Principles of local realism in a Friedmann universe

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Abstract

The problem of time is a statement of the inability to establish the standard model according to a consistent physical framework based on a valid starting point provided from either the concept of time in quantum mechanics (QM) or general relativity (GR). Using the deterministic local realism approach of Bell's inequality experiment, a valid mathematical starting point incorporating both QM and GR can be established using the concept of energy conservation within a volume of spacetime. Because Friedmann established a system that correlates the energy level within the volume of spacetime with the proximity between energy mass, with two opposing universal forces that must act on the reconfiguration of particles when considering a realism-based definite position as they evolve in time independent of observation, it is possible to consider QM time evolution as a form of deterministic thermodynamic work. Considering this volume of spacetime in terms of the local realism interpretation allows one to consider the act of time evolution as a reconfiguration that occurs along with the expansion of volume which allows one to establish an energy conservation argument using only the particles that exist within the volume of spacetime to account for both the gravitational energy and the divergent energy usually attributed to the cosmological constant. With this argument time evolution must cost system energy. For energy to be conserved the use of system energy must be for the act of gravitation as a particle evolves in time. The definition of local realism allows Minkowski spacetime diagrams to pertain to the unseen intervals between measurements. This allows a center frame observer to serve as a background clock to measure time rates in correlation to scale factor expansion. This allows one to consider time rates in terms of work that must occur over an interval of a background clock. In the case of local realism, Minkowski mathematics allow a direct correlation between QM time evolution and the second Friedmann equation.

Introduction

A key problem in any attempt to formalize a theory of quantum gravity is the problem of time. How does a time variable with its special properties in relation to the probability interpretation of quantum mechanics (QM) emerge? The basic problem in answering this question is the incompatibility of QM and general relativity (GR) when considering the concept of time. Without a valid system based on a valid starting point, how can one identify the definition of time?

In QM, the time evolution is described by the Schrödinger equation. The time parameter used in the equation is a background time parameter. When time evolves, it steadily evolves in a fixed manner. A measurement is recorded at one of these fixed times. In relativity, time and space are four-dimensional spacetime manifolds. In both GR and special relativity (SR), a moment of time corresponds to a single spacelike hypersurface in spacetime. Time itself is a parameter that labels the elements of a one parameter foliation on this hyperplane. Placing these labeled hyperplanes together fills the entire spacetime. The difference between SR and GR is that these hyperplanes are curved in GR. In SR, the focus is on hyperplanes and how they are mapped into each other by actions of the Poincare group. The concept is that its gradient everywhere is timelike, and all its level sets are spacelike. In SR, if all admissible families give the same physical answers, then one can make this system sensibly work. In GR, a moment of time corresponds to a spacelike hyperplane if the vectors tangent to each point of the surface are spacelike. To attempt to map GR to SR and QM, it is necessary to use infinitesimal transformations of the Lorentz metric to link the two together with this foliation. When a moment of time takes place, the Lorentzian tangent vector must be spacelike with respect to the Minkowski metric of SR. When a connection does occur, a moment in time in GR points in the spacelike direction. When tracking these transformations that point in a spacelike direction in an attempt to match the background parameter of SR, none can be observed in some cases. Topological obstructions prevent tangent vectors from pointing in the spacelike direction, and the calculation of evolution according to a background parameter is impossible. Of those that are possible, they cannot all be counted. Those that are possible each have an independent definition of time. On the one hand, the evolution of time for QM occurs for privileged SR spacelike surfaces with a background time. On the other hand, general covariance exists in GR, which states that no one set of spacelike surfaces has privilege as a reference system over the others. Creating a system from a foundation of variable time rates without the ability to establish any one of these time rates with any form of significance makes it impossible to sensibly use any particular time rate as a starting point to construct a system. Attempting to use the foundation of QM theory allows only postmeasurement analysis based on the probability construct of the uncertainty principle, UP, to create a classical system. Defining a lightlike, spacelike and timelike separation on a curved hyperplane to establish a system based on this uncertainty is impossible. (1)

From either perspective, a valid starting point to build a system based on the foundation of GR or QM is impossible.

This is not the complete picture when considering the problem of time; there is also the issue of unseen intervals between measurements.

The foundation of the standard model is based on QFT. (2) When considering the post measurement analysis of the observables of QM according to QFT, the Born rule dictates the mathematics and establishes that observation is according to probability. (3) The Copenhagen interpretation is a widely accepted interpretation of postmeasurement analysis according to the mathematics introduced by Born. (4) This is because this interpretation is found to be supported by Bell's inequality experiment. (5) The Copenhagen interpretation implies that the emergence of particles comes from a place that is not real. In this interpretation, any variety of outcomes emerge during observation from a multitude of possibilities, where none of these are real in the sense that they will correlate to what seems to randomly emerge upon observation.

