Origin of the Physical Laws of Nature

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Abstract

The ultimate origin of the physical laws of nature are seldom discussed in science circles. Yet, the regularity of these laws is assumed and depended upon in every scientific endeavor. Some have attempted to explain a spontaneous origin for physical laws; six approaches are described and shown to be deficient. In contrast, Biblical creation provides a refreshing and credible alternative to secular thinking. The laws of nature are closely connected with mathematics, the language of creation. As an example of this physical symbiosis, the insights of German mathematical genius Amalie Emmy Noether (1832–1935) are described.

Key Words: Physical laws, Noether's Theorem, Multiple universes, Postmodernism, Conservation laws

Introduction

The basic physical laws, distinct from man-made laws, cannot be modified or broken. We have no choice but to obey them. These laws are patterns that nature follows without exception, other than divine miracles. Physical laws or rules give certainty and stability to the behavior of the universe, and the science world entirely depends on this regularity. Many such laws have been discovered, and several follow from the discipline of physics:

Ampère's circuital law
Avogadro's law
Bernoulli's principle
Boyle's law
Charles' law
Conservation laws
Coulomb's law
Gauss' law
Gay-Lussac's law
Hooke's law
Kepler's laws of planetary motion
Law of gravity
Laws of thermodynamics
Lenz's law
Newton's laws of motion
Ohm's law
Pascal's principle
Stefan's law
Weber's law
Wien's displacement law

Other fields of science inquiry likewise have alternate sets of laws ranging from the law of biogenesis in biology to the laws of superposition in geology.

This article considers the ultimate origin or source of the laws of nature. That is, where do they come from? Two related topics are not covered here. One is the philosophical discussion of these laws including their application, limitations and logic. Science philosophy is a fascinating topic; however, not everyone agrees. With apologies to philosophical readers, physicist Richard Feynman (1918–1988) is credited with the statement, "Philosophy of science is about as useful to scientists as ornithology is to birds" (Munafo and Smith, 2018, p. 1).

A second area not addressed is the historical discovery and development of physical laws. Much of this pioneer groundwork was accomplished by godly men and women as they "searched out the secrets" of their Creator. As shown

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elsewhere, the entire foundation of modern science follows from the research of pioneer scientists who held strong faith and confidence in a consistent, planned universe including its physical laws.

Views on the Origin of Physical Laws

Throughout my physics career, very little was heard or read concerning the origin of physical laws. This lack of discussion includes the content of university courses, conferences, textbooks, and research programs.

In the spirit of full disclosure, the conclusion of this article is that every physical law carries the clear fingerprint of the Creator. However, many science scholars choose other paths of understanding. Six naturalistic approaches to the origin of laws are identified here along with some representative quotes. These approaches are followed by a brief outline of Biblical creation.

1. Dodging the issue

The laws of nature along with a multitude of physical constants appear to be precisely chosen for our survival and well-being. This is called the Anthropic Principle which refers to the "user-friendly" details of the universe. Examples range from the exact mass of the proton which provides for its stability, to the Earth's orbital location in the habitable zone of the Sun which allows water to exist in liquid form.

To avoid the obvious hint of intelligent design, multiple universes are often proposed. These countless hypothetical universes are assumed to exhibit a great variety of physical laws. In this view, the laws of nature familiar to us are just one possible subset of an infinite variety existing elsewhere. Advocates envision a "vast patchwork quilt of universes, each with its own distinctive set of bylaws, so it is no surprise that we find ourselves in a Goldilocks universe—one that is just right for life" (Davies, 2007). Otherwise life could not begin and we simply would not be here.

A related quote states, "So if we picture our own universe as a bubble, it is sitting in a network of bubble universes of space. What's interesting about this theory is the other universes could have very different laws of physics than our own, since they are not linked" (Howell, 2018). This metaphysical speculation still does not explain the ultimate origin of such laws and it greatly complicates the issue with countless additional sets of laws. A further weakness of this position is the complete lack of supporting evidence for alternate universes.

2. Evolving laws

Canadian physicist Lee Smolin also assumes the multi-universe model and suggests that parent universes somehow spin off descendant "baby universes" with different sets of physical laws. That is, laws vary or evolve from one universe to the next: "Nothing transcends time, not even the laws of nature. Laws are not timeless. Like everything else, they are features of the present, and they can evolve over time" (Smolin, 2014, Preface).

