1. INTRODUCTION

It is important to understand the need for a better classification of physical phenomena based off the ever growing and changing body of empirical fact. What we observe, the experiments are the only studies that can tell scientist about reality. It becomes scientifically unethical to rely on assumptions made about measurements or experiments that cannot ever be examined by science, especially when those assumptions can be reassigned to phenomena experiments can be conducted on. The latter is not only more philosophically consistent, it benefits by establishing what science hopes to achieve: real understanding from observation. Experimenters a few hundred years ago did not conceive the kind of experiments being developed today and the knowledge being gleaned from them and did not imagine how with new understanding the assumptions they did make might be changed to make science even better in light of new facts and methods. The accumulation of over a century of rigorous experimental fact resulting in theories of relativity and quantum mechanics, especially observations made by scientist on the quantum teleportation of wave packets of light [1], Hardy's Paradox [3], and the apparent backward flow of time [4] makes these changes even more necessary. The new classification advanced here, revolves around the concept of interaction going beyond chemical or field interaction or even simple interactions where just energy and momentum are conserved. The two new classifications are geometric and nongeometric interactions. The nongeometric interactions are also called substantial interactions. It is important to have a geometric interaction now because physicists accept many cases where geometric properties result from matter or particles and not from a fundamental geometry. It is also important because a great deal of physical phenomena is modeled with the use of geometry. The substantial interactions become necessary with the realization that if mater does not depend on geometry or the property of space in a fundamental way for its existence then there are likely other kinds of interaction that may have been empirically observed but are not geometric in nature. As it turns out (and will discuss later), not geometric interactions have necessarily been modeled as the imaginary number within geometric models (because geometry is the best understood tool physicist have) and are hereafter termed nongeometric.

Physicists traditionally break down phenomena to simplest concepts that cannot be explained by other phenomena. Space, time, and mass are all examples of this. Scientist then attempt to explain new phenomena or properties using those concepts, and lots of observations has been explained in this way. Geometric interaction is a general concept that space, time, and mass all belong to (discussed below) but is a dependent property of the particle. The reductions of experimental observations to fundamental concepts continue to be important analytically but are not important on an experimental level because an experiment cannot be done to establish which is fundamental: the particle itself or the mass, space, and time used to analyze it. Scientific models to explain facts need to avoid claims to fundamental knowledge to remain empirical and avoid rationalizations. Thus fundamental notions need to be left completely to philosophy. Therefore, given this correction to what belongs in scientific discussion, the experiment more accurately becomes the only tool that can be fundamental to our knowledge of nature. A goal for the classification of geometric and nongeometric properties is to limit models to the observations of experiments without making the human contention to fundamental knowledge.

Classification begins with the study of physical properties: mass, color, shape, and temperature that are all measurable, and they describe the physical systems state. I may take play-doe in the shape of a cube and squeeze it into a ball; physical properties different from geometric properties can be malleable and do evolve. Geometric properties are physical properties using geometric models to describe them. Most physical properties have been described using geometric models but some explanations are nongeometric. Temperature has been thought of as a geometric continuum of energy where between 1 degree and another there is an infinite number of smaller degrees. Modern physics has shown by experiment the geometric theory of temperature is false. Energy is quanticized. The energy it takes to change the shape of the play-doe is jumpy, discrete, and characteristically nongeometric. Therefore, energy undergoes substantial interaction. Still, the time the reshaping of the play-doe is done in, is modeled continuous and geometric. The shape is also widely accepted to be geometric, its dimensions continuous. Therefore the shape is a form of geometric interaction. In all widely applied theories of physics today, concepts of force, space and time are examples of geometric interaction. Energy and mass conservation are too.

For determining if an interaction is geometric or nongeometric be scientific, look to see how the interaction or physical properties are modeled and verified by rigorous experimentation. If a geometric model is backed up by detailed experimental data then the process is likely that of a geometric interaction. The same is true for processes that cannot be explained by geometric applications. Observations from reality determine if an interaction is geometric or nongeometric.