Time evolution in QFT uses a Lagrangian, and the probability construct of harmonic oscillators established on the tenants of the Copenhagen interpretation not only predicts infinite energy when time evolves but also allows infinite energy to arise from observation. (6) QFT predicts infinite energy and is wrong in its prediction. (7) This means that QFT must be wrong on some level as well if it cannot properly model a spacetime that emerges in reality upon observation.

In a QFT based on the foundation of the Copenhagen interpretation, infinite energy is allowed as time evolves because it was never real from where the classical world emerged. It would be impossible to argue otherwise, when the virtual particles of the wavefunction that support using the UP to evolve harmonic oscillators of each field show themselves to exist in spontaneous emission, the Lamb shift and the Casimir effect, while these observations correspond to what the Copenhagen interpretation tells you, that the observation that you see are from a place that is not real, and that is why you will not know what will arise, and that is why infinite energy must arise upon observation.

From this analysis of how this foundation for QFT pertains to the problem of time, it becomes clear that the resolution to the problem of time could come by creating a system that would define particles in a different manner than QFT and establishing the foundation of this system on an interpretation of post measurement that differs from Copenhagen. This would allow the energy to come from somewhere when an observer collapses the wavefunction and could allow a starting point of a system from this perspective to allow the definition for time to be established.

An alternative interpretation that produces the experimental results of Bell's experiment allows one to consider the unseen hidden variables between measurements in terms of local realism. (8) The deterministic local realism interpretation considers the concept of

wavefunction collapse as invertible post measurement analysis of a deterministic function so that a particle that emerges upon observation did not emerge influenced at the moment of observation from an observer effect that caused a wavefunction collapse. When considering the term “local”, the term implies that a particle has a definite place in spacetime in the unseen intervals between measurement. The term “realism” is an interpretation that the unseen hidden variables exist independently of ourselves.

Starting the process to establish a system from a foundation from an alternative approach to the Copenhagen interpretation to create a valid starting point to resolve the problem of time involves considering the issues involved with merging the GR and QM constructs as only attempts to establish a system. From this perspective, the QM and GR constructs were the tools one set out to use to define a system to in turn define time, and these tools failed to provide this context. This alternative approach using determinism does not mean that the constructs of QM and GR are not valid, which means that a deterministic system based on deterministic hidden variables may provide the answers one sought after with the traditional tools and become the starting point itself.

Albert Einstein insisted on this kind of objective reality that would pertain to the unseen intervals between measurement. (9) He tried and failed to develop a theory based on the concept of local realism. The reality of post measurement analysis provided the opportunity that Einstein used to attempt to establish a theory of local realism.

Einstein believed that there may be a missing theoretical construct hidden in the intervals between measurements that could have been overlooked and that could lead to the observations that occur in QM experiment.

Because of this belief, he sought to prove the possibility that this nature pertains to the unseen. In 1935, Einstein, Rosen and Podolsky wrote a paper regarding quantum entanglement stating that a theory based on local realism was possible. (10) By using a quantum entanglement experiment to establish that entangled particles share local position and momentum in the unseen intervals between measurement, the paper argued that this would imply that it would be possible to establish a QM theory in terms of local realism.

In a response in the same journal in the same year, it was Niels Bohr who insisted that it was meaningless to assign reality to the universe in the absence of observation. (11)

As previously mentioned, John Stewart Bell proposed conducting an experiment that would resolve the debate. His experiment involved the measurement of one particle of an entangled particle pair post creation to determine whether post measurement of one particle could in fact redetermine the outcome of the other particle pair post creation.

Bell's experiment is able to determine this because entangled particle pairs have the feature of opposing spin, and the property that spin will be correlated to the axis of the measurement device. From this knowledge, it could be determined whether measurement

of the spin of one of the entangled particles would affect the probability distribution of the second entangled pair post creation.

It was postulated that if the observer effect post creation does somehow affect the particle pair, then the concept that the particles evolved according to local realism from creation until observation was violated because this means the particle pair was somehow affected post creation and did not hold inherent values despite the functions enacted on the other particle.

It was determined that measurements on one particle did affect the outcome of the particle pair post creation.

When measuring one particle post creation influenced the second particle probability distribution, Niels Bohr interpreted this to mean that the hidden variable theory was proven to be invalid. This in turn would mean that the possibility that local realism could pertain to the unseen intervals between measurements was proven to be invalid.