In spite of the lack of any type of mutation-natural selection mechanism, the history of physical laws is said to parallel biological evolution. An immediate problem arises: Similar to the secular mystery of life's origin, how did the first physical laws arise? Notice the analogy here: Both biological evolution and natural science are based on missing foundations.

By extension of Smolin's thinking, it might be suggested that laws should also change or evolve over time within our known universe. However, decades of high-precision measurements of laws and constants show no variation whatsoever.

3. Pure math

MIT cosmologist Max Tegmark gives a novel interpretation of physical laws and reality. He suggests that all matter is part of a mathematical structure, including ourselves: "I argue that…our universe isn't just described by math, but that it is math in the sense that we're all parts of a giant mathematical object, which in turn is part of a multiverse so huge that it makes the other multiverses debated in recent years seem puny in comparison" (Tegmark, 2014). One can readily agree that mathematics is the language of creation. However it is offensive to imply that a person is nothing more than a complex mathematical function. This artificial interpretation of reality reminds one of science fiction films such as *The Matrix* (1999).

4. Postmodernism

This movement was popularized in recent decades. It includes a general skepticism and rejection of traditional laws, truths and values: Objective knowledge simply does not exist. The questioning extends even to mathematics and science. In the extreme, postmodernists conclude that math functions and science laws are arbitrary "social constructs" based largely on Euro-American influence. That is, the established laws of nature are arbitrary, biased inventions. Typical quotes illustrate postmodernism:

Science can be viewed as "a man-made edifice that is historical, not timeless, one of many alternative ways of carving up the world" (Johnson, 1996).

> "…no stone tablet has ever been found upon which laws were either naturally or supernaturally inscribed. On the contrary, the laws of physics are human inventions" (Stenger, 2004).

The dangers of this reinterpretation of science history are expressed: "Postmodernist thought is being used to attack the scientific worldview and undermine scientific truths; a disturbing trend that has gone largely unnoticed by a majority of scientists" (Kuntz, 2012, Abstract). The Wikipedia website includes the topic "Science wars" which discusses this conflict in depth. Fortunately, the postmodern attack on objective truth has diminished in recent years, largely due to its extremism.

5. Randomness

The writings of physicist John Wheeler (1911–2008) suggest that the laws of nature spontaneously appeared at the time of the alleged Big Bang event along with space and time. In Wheeler's words, the laws emerged "higgledy-piggledy" from chaos, perhaps from quantum fluctuations, a notion comically described as "it from bit" (Overbye, 2007). In this view the laws of nature are accidental, or contingent. Lee Smolin puts it this way, "…God is nothing but the power of the universe to organize itself" (Smolin, 2014). Such thinking must assume that the laws governing quantum fluctuations are already in place to control particle fluctuations and initiate new physical laws.

Figure 1. A California wind farm (Wikipedia Commons). Energy exists in many forms including wind, fossil fuel, and nuclear. In every transfer process, some energy becomes unavailable; however, the total amount of energy is always conserved or constant.

6. Secular faith

In this popular view, such questions as the origin of physical laws are declared to be simply beyond our understanding. This position gives the laws of nature an independence from anything other than themselves. They "just are" and we have no choice but to obey them. Paul Davies is a theoretical physicist and cosmologist at Arizona State University who uncovers the religious implication of this viewpoint: "Science can proceed only if the scientist adopts an essentially theological worldview. …even the most atheistic scientist accepts as an act of faith the existence of a law-like order in nature that is at least in part comprehensible to us" (Davies, 1995). It should be noted that Paul Davies himself pictures God as an impersonal, abstract idea, somewhat similar to that of Einstein's view (Davies, 2016).

Davies gives additional insight into the current state of secular science. He suggests that a common theistic faith in early science was finally extinguished by the "God is Dead" movement first promoted by German philosopher Friedrich Nietzsche (1844–1900). That is, the very idea of the Creator God was deleted from science inquiry. As a result, ever since, natural laws freely float in the science world with no source. There seems to be an "I don't know and I don't care" attitude toward the ultimate origin of physical laws and constants.

