws. Thus the dimensionless numbers D_1 and D_2 became ratios (Q_1/Q_2 and Q_3/Q_4 respectively) as shown by the following transformation:

$D_1 \rightarrow Q_1/Q_2$
$D_2 \rightarrow Q_3/Q_4$

(2)

Scale principle or *scale law*
$\left(\frac{Q_1}{Q_2}\right)^n \left[< \mid \leq \mid = \mid \geq \mid > \right] S \left(\frac{Q_3}{Q_4}\right)^m$

then the ratios Q_1/Q_2 , and Q_3/Q_4 became particular ratios and the scale factor *S* took a specific value. Somehow nature produced the final ratios directly form the Scale Law (1). However I shall write the Scale Law according to relationship (2) instead of using relationship (1) because this way the Law is closer to the form of the normal laws it has created.

For example when nature created the equation for the black hole entropy the transformation process was as follows

$$D_1^n \text{---} \rightarrow \left(\frac{R}{L_P}\right)^2$$

$$D_2^m \text{---} \rightarrow \frac{S_{BH}}{k_B}$$

$$S \text{---} \rightarrow \frac{1}{\pi}$$

The exact details and reasons of this transformation process are unknown. Then the transformation yields the following law for the black hole entropy

$$\frac{R^2}{L_P^2} = \frac{1}{\pi}\frac{S_{BH}}{k_B}$$

R = black hole radius
L_P = Planck length
S_{BH} = Berkenstein-Hawking's black hole entropy
k_B = Boltzmann's constant

Where

$$L_P \equiv \sqrt{\frac{\hbar G}{c^3}}$$

After some basic algebra I get the formula for the black hole entropy. (See reference [10] for a complete derivation of the formula.)

$$S_{BH} = \frac{k_B c^3}{4\hbar G} A_H$$ (Berkenstein-Hawking formula for the black hole entropy)

When nature created a different law it used a different transformation process. For example the transformation process for Einstein's relativistic energy was

$$D_1^n \longrightarrow \frac{E + m_0 c^2}{pc}$$

$$D_2^m \longrightarrow \frac{pc}{E - m_0 c^2}$$

$$S \longrightarrow 1$$

Thus nature created the following law

$$\frac{E + m_0 c^2}{pc} = \frac{pc}{E - m_0 c^2}$$

Which after algebraic steps we recognize as the Einstein's famous formula for the relativistic energy

$$E^2 = p^2 c^2 + m_0^2 c^4$$

See reference [2] for a more detailed explanation.

Let us come back to relationship (2) and let us explore it more closely. The symbols shown there stand for

a) Quantities:

(i) Q_1, Q_2, Q_3 and Q_4 are physical quantities of identical dimension (such as Length, Time, Mass, Temperature, etc), or

ii) Q_1 and Q_2 are physical quantities of dimension 1 or dimensionless constants while Q_3 and Q_4 are physical quantities of dimension 2 or dimensionless constants. However, if Q_1 and Q_2 are dimensionless constants then Q_3 and Q_4 must have dimensions and viceversa.

(e.g.: Q_1 and Q_2 could be quantities of Mass while Q_3 and Q_4 could be quantities

of Length).
The physical quantities can be variables (including differentials, derivatives, Laplacians, divergence, integrals, etc.), constants, dimensionless constants, any mathematical operation between the previous quantities, etc.

b) Relationship type: The relationship is one of five possibilities: **less than or equal to** inequation ($\leq$), or **less than** inequation (<), or **equal to** - equation (=), or a **greater than or equal to** inequation ($\geq$), or a **greater than** inequation (>).

c) Scale factor*: S* is a dimensionless *scale factor*. This factor could be a real number, a complex number, a real function or a complex function (strictly speaking real numbers are a particular case of complex numbers). The scale factor could have more than one value for the same relationship. In other words a scale factor can be a quantum number.

d) Exponents: *n* and *m* are integer exponents: 0, 1, 2, 3, …
Some examples are:
example 1: $n = 0$ and $m = 1$;
example 2: $n = 0$ and $m = 2$;
example 3: $n = 1$ and $m = 0$;
example 4: $n = 1$ and $m = 1$;
example 5: $n = 1$ and $m = 2$;
example 6: $n = 2$ and $m = 0$;
example 7: $n = 2$ and $m = 1$;
It is worthy to remark that:
i) The exponents, *n* and *m*, cannot be both zero in the same relationship.
ii) The number *n* is the exponent of both Q_1 and Q_2 while the number *m* is the exponent of both Q_3 and Q_4 regardless on how we express the equation or inequation (1). This means that the exponents will not change when we express the relationship in a mathematically equivalent form such as

$$\left(\frac{Q_4}{Q_3}\right)^m \left[< \left| \leq \right| = \left| \geq \right| > \right] S \left(\frac{Q_2}{Q_1}\right)^n$$

iii) So far these integers are less than 3. However we leave the options open as we don't know whether we shall find higher exponents in the future.

