Thomas at pennsylvania state university with abhay ashtekar

Thomas Thiemann was born in Germany in 1967 and later pursued a career as a theoretical physicist in the quantum gravity field. He is an active professor at the University of Erlangen- Nuremberg and has given lectures in the past on his theories and applications of his field at prestigious universities like Cornell University and Harvard College.

In 1994, Thiemann pursued his doctorate with the book titled For Canon Quantization of Gravity within Ashtekar Formalism with Hans A Kastrup. He then pursued post-doctoral research at Pennsylvania State University with Abhay Ashtekar (from his doctoral work) and later on at Harvard University. In 2000, he published Mathematical Formulation of the Quantum Einstein Equations under the University of Potsdam. He also led the Gravitational Physics department in 1997 at the Max Planck Institute in Potsdam and later became a professor in 2003 at the Perimeter Institute. Later on, he continued his educational career at the University of Waterloo by being an Associate Professor and later on securing his Professor position in Erlangen University in 2009. He currently leads the Quantum Gravity department at that institute and is mainly known for his works in loop quantum gravity theory in addition to his multiple mathematical formulations. It should be noted that the majority of this paper will focus on background information to quantum gravity and Thomas Thiemann's analysis on them based on an archive of his lectures from Cornell and multiple books.

To begin, Quantum General Relativity or Loop Quantum Gravity has made massive strides in the past 15 years, yet this entire field is filled with barriers that puzzled physicists for more than 70 years. The Loop Quantum Gravity field deals with a mathematically rigorous approach to quantifying and

rationalizing the gravitational field. Currently, there are two likely candidate theories in this field which deals with the quality of background independence and the minimality of structures. Before progressing in this topic, it should be noted that background independence is defined by non-perturbative, or non- disturbing, approaches to a defined background of knowledge. A non-perturbative approach would not further complicate known constants or classical background metrics and would also not involve the perturbative theory in theoretical physics- a theory in quantum mechanics that deals with approximations to condense large known quantities into a simpler one. The second aspect, minimality, is a candidate theory in quantum gravity because it may be able to combine two fundamental principles of modern physics, or quantum theory and a theory of general covariance, without contradicting each theory.

Specifically, this deals with what scientists have attempted to do throughout years: essentially approach minimality by creating the QGR or Quantum Gravity Relativity theory that combines other theories through using known mathematical models and non-perturbative approaches to result in a defined theory that will revolutionize the current foundations of physics. Specifically, Thomas Thiemann, a mathematician and physicist, is one of the many scientists who wish to arrive at a valid QGR theory that overcomes the many obstacles behind, essentially, quantifying infinity. As summarized before, the foundations of physics are mainly supported by pillars of General Relativity, or GR, and Quantum Theory. General Relativity falls under Einstein's explanation for physics with his theory of gravitational forces while the other theory, Quantum Theory or QT, supports the Quantum Field Theory or QFT,

which explains the basic behaviors of particle physics. This theory, or QFT, essentially characterizes all forms of matter (and all forces as well like electromagnetic, weak, strong forces for particles). In the basic understanding of regents physics, these forces were mentioned and in Quantum gravity, especially through the QFT, particles like leptons or the electron neutrino, quarks, or bosons have properties explained by this theory and these particles all collectively form the standard model of all matter that we know today.

Out of the four fundamental forces, gravity is not included in QFT theory and thus begins the problem that Thomas Thiemann hopes to solve. The problem is that the QFT leaves out the fourth force, or gravity, and thus by combining GR with QFT, or QT, we can hopefully arrive at the desired Quantum Field Gravity theory, or Quantum Theory, that may explain the concepts of cosmology and astrophysics. An in depth analysis of General Relativity theory is required before progressing further into this problem. Thiemann describes General relativity as Einstein's mathematical interpretation of gravity where gravity is influenced by the curvature of space. This is specifically found in the current model of the solar system and explains another concept in basic, or regents level physics, Kepler's laws.