This was taken to mean that the Copenhagen interpretation was correct and that the collapse of the wavefunction from the interval between measurements was from a place not real.

To Niels Bohr and John Bell, this post creation influence proved that EPR was an invalid premise, yet while it is true that post creation influence affected the particle, the concept of local realism was not completely invalidated from Bell's experiment. There could exist an equally valid description of Bell's experiment based on local realism.

In a BBC radio interview in 1985, Bell himself provided an alternative that allows local realism to coexist with the experimental results of Bell's experiment, superdeterminism. (12)

Realistic interpretation requires determinism to dictate the evolution of the particle so that a post measurement observation does not affect the particle post creation. If one considers that two predetermined events are correlated as if they both simultaneously exist, then consider that the universe will unfold in sequence from beginning to end, the concept of superdeterminism, must attribute the interaction between the two preexisting events in terms of the sequential nature of reality, so that the future observations act on the pair creation in its past, must be considered a property of spacetime that equates future observation to immediate observation.

The particles could have evolved in the unseen intervals between measurement according to deterministic realism with this form of post creation influence on particle pair creation. When the particles arise and are seemingly affected post creation, they have truly been evolving according to how they were measured upon observation in the future as they have been since the moment they were created.

The concept that deterministic local realism dictates the outcome of Bell's experiment is on equal footing to the Copenhagen interpretation assuming that both explanations provide an adequate explanation for what one has observed to occur.

While local realism could exist in terms of a deterministic reality, Einstein did not provide a theory based on determinism so that one could sensibly speak of such a concept regarding the unseen intervals between measurement. While his EPR premise was not accepted by Niels Bohr, it was the fact that this premise was not utilized to establish a theory that could provide the results for Bell's experiment in terms of determinism that Einstein's EPR premise has been put aside in favor of the Copenhagen interpretation.

When considering the concept of post measurement analysis in terms of deterministic local realism, the observation of a quantum particle is an invertible deterministic event that correlates to the unobserved deterministic evolution of the Schrödinger equation. The theory of thermodynamic determinism (TD) is based on a definition of the system, as it must exist in terms of deterministic local realism to produce the results of Bell's experiment. This involves extending the concept of realism, with the concept that reality in the unseen intervals between measurements obeys the same laws of physics that the observed world does, so that what transpires in the unseen intervals between measurements seamlessly corresponds to the laws of physics in the observed reality that are presumed to dictate the particles that emerge in the results of Bell's experiment.

Theoretical physics can involve using what cannot be seen to understand what can be seen so that what cannot be seen is established with the correlation between the observed and unobserved. No one has seen a virtual particle, yet what cannot be seen can be established by what can be seen when the virtual particle that cannot be seen acts on the real particle in the QM experiment. TD establishes what cannot be seen based on what must exist to produce the results of Bell's experiment that can be seen.

Because of the loophole in Bell's theorem, superdeterminism, TD uses the interpretation of deterministic local realism to attain the locality to build a physical framework in the unseen intervals between measurements to use it to find a definition for time.

Defining system

The mass of the universe in the context of GR loses energy as the scale factor expands. (13) In this context, realism implies that the finite mass of GR that does emerge from the unseen upon observation does so from hidden variables that have a perfectly conserved energy level in the unseen intervals between measurement that correspond to the scale factor that dictates the mass of GR.

In relativity, time dilation is a function of energy level, as differing rates of time are observed to be correlated with differing energy levels of the same amount of mass. (14) The concept that the time rate changes as energy changes is one that is usually attributed to gravitational potential or acceleration that has affected two similar masses so that one can identify the

effect of the time rate between the two masses as it differs from the effect that changes the energy level. In TD, this concept is applied in the context that the mass of the universe decreases the energy level and changes the time rates as the universal volume of spacetime expands.

The concept that an expansion of spacetime began to occur from a zero-volume state is typical to explain observations of the CMB that imply a so-called big bang expansion scenario. (15)

While the classical world emerges from unobserved energy in a probabilistic way, the energy that is observed must have arisen at a particular energy level based on an expansion that started from a zero-volume state. Because the time rates must correlate to the energy of the stress energy tensor as the volume of space expands according to Friedmann's equations, this means that a system exists in the unseen intervals between measurements that behave according to the properties of spacetime given context by a Minkowski spacetime diagram.

QFT models the energy distributed throughout spacetime according to a scalar field that evolves according to a Lagrangian. (16) The theory of cosmic inflation defines the energy value of the scalar field in terms of volume. (17) In TD, the energy within this scalar field is distributed in a homogenous and isotropic distribution and is used to describe the energy level of the mass within this scalar field in terms of volume.