Also, to clarify, many physical properties are supervenient to space and time. To be supervenient is to be related in a dependent way to other properties. Still, space and time are effective properties of particles so processes may change how space and time are observed through geometric interaction. Time and space dilations between relative objects are a great example of this. Also, electrons or photons, for instance, may take on new geometrically modeled identities such as a wave or a particle (the famous wave-particle duality) similar to how play-doe may take on new shapes. However, changes in geometric identities (between wave models and billiard models) do not evolve and the different effective processes are not classically measurable. The processes that lead to new geometric identities all relate back to the study of geometric and nongeometric interactions of particles.

2. THE GEOMETRIC EQUVALENCE LAW AND ITS APPLICATION TO PHYSICS

To develop an understanding of geometric interaction we must begin with the particle in its most simple, state, by itself without any other particles. The objects geometric property of space suffused with forces like gravity and electromagnetism is all about it, similar to the way a human's appendages grasp at things and walk around. Space and the so called fundamental forces, are inseparable concepts that cannot be conceived without each other. Now we introduce a second particle. It too must have a geometric property of space. This space cannot simply be a relational distinction given to the two particles and is not just an abstraction for dimensional analysis. Space is a physical consequence resulting in measurable geometric interaction of forces and proximity resulting from both particles independently. By the previous statements, I do not argue the particles are more fundamental than space in the sense of the classical claim that the properties of space can be described through detailed analysis of the inner workings of particles. I argue the particles are empirical giving them irreconcilable precedence over space, a concept unobservable by itself. With this view at hand, it is quickly realized that independent phenomena have the same geometric properties that give sense to the extensions of space around them, otherwise the laws of physics will not be the same for some bodies. The law that all particles have the same geometric properties is significant and provides an explanation for many other concepts in physics. Inertial and non-inertial reference frames, energy and momentum conservation, relativity, and entropy all result from the geometric equivalence law. To restate, for each particle the property of space is its own property but the properties are the same for all particles so that space capturing all of the particles there in must be continuous and consistent. This is similar to the symmetry in gauge theory that states all particles are the same, except here it is also the geometry that is the same. It is the geometric interaction of the properties of the independent particles that leads to the somewhat accurate Newtonian concept of space that in turn allows the property of motion and the laws of dynamics he conceived. Velocity, acceleration, momentum, and force can all be defined given the geometric equivalence law.

Newton certainly could have thought of geometric interaction himself if he had reason to but he did not have the prolific body of experimental science the 21st century scientist has and the idea will have been unnecessarily complicated to him without the detailed empirical evidence from atomic physics, statistical and quantum mechanics, and special and general relativity. A contemporary of Newton might have argued it be simpler to have an unobservable and independent absolute space then some kind of geometric interaction taking place. The same was true of Aristotle's contemporaries who preferred the four elements: Earth, Wind, Fire, and Water to other models that did not have any data to back them up. Geometric interaction is not directly reducible to a basic measure of space but infers another level of potentially complicated processes for which there was no experimental cause in Newton's time. Further, Newton could argue non-inertial motion is an empirical observation relative to an absolute space. In his time, Newton's paradigm was the simplest to fit the empirical facts available in his day.

So, motion arises from an interaction of geometric properties of particles. Motion allows for the development of time taking devices so time is a geometric property. Both time and space may be referred to as geometric identities useful to scientists for creating measuring devices.

Further the consequences of relativity arise from geometric interaction. An electromagnetic field is a geometric construct composed of both magnetic and electric fields that extend radially outward effecting like and unlike charges with dynamical forces. The field is in part a geometric interaction with how it applies itself. How a field exerts itself relies on the geometric properties of particles. The speed the field applies must also be, by definition, a fundamental property of the geometry. Because the properties of geometry are the same for all particles the rate at which the electromagnetic field applies itself to the particles geometry is also the same for every particle. This is another way of saying the speed of light is constant. This fact leads to the relativistic, geometric interactions for the motion of particles. In the past, fields were seen as properties of materials, particles, or objects but the space existed statically independent of the object. The view has been “particles float in a sea of space” and that forces, like gravity, act on space to curve it. In this paper the erroneous, fundamental notion of space is purged and relativistic phenomena is a natural consequence. The relativistic, empirical phenomena that have been studied for the last century support the theory that the geometric properties of particles are attributable to each individual particle and that these independent geometric properties are interacting in ways leading to the familiar time and space dilations as they are observed between independent objects. Einstein did not see any reason to change the status of fundamental concepts as all of the empirical observations can be reduced to them. It is also likely that to warrant such a change an experiment must be done to exemplify one idea over the other. This has not been accomplished until recently and will be discussed in more detail later.