Physical Laws and Biblical Creation

There is a common shortcoming in all six of the preceding discussions: None follow through with a credible explanation for the ultimate origin of the laws which control the operation of the physical universe. In contrast, Biblical creation provides a refreshing alternative with several origins details provided. Details are given in the form of questions and answers:

1. Are the laws of nature eternal or do they have an origin?

All details of nature including its laws have a supernatural beginning. As Colossians 1:16 explains, "For by him [Christ] all things were created: things in heaven and on earth, visible and invisible…all things were created by him and for him." The verse is clear that there is an intelligently planned starting point for nature and the physical laws of nature, and also the spirit world.

2. When were physical laws established?

Possible answers include during or at the completion of the Creation Week. As the week takes place, material objects are spoken into existence (Psalm 8:3).

In this supernatural process, physical energy is added to the universe from God's infinite reserves. This implies that the law of conservation of energy, and perhaps other laws, are not yet established across the cosmos until the work of Creation is complete.

3. Are physical laws self-sustaining?

Colossians 1:17 explains that Christ is before all things, and in him all things hold together or consist. This verse describes a direct interface between the physical and spirit worlds. The Greek verb for consist (συνιστάω, sunistaō) means to cohere or preserve. Extra-Biblical Greek use of this word pictures a container holding water within itself. The word use in Colossians is in the perfect tense which normally implies a continuing state arising from a completed past action.

A second reference, Hebrews 1:3, declares that Christ upholds or sustains the universe by his Word. Uphold (φέρω, pherō) describes the maintaining of all things including physical laws.

To consider just one implication, suppose the Creator turned his back on the universe for one moment of time. Physical laws would be unenforced, and instant chaos surely would follow. Thankfully this does not happen because the Creator faithfully upholds the laws He established.

3. Do physical laws change by either decaying or evolving?

Physical laws are constant, or immutable, at least in the present age, other than divine miracles: "…you established your faithfulness in heaven itself" (Psalm 89:2). The permanent physical laws continually are displayed by the change of seasons, the exact occurrences of solar eclipses and steady sunshine.

4. Are physical laws understandable?

Not entirely. Job was asked by his Creator, "Do you know the laws of the heavens? Can you set up God's dominion over the earth?" Job 38:33. This rhetorical question has an obvious negative answer.

Much is known of physical laws yet there remain deep mysteries. Consider the familiar law of gravity with its precise inverse-square formula. The current interpretation is that massive objects somehow curve or warp nearby spacetime. However, why does gravity exist in the first place? And why is it always attractive, never repulsive, and how does it give curvature to space? Credible scientific answers are lacking.

The science world searches for a "Theory of Everything" (TOE) which ties together all the distinct natural laws of the universe into one expression. Steven Hawking (1942–2018) remarked, "…if we do discover a complete theory… it would be the ultimate triumph of human reason—for then we would know the mind of God" (Hawking, 1988). The quest for a final theory is futile because the mind of the Creator God, far beyond Hawking's impersonal interpretation, is infinitely above our capacity for full understanding (Isaiah 55:8–9).

Conservation Laws

There is a special set of physical laws which merits further discussion. Perhaps the most familiar law of nature is the conservation of energy, also called the First Law of Thermodynamics. Energy becomes unavailable over time as described by the Second Law of Thermodynamics; however, total energy amounts cannot be created or destroyed. This energy law supersedes the earlier idea of mass conservation from Isaac Newton's era. This follows because energy (E) and mass (m) are interchangeable by the relationship $E = mc^2$ where c is the speed of light in a vacuum. Mass is popularly described as "frozen energy."

Table I summarizes four conserved physical quantities and their related mathematical symmetries, illustrating Noether's Theorem (1918).

Energy belongs to the special category of physical laws where quantities do not change over time in a closed system, that is, in the absence of outside forces or influence. Four major conservation laws are listed in the Table and there are additional lesser-known conservation laws. The quantities originally could have been described in a negative way as not changing. However, the term conservation, or constant, gives a positive expression to these fundamental laws. Note that this use of the word conservation is distinct from the environmental term of saving or conserving energy.

Noether's Theorem

Amalie Emmy Noether (NUR-ter, 1882–1935) was a talented German mathematician and a pioneer feminine

Table I. Four conserved physical quantities and their related mathematical symmetries, illustrating Noether's Theorem (1918).