The energy density of mass within a particular volume can be correlated to the proximity between masses within the universal scalar field as the energy value changes from volume expansion. This is because according to Friedmann, the expansion causes the proximity between the mass to expand between points of mass within the volume in a homogenous and isotropic manner. (18) When considering the universe on a global scale, it is the volume of the scalar field that is the determining factor in its energy value, while the proximity between mass corresponds to the measure of the energy value.

According to the local realism interpretation, as the unseen Hamiltonian evolves, the act of time evolution is in terms of a definite point of energy within the scalar field that reconfigures to a new definite point within the scalar field as it evolves in time.

In this context, according to Friedmann, the placement of energy as it evolved in time is dictated by the values of energy density of both the convergence and divergence forces that have acted on the time interval as it reconfigures, and the values of either opposing force is determined by the scale factor. (19)

The final placement of the energy as it evolves in time is in terms of the energy level it has maintained as the two forces competed on its placement. The placement of the particle must be in a location within the homogenous and isotropic distribution that represents its change in energy, which corresponds to the forces acting on it as the universe simultaneously converges and diverges.

As a particle reconfigures as it evolves in time within the volume of the scalar field, the force on the particles that converges is a function that adds energy to the scalar field, while the force that acts to diverge spacetime is a function that acts to diminish the energy, so that the change in energy of the system must be correlated to the placement of the particle according to

$$E_2 - E_1 = Q - W$$

The value of Q is determined by the force of gravitation, with a convergent act that is valued based on its potential to increase the energy level over the interval toward a greater energy density. (20) To date, the value of the divergent force of expansion W is assumed to be based on a constant of energy that exists within the system referred to as the cosmological constant. This value increases in proportion to the volume. (21)

The value of Q over an interval of time slows the effect of expansion on the placement of the particle during an evolution of time. If gravitation negates the value of divergence during reconfiguration, the value of divergence is equal to the change in volume that does occur, plus the value of Q . The particle is moved in spacetime by a net energy loss from expansion.

When considering the Twins paradox scenario, one considers the concept that increasing energy from the acceleration of one mass of a pair of identical masses causes the time rate to decrease for the accelerating mass. While time is slower, the acceleration is relatively faster, and the twins are able to meet again in space. (22) This deviation from a shared time rate can be measured using a Minkowski spacetime diagram. (23)

The concept of realism allows the concept that a QM function occurs and evolves at a set time rate in the unobserved intervals between measurements. Theoretically, calculating the rate at which this occurs is not impeded with the concept of the UP. Because the time rates of mass increase in perfect correlation to the volume increase of the universe, using a set energy level as the center frame observer of a Minkowski spacetime diagram to track the time rates that increase as the volume expands enables one to theoretically correlate the time functions that do occur within the system to the energy loss that occurs as the expansion of volume occurs over the time interval of the set energy level at the center frame.

When applying the concept of deterministic local realism to the unseen intervals between measurements, the mathematics of GR and QM are incorporated into a single physical framework when the time functions and volume are correlated with the mathematics of Minkowski spacetime over the interval of a background clock.

Defining time

Defining time involves merging the two concepts established by interpreting Friedmann's universe according to the deterministic local realism interpretation to

establish the necessary parameters for an energy conservation argument. The first concept was that energy conservation of the systems mass-energy is correlated to the placement of a particle, so that as it evolves in time, the opposing forces of Friedmann's equation act on the particle as it reconfigures to place it into a configuration that is in terms of how much change in energy in the system has occurred. The second concept was the fact that a background clock could mathematically calculate time rates in correlation to changes in volume.

The mass energy of the universe is distributed in a homogenous and isotropic way correlated to volume, while volume is correlated to the value of the internal energy so that

$$E = E_f V,$$

where E is the internal energy, E_f is the mass energy in terms of the proximity between energy distributions within the volume and V is the volume of spacetime.

The classical zeroth law of thermodynamics establishes a measure of thermal equilibrium so that this can lead to a large-scale definition of temperature. In classical thermodynamics, the zeroth law establishes that temperature A is at thermal equilibrium with temperature B and that if temperature C is at thermal equilibrium with B , then it is at thermal equilibrium with temperature A . (24)

Defining the value of energy of both a particle position in the system and the system as a whole in terms of the system volume allows one to consider the position in terms of temperature analogous to the zeroth law. Temperature A or B would be in terms of scale that is in correlation to the proximity between mass that is distributed in a homogenous and isotropic way.

When convergence occurs, the mass could achieve a higher temperature value because this potential position exists within the volume of spacetime. Alternatively, when divergence occurs, the new position is a new temperature value of both the particle and the system.