Next, the concept of energy is in part, a geometric interaction because it is defined in all cases with geometric measurements (the space and time identities). Energy can also be nongeometric because it is discrete--more on the importance of energy being both geometric and nongeometric later. Classically, energy depends on a geometric interactant called mass that relates geometric force to geometric acceleration. However, as long as the mass is always constant or conserved the energy too must always be constant because the geometric properties of each particle are the same so the laws governing each billiard-style interaction must be the same. The classical conservation of energy law is in part nothing other than an extension of the principle that all geometric properties are the same for all particles. Because mass defined for kinematic interactions is only geometrically interacting, the conservation of mass-energy will completely fall under the geometric equivalence law and is obvious in hindsight. It is important to note the relativistic equivalence of mass-energy is entirely geometric, but this law has no precedence over substantial interactions still undiscovered.

The bulk of Netwonian mechanics, relativity, and the many conservation laws that go with it are all part of the analysis of geometric interactions; Newtonian physics amounts to the technique of showing how geometric forms can be changed into different geometric forms via geometrically defined concepts. Acceleration transforms into force through the geometric concept of mass. Velocity transforms into momentum. The acceleration of a field of objects is transformed into gravity. The conservation laws become self-evident because the experiments are designed to deal only with the properties the objects had to begin with and nothing physically new can possibly pop up (because there isn't a fundamental space for anything to pop into) in light of geometric equivalence.

Entropy itself is an extension of the geometric equivalence law. If I were to touch my hand to a hot burner and my hand were to get colder then there would have to be something special about the geometric properties of the burner different from my hand. Instead geometric properties being the same for everything results in the energy over countless interactions getting shared and averaged out to equilibrium. Increasing entropy is an expression of the equivalence of geometric interaction between all the particles in the system. The geometric equations with the assumption of an underlying, fundamental space does not make increasing entropy necessary but entropy viewed as a consequence of geometric interaction does. Changing the particles geometric properties of a system to decrease entropy through geometric interaction with others is possible to imagine, but such a change will also change the laws of kinematics, a consequence of the same geometric interactions. Such musings are imaginary—not the physics of geometric properties of bodies yet discovered.

It is equally obvious, in hindsight at least, by thinking of acceleration as one kind of geometric form that can be transformed into both linear forces and a gravitational field with nothing else physically to distinguish between them results in the bending of light being explained by gravitation as well. The geometric equivalence law is again self-evident. The equivalence principle is taken into the fold. So, general relativistic effects are another form of geometric interaction that relates the geometric mass to a four dimensional geometric curve.