The scale law (1) can also be written as

$$Q_1^n Q_4^m \left[< \left| \leq \right| = \left| \geq \right| > \right] S\, Q_2^n\, Q_3^m$$

Next section shows ten laws that I believe were spawned by Scale Law.

5. The laws Spawned by the Scale Law

The following table (Table 1) shows 10 different laws I believe the Scale Law has spawned (created) "before" or during the Big Bang.

Meta Law: the Scale Law $D_1^n \left[< \mid \leq \mid = \mid \geq \mid > \right] S \; D_2^m$				
Name of the Law	**How nature spawned this law**	**Fundamental form of the law according to the Scale Law**	**How humans formulated this law**	**Ref**
(1) Heisenberg uncertainty principle	$D_1^n \longrightarrow \frac{\Delta p}{M_P c}$ $D_2^m \longrightarrow \frac{\Delta p}{M_P c}$ $S \longrightarrow \frac{1}{2} = 0.5$	$\frac{\Delta p}{M_P c} \geq \frac{1}{2} \frac{L_P}{\Delta x}$	$\Delta p \, \Delta x \geq \frac{\hbar}{2}$	[1]
(2) Black Hole Entropy Formula	$D_1^n \longrightarrow \left(\frac{R}{L_P} \right)^2$ $D_2^m \longrightarrow \frac{S_{BH}}{k_B}$ $S \longrightarrow \frac{1}{\pi} \cong 0.318$	$\frac{R^2}{L_P^2} = \frac{1}{\pi} \frac{S_{BH}}{k_B}$	$S_{BH} = \frac{k_B c^3}{4 \hbar G} A_H$	[2]
(3) The fine structure constant	$D_1^n \longrightarrow \frac{\alpha}{1}$ $D_2^m \longrightarrow \left(\frac{e}{Q_P} \right)^2$ $S \longrightarrow 1$	$\frac{\alpha}{1} = \left(\frac{e}{Q_P} \right)^2$	$\alpha = \frac{e^2}{2 \varepsilon_0 h c}$	[3]
(4) Einstein's relativistic energy formula	$D_1^n \longrightarrow \frac{E + m_0 c^2}{pc}$ $D_2^m \longrightarrow \frac{pc}{E - m_0 c^2}$ $S \longrightarrow 1$	$\frac{E + m_0 c^2}{pc} = \frac{pc}{E - m_0 c^2}$	$E^2 = p^2 c^2 + m_0^2 c^4$	[4]

Name of the Law	How nature spawned this law	Fundamental form of the law according to the Scale Law	How humans formulated this law	Ref
(5) Newton's law of universal gravitation	$D_1^n \longrightarrow \frac{F_G r}{m_1 c^2}$ $D_2^m \longrightarrow \frac{m_2 c^2}{F_P r}$ $S \longrightarrow 1$	$\frac{F_G r}{m_1 c^2} = \frac{m_2 c^2}{F_P r}$	$F_G = G\frac{m_1 m_2}{r^2}$	[5]
(6) Friedmann equation	$D_1^n \longrightarrow \frac{\dot{R}}{\left(\frac{R}{R_0} + K\right)c}$ $D_2^m \longrightarrow \frac{\left(\frac{R}{R_0} - K\right)c}{\dot{R}}$ $S \longrightarrow 1$	$\frac{\dot{R}}{\left(\frac{R}{R_0} + K\right)c} = \frac{\left(\frac{R}{R_0} - K\right)c}{\dot{R}}$	$\left(\frac{\dot{R}}{R}\right)^2 = \frac{8}{3}\pi G\rho - \frac{kc^2}{R^2} + \frac{\Lambda}{3}$	[6]
(7) Formula for the Schwarzschild radius	$D_1^n \longrightarrow \frac{R_S}{M}$ $D_2^m \longrightarrow \frac{L_P}{M_P}$ $S \longrightarrow 2$	$\frac{R_S}{M} = 2\frac{L_P}{M_P}$	$R_S = \frac{2GM}{c^2}$	[7]