When the volume expands, the values of temperature and internal energy must change in correspondence so that

$$dE = E_f dV,$$

where the change in internal energy must occur along with the change in particle position in correlation to the change in volume.

When considering that opposing forces act on the structure, any change to the placement of the particle or the volume is in terms of heat added minus heat lost, which directly corresponds to the value of the internal energy of the system. This is because the act to converge or diverge is to add or remove proximity between the energy mass.

The fact that the change in energy of the system is in terms of heat addition or heat loss is an exact analogy to the energy conservation laws that dictate the change in energy of the classical first law of thermodynamics.

The classical first law of thermodynamics establishes that any change to the internal energy of a system is defined by:

$$E_2 - E_1 = Q - W,$$

where the internal energy of one volume changing to another is equal to the heat added to system Q minus the heat subtracted from system W . (25)

Alan Guth used an energy conservation argument to consider energy density within a volume of spacetime to establish that energy could arise in the system for free using the systems repulsive gravitational field as the energy source. (26)

Cosmic inflation established that it was necessary for the internal energy of the system to provide the energy for any addition of energy to the system. When energy cannot fall as the volume expands, introducing energy must come from the source that causes the expansion of volume to begin with. The fact that internal energy must be used for an act of energy addition as volume expands in order to conserve energy as the system evolves implies that the internal energy of the system is seen as a measure of usefulness to do work and that the pressure acts out the transfer of energy into the form of additional energy into the system.

Alan Guth's argument uses an expansion that already occurs as a property of spacetime, the force of the repulsive gravitational field of the inflaton field, to provide the source of pressure that enacts out an addition of energy as it expands the volume of the universe.

The energetic system in TD is not considered to have a repulsive gravitational field that acts out the expansion of the universe using an energetic source that one can attribute a repulsive gravitational field in correlation with. The volume only contains an energy mass that has a gravitational field.

When considering that energy does fall as the volume of spacetime expands in the Friedmann universe, if one imagines that volume has increased, a particle changes its definite position in terms of the pressure of volume expansion. If the act of pressure must use system energy, the reconfiguration that is acted on by the pressure of the system must be considered a function that costs system energy.

The pressure must have transferred internal energy of the system into the form of movement that acted out the index of the systems own energy loss. Because internal energy was transferred into movement, it must be considered the work of the system. The system internal energy must be considered in terms of its usefulness to do work.

To maintain conservation of energy in a Friedmann universe, the system must use its own internal energy to supply the energy for the pressure that acts to expand and reconfigure the particles so that

$$P=E$$

where P is the force of the expansion of the universe and E is internal energy that must be the energy source of the pressure of expansion. This does not mean that internal energy caused the pressure of expansion, only that it must be the source of energy for the expansion.

While it can be argued that the reconfiguration of a particle acted on by divergence is work of the system, it would be impossible to attribute this function to the cause of the energy loss. If the pressure function that acts on reconfiguration is the loss of usefulness to do work, but the reconfiguration cannot be said to have initiated the use of system energy in its reconfiguration, because the reconfiguration only acts when it uses the energy of the energy loss in the first place, then the use of energy that is the cause of both the pressure and the work that used the energy in its reconfiguration must have been used by a separate act that occurs in the system that used the energy itself and initiated the functions of expansion that occurs. When considering that the internal energy must be considered in terms of its usefulness to do work and that volume expansion occurs, the internal energy lost from expansion must have used the energy for an act in the system if the system internal energy or usefulness to do work is conserved. Therefore, there needs to be a source of energy use that occurs to allow expansion to occur without violating energy conservation. This source of energy use allows the work of the system to index the energy

loss that is occurring from this energy using action in the system. Because the internal energy of the system is conserved into pressure while expansion cannot have been what initiated the energy use, the pressure of the Friedmann universe must be an index of energy use of some alternate function that occurs in the universe, versus a function of a repulsive gravitational field.

Defining the source of energy use

Particle reconfiguration occurs with both opposing forces acting on its placement according to $E_1 - E_2 = Q - W$. The act of a change in volume means that the energy use of work overpowered a convergent function that did occur. With a local realism-based definite position, this convergent function must be viewed as a function that is the attempt at a position that is of greater energy, and this value that it could achieve by change in position is the value that negates the change in volume that occurs. Heat flows between temperature differences in classical thermodynamics. (27) This act must be considered as a form of heat flow of the system; it was the attempt to achieve thermal equilibrium with a possible configuration that is in terms of a different temperature when it makes a move toward the zero-volume state. The value of convergence that does occur is overpowered by the act of expansion that eliminates any increase in internal energy that could have occurred.