The influence of gravity around a large mass or curved space would increase the gravitational attraction of that object to allow celestial bodies to cover the same areas within the same time in an elliptical orbit. The GR theory of Einstein could also be explained through a simple tarp and ball diagram. If a tarp covered a large surface and a bowling ball was placed in its center, the ball would curve the tarp such that smaller balls would be attracted to the

larger balls more due to the curvature of the tarp. Currently, GR of Einstein is currently accepted as the best explanation of the gravitational field, even beyond Newton's approach, and has been applicable in gravitational lensing, gravitational radiation, black holes, expansion of universe and the observed red and blueshifts of space. It should be noted that GR is a classical theory, or a theory that breaks down when applied at a microscopic model. On the other hand, Quantum theory is not a classical theory and focuses on the microscopic level. To illustrate this concept, Thiemann adopts a kinematic approach. In classical theory, trajectory, position and velocity can be explained and quantified while in microscopic levels, this all fails.

Quantum theory rationalizes the movement of particles aligning with Heisenberg's uncertainty obstruction theory which basically allows for probabilities of the position of a particle instead of definite values. In macro level, this may not apply since the small particles all add up and each probability balances out, similar to a line of best fit pattern that has been repeated many times. As it stands, QT is the best probability theory that explains particle physics and has been verified in many experiments involving high precision particles.

Thiemann invokes research of energy accelerators as proof to the precision of QT. As mentioned before, while GR is a classical theory and geometric theory and QT is not, to construct the desired QFT requires an immense amount of math with finding asymmetry between gravitational forces at macroscopic levels with non gravitational interactions at the micro level. Much of Thiemann's prior work explained in For Canon Quantization of Gravity within Ashtekar Formalism and Modern Canonical Quantum General

Relativity deals with approaching this asymmetry and attempting to quantify concepts that have puzzled physicists for 70 years. It should be noted that in the latter book, from a brief read, Thiemann does offer valuable answers to some of the mathematical formulations behind Einstein's theory with Quantum Theory, like approaching the aspect of classical theory with Lagrangian formalism and his own formula where Euler's estimation strategy couples with Einstein's notation techniques. The task at hand for many physicists in this field is that Gravity is paired up with matter in such a way that gravitational theories are explained and applied to matter through a geometry model but falls apart at micro levels. Yet, since gravity acts on all matter, gravity exists in a vacuum and at micro levels, a concept that has yet to be accurately quantified. In terms of Thiemann's mathematical works, to use classical theory of gravity and to explain gravity in a vacuum, one must use expectation values and certain vectors since the choice of the vacuum for analysis focuses more on classical geometry than a conceptual approach.

This however is yet to be proven in situations of particle physics outside a vacuum and anywhere in space. In Mathematical Formulation of the Quantum Einstein Equations, Thiemann describes General Relativity as a theory that predicts its own failure. One such instance could be observed in the life of a star where the entire matter is often compressed into a small volume where no force would prevent its collapse to a single point- this is only explained by casuality where the curvature of space allows for light to enter the center. In contrast, if everything did collapse into the center this would be singularity and in this instance, both matter and energy becomes

infinite. Which is why, when quantifying equations for this concept, one must quantify infinity. Works of other physicists beyond Thiemann, like Penrose and Hawking, have devoted most of their times to explain total gravitational collapse in terms of predictions of GR. Yet, as physicists have attempted for 70 years, equations can not help explain GR since they become meaningless when dealing with infinity.

The concept of QFT is never exact. In terms of accelerators from Thiemann's experiments, QFT offered precise predictions yet the question of " why" is not answerable by current physics. The reason for this is that the theory of Minkowski Space invokes multiple mathematical theories for non-interacting fields in space yet to include concepts of Quantum field theory into this, we invoke the perturbation theory, mentioned prior. When doing so, we conflict with perturbative theories in other areas like one called the Gell- Mann and Low theory. When combining one mathematical approach to QFT, we risk destroying established theories in this field from the past by data that does not make sense and can not be explained currently. Thiemann, in his work, uses methods to circle around this problem, like through renormalisation procedures where infinity is removed yet this still interferes with perturbative theories since we leave out the most important variable in the equation-infinity. Quantum field theory currently violates the principles of General Relativity. As Thiemann approaches this field in his current work, he notes that a simple method would be to use perturbative methods of QFT to expand the variables and metrics for a description of GR.