The pragmatic analysis astutely keeps science from skipping ahead and possibly become misguiding--to recognize further tools, methodology, and experimentation are desperately needed before geometric theories can be constructed or claims to knowledge of everything can be made. For a unified theory, focus on a detailed understanding of the laws that govern substantial and geometric interaction of particles is essential. At this time, little is known about what these laws may be, just as little was known about the laws governing atoms when Dalton first proposed their significance in chemistry. Even if all the laws are discovered a unified theory cannot tell us anything about a fundamental knowledge of everything. Ranking knowledge is a human pathos. Still, given today's massive array of geometric tools for empirical observation, and today's unwillingness to seriously consider nongeometric properties for what they are, any new non-geometric tools are unlikely to even be conceived and if conceived few will accept the importance of their application, denying observations they make, stalling theories that can be developed around their findings. This is understandable. For the contemporary scientist geometric observations are fundamentally different from nongeometric observations because geometric observations make predictions that are geometrically causal, i.e. from information today I can determine the events of tomorrow. This is the basis for all empirical study in science today and is used as a standard to describe the importance of models. Nongeometric tools will not make predictions; adjustments to the tool will change what is predictable (or geometrically causal in nongeometric ways) using a controlled method giving the tool objective scientific merit. A great example of such a tool under development is that proposed by scientist in their paper on the multi-time measurement of quantum states [2]. Their paper suggests time may be objectively flowing backwards so events in the future may causally effect those in the past. The realization here is that fundamental time, unscientific in its origins, will be scrutinized by experiments as if it were just a property of the interacting particles at different moments. Deeper deductive insight recognizes substantial interactions taking place independent of the flow of time happen in conjunction with the geometric timed events. Just as Dalton's unseen atoms helped define possible chemical reactions, ungeometric substantial interactions are effecting what and how information may be determine geometrically. More nongeometric tools are likely to be developed as new links between the substantial interactant nature of mass and charges are discovered.

A great deal of the consequences of geometric interaction results in gauge symmetries, the results leading to a possible conclusion the difference between fundamental geometry and geometry as a property are not very relevant or may even be arbitrary. The paper goes beyond gauge theory, the study of what is possible to measure and experiment on, by simply stating everything we can know is physically observed through interaction and phenomena—an idea eliminating the assumption of fundamental geometry. The rationalist notion geometry can explain everything as a fundamental framework is not supported by experiments and does not adhere to strict standards for an empirical science. The purpose for the change from geometry to property is how easily doing it demystifies the experiments of quantum mechanics. That the change makes gauge symmetries and the consequences of relativity and entropy more obvious further establishes the correctness of the idea. Thinking of geometry as interaction forces thinking about the limitation of what is knowable during an experiment. It also forces thinking of what is actually supported by experiments like the verification of Aharonov–Bohm effect [5] helping establish the geometric **E** and **B** fields are not fundamental. While the electric potential is important, many leading scientist began making the case the potentials are fundamental following the results of the experiment, a senseless debate for the theoretical scientist being that experiments cannot conclusively determine the status of knowledge.

3. THE SUBSTANTIAL INTERACTIONS AND THE FOUNDATION OF QUANTUM MECHANICS

If we are to understand the interactions of particles in the most detail possible (and therefore understand atomic interaction) an equation that includes both the geometric interactions and the substantial interactions must be put forward. Schrödinger's equation is just that. Schrödinger's equation is a differential equation that satisfies the conservation of energy equation incorporating the continuity of energy in geometric interactions along with the discrete energy exchange of substantial interactions, and the consequent wave-particle duality: two completely different geometric identities observed via substantial interactions. The equation predicts all sorts of new kinds of substantial interaction within the consistent guidelines of the geometric equivalence law, both relativistic and otherwise. In setting up Schrödinger's equation a principled and simple, easy to understand and intuitive description can be given to all factors of the equation clearly specifying the physical system we are trying to understand. However, when the equation was first derived the concepts being applied to the derivation were very different from those described here. The quantum theory was described by Einstein, Bohr, and Plank in that day, and the particles were fundamentally described existing in space. The discrete energy was characteristic of a particle and was not thought to be nongeometric in the way discussed above. The particles had also been experimentally observed to behave as waves. When these concepts were taken together and applied to a differential equation satisfying the conservation of energy an imaginary number, the $\overline{-1}$ is forced upon the equation. Problems with interpretation followed. The $\overline{-1}$ in Schrödinger's equation is not founded on physical principles as factors in equations derived before it was. In a physical system were particles move around in the dimensions of space and time it is not obvious why the imaginary number should be there at all. Everything being modeled in the equation is physically real. Now, consider the dimensions of space and time are properties of the particles; the dimensions only exist as extensions of them. As the proximity interaction goes to zero (the particles get close to each other) the geometric identity of space also goes to zero. Given the de Broglie postulate and the quantization of energy, that there is a geometric complementarity and energy is not geometrically continuous during these events suggests what happens at proximity ≈ 0 is not like the geometric properties physicists are used to modeling. If what happens during these events is not geometric then it is impossible to get information about it by using geometric measures or geometric analytical tools like differential equations. Still, measured geometric events are happening and producing consequential interactions and reactions within the geometrically defined space. Physical observation demands the impossible still is possible. When space-time is fundamental it does not make sense to say the space-time becomes nongeometric during events without providing rigorous detailed math, making predictions that may be observed to establish how the space becomes anything else but what it has been. Here, such rigor to develop unnecessary theory is unscientific: the geometric interaction depends upon the particles; interactions are observed by experiment and nongeometric observations are their properties. Nothing more rigorous then the fact of what is observed is needed.