Conservation Law	Mathematical Invariance
Energy	Time translation
Linear momentum	Space translation
Angular momentum	Space rotation
Electric charge	Schrödinger equation (Complex wave phase changes)

scholar. Because her family was Jewish, the rise of Nazism led to her dismissal from an academic position in 1933. Emmy was welcomed in the U.S. where she joined the faculty at Bryn Mawr College in Philadelphia, also lecturing on mathematics at Princeton University. Unfortunately, Emma passed away from health issues just two years later at age 53. I can find no information or quotes on the personal faith of Emmy, apparently a life totally dedicated to the pursuit of mathematics (Rowe and Koreuber, 2020).

Emmy Noether was gifted with deep insights connecting mathematics and physics. She showed in 1918 that physical quantities described by symmetric mathematical equations lead to physical conservation laws. This is called Noether's Theorem and links the two important concepts, math and physics. In technical terms, every differentiable symmetry of the action of a physical system leads to a corresponding conservation law. The symmetries are not geometric as in a visible mirror image but instead involve math functions (Collins, 2006).

As an example, the equations of motion do not depend on a particular location or coordinate system. That is, the laws of motion are valid everywhere and in any direction in space. This translational symmetry is described as spatial invariance (another word for symmetry) and leads to the law of conservation of linear momentum. As a second example, time invariance means that the same physical laws apply in the past, present, and future, leading to the law of conservation of energy.

The proof of Noether's Theorem is not trivial and includes the Lagrangian function along with abstract algebra, which Emmy also pioneered. Proofs of the theorem are discussed on many internet sites. For interested readers, an Appendix at the end of this article shows how time invariance for a particle leads to conservation of energy.

Figure 2. A 1910 photograph of Emmy Noether at age 28 (Wikimedia Commons). She excelled in abstract algebra and theoretical physics. The Noether Theorem (1918) connects mathematical symmetries with physical conservation laws.

The Table [see above] lists four mathematical symmetries and their related conserved quantities. Noether's Theorem has been called the "most beautiful idea in physics." Beyond classical physics, it has proved valuable in relating symmetries and conservation laws in high energy particle physics. The theorem further contributes to the understanding of quantum theory, supersymmetry, broken symmetries, superstring theory and other ideas in modern physics.

Conclusion

This paper explores the origin of the fundamental laws of nature. These laws describe the behavior of matter and energy across the universe. They provide the foundation for all fields of science, yet their emergence remains a mystery, at least apart from a divine cause. Noether's Theorem further shows the close relationship between several physical laws and mathematics. Whether considering the behavior of electrons or galaxies, all physical laws proclaim the handiwork of the Creator.

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Appendix

This section shows how time symmetry, or invariance, leads to energy conservation for a simplified system. Alternate approaches appear in many texts. We use the Lagrangian expression 'L' for the state of the system in classical mechanics, defined as

$$L = KE - PE$$

where KE and PE are kinetic and potential energies. Consider a single free particle with mass m, position q and velocity q' at time t.

$$L = L(q, q', t)$$

By the chain rule,

$$\frac{dL}{dt} = \left[\frac{\partial L}{\partial q}q' + \frac{\partial L}{\partial q'}q'' + \frac{\partial L}{\partial t}\right]$$

If the Lagrangian is time independent, a condition for Noether's Theorem, the last term is zero. Next we apply the Lagrange-Euler equation, a useful tool proved elsewhere,

$$\frac{d}{dt}\left[\frac{\partial L}{\partial q'}\right] - \frac{\partial L}{\partial q} = 0$$

Combining terms,

$$\frac{dL}{dt} = \frac{d}{dt}\left[\frac{\partial L}{\partial q'}\right]q' + \frac{\partial L}{\partial q'}q''$$

$$= \frac{d}{dt}\left[\frac{\partial L}{\partial q'}q'\right]$$

Rewriting the expression,

$$\frac{d}{dt}\left[\frac{\partial L}{\partial q'}q' - L\right] = 0$$

Therefore,

$$\left[\frac{\partial L}{\partial q'}q' - L\right] = constant$$

As before,

$$L = KE - PE$$

We will assume

$$\frac{\partial PE}{\partial q'} = 0$$

that is, the potential energy does not depend on the particle velocity.

Now since

$$KE = ½ mq'^2$$

Then

$$\left[\frac{\partial KE}{\partial q'}\right] = mq' = 2KE/q'$$

Evaluating the previous constant,

$$2KE - KE + PE = constant$$

Therefore

$$KE + PE = constant$$

The conclusion: Total energy for the particle is conserved as long as the listed conditions are met.