Name of the Law	How nature spawned this law	Fundamental form of the law according to the Scale Law	How humans formulated this law	Ref
(8) The Bohr postulate	$D_1^n \longrightarrow \frac{mv}{M_P c}$ $D_2^m \longrightarrow \frac{L_P}{r}$ $S \longrightarrow 1, 2, 3,...$	$\frac{mv}{M_P c} = S\frac{L_P}{r}$ $S = 1, 2, 3,...$	$mvr = n\frac{h}{2\pi}$ $n = 1, 2, 3,...$	[8]
(9) De Broglie wavelength-momentum formula	$D_1^n \longrightarrow \frac{h}{\frac{M_P c}{\lambda}}$ $D_2^m \longrightarrow \frac{L_P}{r}$ $S \longrightarrow 1, 2, 3,...$	$\frac{h}{\frac{M_P c}{\lambda}} = S\frac{L_P}{r}$ $S = 1, 2, 3,...$	$2\pi r = n\lambda$ $n = 1, 2, 3,...$	[8]
(10) Schrödinger equation	$D_1^n \longrightarrow \left(\frac{\lambda}{\sqrt{\frac{\Psi}{\nabla^2\Psi}}}\right)^2$ $D_2^m \longrightarrow 1$ $S \longrightarrow -4\pi^2$	$\left(\frac{\lambda}{\sqrt{\frac{\Psi}{\nabla^2\Psi}}}\right)^2 = -4\pi^2$	$\nabla^2\Psi + \frac{8\pi^2 m(E-U)}{h^2}\Psi = 0$	[9]

Table 2: This table shows how nature spawned ten different laws of physics from just one Meta Law.

6. Conclusions

In summary, my previous papers [1, 2, 3, 4, 5, 6, 7, 8, 9] suggest that *the Heisenberg uncertainty principle, the formula for the black hole entropy, the fine structure constant, Einstein's relativistic energy equation, Newton's law of universal gravitation, Friedmann equation, the formula for the Schwazschild radius, the Bohr Postulate, the De Broglie wavelength-momentum relationship and the Schrödinger equation*, are special cases of a more fundamental and general Law: the Scale Law.

But the Scale Law, unlike all other known laws, is not a normal law but a Meta Law: a Law that nature used to spawn or create the laws of physics we are familiar with. Now we are closer to the truth because we have answered the question: **Where do the laws of physics come from?** with the answer: **They come from Meta Laws** (assuming there is more than one). But we cannot claim victory because another question arises: Where do Meta Laws come from? And the answer could be: they came from a "Pre-Universe" that "existed before" the big bang. But again, another question comes up: How did this happen? Then is when we run out of answers because we do not know anything about the "Pre-Universe" or "Meta Universe". Despite this lack of knowledge, I have assumed that this "Meta Universe" contained the most fundamental Laws of physics: Meta Laws.

REFERENCES

[1] R. A. Frino, *The Heisenberg uncertainty principle and the Scale Principle*, viXra: xxxx.xxxx, (2014).

[2] R. A. Frino, *The Black Hole Entropy and the Scale Principle*, viXra: xxxx.xxxx, (2014).

[3] R. A. Frino, *The Fine Structure Constant and the Scale Principle*, viXra: 1406.0169, (2014).

[4] R. A. Frino, *The Special Theory of Relativity and the Scale Principle*, viXra:1406.0144, (2014)

[5] R. A. Frino, *Newton's Law of Universal Gravitation and the Scale Principle*, viXra: 1407.0023, (2014).

[6] R. A. Frino, *Cosmology and the First Meta Law: From the Realm of Quantum Mechanics to the Large-scale Structure of the Cosmos,* viXra:1406, (2014)

[7] R. A. Frino, *The Schwarzchild Radius and the Scale Principle*, viXra: 1406.0164, (2014).

[8] R. A. Frino, *The Bohr Postulate, the De Broglie Condition and the Scale Principle*, viXra: 1407.0004, (2014).

[9] R. A. Frino, *The Schrödinger Equation and the Scale Principle*, viXra: 1407.0042, (2014)

[10] R. A. Frino, *The Quantum Theory of Black Holes*, viXra: 1406.0036, (2014).