For the usefulness of energy to be conserved as the volume increases, the system must act in some way that is the cause of its energy use. Because there are only two forces in the system, and the action of divergence cannot be an action that initiates energy loss, this act of heat flow can and must have cost system energy in order for expansion to occur in a way that is in accordance with energy conservation.

An analogy to the second law of thermodynamics ensures that energy use as heat flow occurs is used by the reconfigurations of expansion that have already been identified as work.

The classical second law of thermodynamics states that entropy must always remain the same or rise after any entropic transformation of the system. (28)

Because any reconfiguration acts to converge proximity with other masses, it must evolve toward this temperature difference as if it is attempting to restore the zero-volume state. Because it can be said that this form of heat flow requires system energy to attempt to achieve thermal equilibrium, the cost of this attempt will require system energy, which makes it impossible for energy to ever rise to the maximum temperature value. In every reconfiguration, the universe will expand more than it will ever converge. This means that a potential configuration will always exist that will move energy and cost system energy without any hope that equilibrium with a zero-volume configuration will ever be achieved. Because of this one would say that energy could never increase, it could only stay the same or diminish.

Considering that energy cannot increase, but an attempt must occur in order for the usefulness of internal energy to be consumed, when calculating change in volume using $E_1 - E_2 = Q - W$, the value of energy increase Q , is overpowered by the cost that this act must incur of the systems internal energy W , resulting in a net energy decrease that then results in expansion. This implies that the heat flow of convergence acts as a negative pressure when it uses the energy of the system. By using energy, heat flow allows the loss of usefulness to occur in a manner that allows convergence to be seen as a force that pulls the piston in a manner consistent with energy conservation. This force then dispels system energy into the work of divergence that then indexes the systems own increase in entropy using the systems own internal energy.

Now that time evolution can be identified as the initiation of the use of system energy, the act of reconfiguration can be considered a source of $-P$ that acts as a suction on the piston of the universe. The time functions that occur in the universe over the interval of a background clock must correlate to the expansion rate because any time evolution is a use of energy that translates into expansion of volume.

Because a change in the internal energy of the system means a change in the time rate, a change in the value of the negative pressure increases as the volume increases so that

$$dW = -PdV = EfdV$$

As volume increases, values of work increase compared to the original value, so that more work over that same interval of time occurs and energy is used at a greater percentage. This change in W is the change in the amount of $-P$. This measure over an interval of the background clock allows one to find the pressure of the work that occurs within the system

that acts to increase the volume of the universe. This is the use of the second mathematical concept allowed by the deterministic realism interpretation. Its use is to provide meaning to differing expansion rates as volume expands by comparing differences over a time interval that remains at a set rate. When considering that the value of gravitation is in terms of the scale factor, one can derive

Friedmann's second equation over the intervals of the set background clock using a Minkowski spacetime diagram.

The final classical thermodynamic law to be mentioned is also analogous to the mechanics of the TD piston. The classical third law of classical thermodynamics states that the entropy of a closed system at thermal equilibrium approaches a constant value as the temperature approaches absolute zero. (29)

The universe's heat potential or usefulness to do work was at its maximum potential at zero volume, and thus, the universe had zero entropy early on. Any measure of a nonzero volume is a measure of entropy that has increased. Maximum entropy in the universe is a state where there is no longer any system energy to conserve into work. There cannot be any change in volume without temperature because there cannot be any energy that will be used to achieve such a task. At this point, internal energy will be completely used and will not be able to change the value of entropy because it would be impossible to use energy that would increase the volume of spacetime.

Defining QM experiment

In a system that has preset conditions of energy that have been set into motion using energy for work according to set values based on the energy level of the system, all movement and outcome in the system has been set into motion in a deterministic manner until all internal energy is conserved into outcome.

Every event has had deterministic origin from the preset conditions of the universe even if these events are set into motion from the other effects that must occur as time itself evolves. This means that every event that occurs is deterministic with outcomes predetermined by preset conditions, including the event of the physical act of observation.

The development of the physical framework of the TD piston allows one to interpret the influence of delayed observation in terms of this energy conservation as this system evolves. The concept that an observer's effect post creation of the entangled pairs acts on the particles at the moment that they are created has already been established as a property of spacetime when considering the deterministic local realism interpretation. This concept that delayed observation is equal to immediate observation is consistent with the experimental results of the delayed choice experiment. (30)

The observer action that occurs when an observer views an experiment, either immediately or in a delayed manner, must be a function that occurs in terms of the systems energy conservation of internal energy into work.