However, some problems of this is that this approach is a linear approach while GR is not and the concept of Planck area through the geometrical

analysis of GR includes negative mass. Research in the field offers an advanced algebraic formulation of combining these two theories which includes hyperbolic spacetimes as a framework. This, as Thiemann describes, is valid but since QFT relies on classical theories and metrics in certain instances, when these concepts are deprived the entire theory is destroyed.

When quantifying gravity, the classical metric breaks down at the microscopic and fundamental levels which further complicated QFT since that relies heaving on background variables and set metrics. Thus, Thiemann's work includes that GR and QFT is currently incompatible until further strides in mathematics of physics is made. Currently, he attempts to generalize principles of QFT to explain the background independence of GR. At his current University Erlangen, Thiemann's approaches to Quantum Gravity have never been successful. This is primarily because including gravity at the microscopic level relies on quantifying multiple infinities and analyzing something that can't be explained by mathematics.

Currently, he focuses on promising candidate theories involving non perturbative methods and background independent methods, or methods that do not directly include unknown variables and also does not disturb background knowledge. He emphasizes how his current work involves canonical and path integrals formulations of GR theories along with a promising theory from Loop Quantum Gravity Ansatz Theory. His work involves using these theories and combining them with formulations by a theory called the Yang-Mills theory (both these theories involve quantifying behaviors in particle physics). Yet, when using these theories, Thiemann has

to maneuver around certain limits and constraints like the Gauss constraint, which is inevitable because of spacetime morphing (observed in the tarp shaped curve). Thiemann also explains that in order to approach this complex problem, new mathematical methods must be made to analyze create QFT in respect to GR.

While this field may seem hopeless, currently, the future may reveal promising research prospects in quantum gravity: astrophysics, cosmology, gravitational wave physics. It should be noted that modern cosmology became a precise discipline from multiple research experiments and can be quantified from satellite data. While it remains precise experimentally, the hopes of QFT seems bleak but the applications of this theory are vast.

The concept of Quantum Gravity theories may relate back to the fundamental regents concept of the standard model and the forces of the universe. There are four fundamental forces in the universe that are observed which are strong nuclear force, electromagnetic force, weak force and gravitational force with gravitational force being the weakest in the list and strong nuclear force as the strongest force. In terms of the standard model, this model categorizes sub-atomic structure to better understand matter and this development began in the late 1960s. Forces factor into the standard model when all fundamental forces act on hadrons while strong nuclear forces do not act on leptons (only affected by the other three forces including gravity).

Despite the forces on hadrons and leptons, the similarity is that gravitational forces act on both hadrons and leptons. In the sub-atomic level, gravity still

acts but observed phenomenon like definitive values for macro objects, like a position's trajectory, can not be found in micro level. Thus, the concept of QFT is involved in this case. For the standard model, planck limits and parameters are often considered since energies above the Planck scale allows gravity to influence as a variable. The concept of quantum geometrodynamics, or QFT, is heavily developed through Thiemann's life research with his attempt at unravelling the math behind such a theory. If possible, this theory would finally unite QFT into higher energy models, and particle physics in general, to ultimately expand our knowledge on the standard model.

QFT could also be incorporated in space-time, like in Kepler's laws as mentioned before, and the concept of the Big Bang Theory as well as blueshifts and redshifts. By including gravity in particle physics, an entire foundation will be renovated that will ultimately revolutionize our understanding of physics. Despite his extensive educational background in quantum physics, Thomas Thiemann has not been awarded any major awards or honors. However, he has been nominated for the Bonstein Prize for his work on Quantum gravity. If there's any way to summarize his work, it's that the concept itself seems impossible to counter with the current known knowledge of math and physics. There exists too many limits and many variables that exists, including negative mass from Planck's limits and infinity. Thiemann's major works involve translating and uncovering the math behind marrying GR to QT to make QFT.

His work, as described throughout the paper, builds upon current knowledge derived from Einstein's formulations and other theories. Yet, similar to how

Newton invented calculus for physics, our generation requires an innovative mind, or minds, to discover new mathematical approaches to account for new theories in modern physics. Thiemann's work will definitely serve as a foundational step to this, yet it is a small step to overcome this obstacle of combining two theories. But, if created, the QFT has potential to entirely revolutionize how we view physics, from the structure of space and time to the origin of the universe.