So it follows, in deriving Schrödinger's equation from physical principle based on observation, there is a mathematical tool that represents the impossible: $\sqrt{-1}$ that may be applied to geometric models. There are no 2 real numbers that are identical that can be a factor of each other and equal a negative. What we are trying to study in the micro world is similarly impossible. The measured and the tool of measurement are both creating its property of space we have defined as the measurement, let both equal 1. But during the interaction the result is the opposite of something that may be measured geometrically, -1. What is geometric cannot be geometric at the same time but in the real world we are modeling (with the tools in mathematics and measurement we have thus far conceived), they coexist and relate to each other. Lacking nongeometric tools makes nongeometric observation and theory difficult in how we have defined the measurement of the particle itself making $\sqrt{-1}$ physically necessary. Scientist have been unclear in their understanding of quantum mechanics because they expect to get geometric predictions from events that are not geometric! Scientist believe the geometry is fundamental though no experiment can tell them so.

In solutions to Schrödinger's equation, the wave function, after some direct computation, produces probability densities of where they can expect the particle to be rather then geometric determinations! Because matter does not exist in fundamental space, the result is expected and not surprising. This result is due in part to the nongeometric nature of the interaction reflected by the imaginary part of wave functions not only due to the de Broglie postulate which had always been intended as a real geometric description of matter. Quantum mechanics will never be deterministic but much can be determined from what is nongeometric.

Evidence of nongeometric interaction includes the electron double slit experiments. When the electron is observed, a substantial interaction occurs changing the geometric identity (given its geometric proximity, both temporal and spatial of the apparatus) of the electron, and hence, how it will be observed later (i.e. the experimental apparatus is a nongeometric tool that changes what is predictable later). The interaction, being nongeometric, does not take time or is required to commute space in any locally realistic way.

Further reasons to usurp the notion science exists in space and time--the idea matter is anything that takes up space, in a popularist way (because some scientist are aware of the problem but are unsure how to make the correction), is by how obviously unscientific and inconsistent it makes the physics community look. There is no experiment to verify fundamental space and time; there is no corroboration, but there are precise experiments contradicting it, where matter pairs are created. Clearly they did not take up space before they were created, but now, by the standard of old ideas, they do. It follows, the definition matter takes up space is not always true; that definition is not precise, complete, or scientifically determined; it leads to misunderstanding and confusion. Matter is anything with properties and can be experimented on; put another way, it maters! The classification of geometric interaction and substantial interaction places vestigial assumptions like fundamental space under intense scientific scrutiny that more accurately reflect modern experiments. By incorporating geometry as an interaction, a non-scientific assumption is brought more clearly into the objective realm of experimentation..

4. CONCLUSIONS

New facts from experiments should be analyzed in terms of geometric or substantial interactions; these interactions may be further classified—they can describe any phenomena that may be observed, not just geometric ones. Analysis using these concepts gives better insight and clarity going forward providing cohesive explanations beyond the scope of this essay for the EPR paradox, Hardy's Paradox, entanglement, a more general understanding of complementarity, Bells theorem, double slit experimentation, and gives deeper meaning to the inherent probabilities in quantum mechanics recently vindicated by physicist at the University of Vienna [6]. It simplifies our understanding and clarifies the discoveries of quantum mechanics.

1. ACKNOWLEGMENTS

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