When considering the dual slit experiment, the outcomes that are observed to occur upon observation are based on the observer effect that imposes this observer action at the moment an event occurs or in a delayed fashion. In either Bell's experiment or the dual slit experiment, this observer effect must have imposed restrictions on the possibilities that work can evolve according to in terms of acting on the experiment in a way that affects the wavefunction that energy will evolve and move in spacetime according to.

In the case of the dual slit experiment, the observer effect will be one that has acted on how the real energy of work will evolve until observed again, based on whether observation has occurred or not. The wavefunction must be seen as guiding the evolution of particles in the unseen intervals according to what observation will impose on what could occur so that what possibilities exist in the future act on the outcomes as they go on to occur based on whether observation has occurred.

When considering Bell's experiment, the action of measurement imposes the action that forces the particle to evolve according to the spin necessary in the unseen based on the future measurement until observed.

The system evolves using internal energy to move the energy of the system to new locations. Because one particle is moved according to one use of the systems energy, there cannot be two places to which a particle evolves at once. In the unobserved dual slit experiment, there is only one particle that continues past the dual slits, and the possibility that the particle has passed through both slits in the future must be considered as both an evolution according to energy conservation and an inclusion into the experiment, a factor that will act on the wavefunction. This factor will interfere with the real work that will occur according to energy conservation. The factor that influenced the work that did occur according to energy conservation must have been a possibility that energy could have been violated, so that while in actuality it was not, the real work of the particle was acted on by the second virtual particle as if it was now able to because of the possibility that it could have existed. This possibility that existed acted to interfere with the outcome of real work, even though this possibility was a violation of energy conservation.

This possibility for an energy conservation violation is in terms of the system. The pattern of interference is observed to have affected the time evolution of the real particle as it evolved in the unseen intervals between measurement, based on the pattern multiple particles form when they hit the wall of the experiment.

The concept that a possibility that energy conservation could be violated, which then affects the placement of energy as it evolves, is a concept that is standard in QFT. Virtual particles that could have possibly occurred affected the plates of the Casimir effect experiment. (31)

In TD, because virtual energy violations were possible, they affected the outcome of the work of real energy. The TD system interprets the interference patterns that emerge from the unobserved dual slit experiment in the same way as it does when considering virtual particles acting on the outcome of real energy reconfiguring at the cost of system energy.

By using the system to define the observer effect function, one can interpret the observations according to the concept that an observer is eliminating the possibility of violations of energy conservation. This in turn sets the course for the particle to evolve into the unseen according to perfect energy conservation without interference, as opposed to the unobserved scenario. Observation eliminates the possibility that a particle could violate energy conservation, analogous to the elimination of possible wavelengths that could exist between plates of the Casimir effect when the plates are closer or further apart.

TD interprets the observation of the entangled particles of Bell's experiment according to a certain spin measure as an act by an observer that has acted on the wavefunction during the entangled pairs creation. This observation must have then dictated the possibilities that a particle could evolve according to within its wavefunction. In this experiment, it is not the energy conservation violation that has been eliminated by an observer but instead the property that an observation will impose an effect on spin that affects the particle pair. Immediately upon creation, the entangled particles evolve in time in the unseen intervals between measurement according to the required spin until observation by the measurer. In this scenario, the system requires Bell's inequalities to be violated because the observer imposes the effect on the particle the moment observation comes into contact with the particle.

The fact that future possible energy conservation violations act on real work as particles evolve in time into the future invites the possibility that this kind of interference from a virtual future particle is the cause of the function of particle convergence that must be seen as a form of heat flow.

While it must be said that the act of convergence will have the particle reconfigure toward a closer proximity to other mass in the future of its evolution, it could be said that the possibility of the future configuration of the particle acts on the particle as if there was a heat flow, because it was a different temperature, so that this temperature difference was what initiated the act of work to begin with.

According to Friedmann's equations, the outcome of reconfiguration was as if one temperature was attempting to achieve thermal equilibrium with the future possible configuration and over the reconfiguration succeeded. This must be true because the value of this success is one that negates the value of work.

When considering color confinement, the concept that possible temperature differences could act on the outcome of real work is analogous to how a virtual gluon acts on the work of a real particle as it evolves in time in terms of the virtual particle function of its charge.

(32) From this, it can be said that a particle will act as if this virtual possibility acted on the real particle in terms of its temperature difference, and the universe must behave as if this act cost internal energy of the system.

Origin of time

The process of deriving expansion rates over an interval of the background clock begins at the Quark epoch. This is the period of expansion that begins to occur directly following cosmic inflation. (33)

The expansion of the cosmic inflation paradigm is introduced when a statistical deviation of energy creates a false vacuum that cannot be reduced to the value of the true vacuum.

When the repulsive field of the energy that has arose pushes the volume of space, the fact that energy cannot decrease means that additional energy must come into the volume of spacetime at the expense of the energy of the repulsive field. The increase in the energetic value within the volume increases the value of its negative repulsive energy, causing more expansion that will only serve to add more of the energy with an increased value of the repulsive field.

The original deviation of energy had the inability to decrease as the volume expanded, and the energy was defined by its repulsive field that started the exponential expansion. An energy conservation argument implies that the energy comes from itself. As the volume expands, more energy is added, and more negative pressure from the increase in the value of the repulsive field means that more energy will be added to the system for free. (34)

The concept of time in the context of cosmic inflation is one that is based on the change of state, so that by a measure of the addition of energy to the system from the repulsive field, one can say that time has evolved, in the context that the system has changed.

The effect of cosmic inflation on the energy level is equivalent to a state that is as if the Quark epoch has evolved from a zero-volume state.

This cosmic inflation has created the recipe for work to begin. The result of the creation of energy that is at a reduced energy is in terms of energy density that is correlated to the volume as if it has expanded in a homogenous and isotropic manner. Inflation has created a system with energy at a sufficiently low energy to evolve in time. Inflation has also created the energy that can be used for the work of time. If time is work, then energy that does not have a time rate moves within space for free and is a form of internal energy that can be used for work. The newly introduced volume of space allows the possibility of a future higher energy configuration to exist for the action of heat flow to occur.

The flatness and horizon problem

The flatness problem is a statement of the need to explain why the universe evolves in a way that the flatness of spacetime is observed to have influenced the outcome of the propagating waves as they have traveled through space. These waves have propagated according to a flat universe. (35) Why does gravitation never halt or decrease expansion but instead allows an infinite increase in volume that will only stop at infinity? This question is one that assumes that competition exists between the two opposing forces.

By actively considering that work occurs according to perfect energy conservation starting from the specific preset conditions imposed by cosmic inflation, one can rephrase the question when seeking to find the correlation between gravitation and the force of divergence. When considering the persistent flatness of the curvature of spacetime as the scale factor increases, one can now ask the question in terms of the TD piston, instead of the competition scenario that formerly existed, so that one can now ask, why not a closed or open universe as work occurs?

The question is now a question about energy conservation as the TD piston evolves. The question is now why does a potential temperature difference within the wavefunction that causes the work of the system never decrease the change in volume or stop costing energy? The answer is obvious and there is not a problem. Energy conservation of work occurs, and the work costs energy, which was the cause of the volume increase. The flatness problem in terms of the Copenhagen interpretation was the problem of an ill-defined system, which left open questions about the meaning of the correlation between certain functions of the system that have obvious correlations in TD.

When considering the flatness problem in this light, when one asks the question in regard to the openness of the universe, the question is defined in a new context in this case as well. The original question is where one asks, why does the universe increase its scale factor, and the energy decrease of mass is never too great so that the mass that exists is too little after the scale factor increase, so that the outcomes of the propagating waves bend away from each other as they occur? This is again a misunderstanding of the systems energy conservation function, as internal energy is conserved into the outcome of work. To ask this in the context of TD, would be to ask, why is the outcome of work not affected by an undue decrease of mass during volume increase? Mass was only supposed to be lost from the use of work. Conversely, why did the volume increase occur more than a function of time used energy? This would force the loss of energy to occur greater than the work that has occurred. Decreasing the mass and allowing an open universe act of divergence to occur. Either way, one would be asking what would happen to the outcome of a propagating wave traveling in a straight line in a system formerly obeying the concept of perfect energy conservation that has now switched to one that is unduly losing energy. The answer is that any outcome would diverge if there were violations of perfect energy conservation as work occurred.

There are three possible scenarios where energy conservation could be violated, and in each of these scenarios, there is a way where the violation would result in either an open universe like influence on the result of the outcome of work, or conversely, the result of a closed universe like influence on the outcome of work.

The first scenario is where the volume increase does not occur according to $dE = EfdV$.

Any addition of volume increase would be beyond the work that has occurred and would give a result of an open universe effect on the outcome of work when it removes the energy of mass without the occurrence of work. Inversely, any subtraction of volume increase during the work results in an outcome of work that results in a closed universe. Any energy that would have formerly been lost with perfect energy conservation was not lost, which dictates that more gravitation acts on outcome than it should.

The second scenario where energy conservation could be violated is very similar to the first scenario. This time, instead of a deviation of the amount of volume increase, volume increase is what it should have been, and the amount of energy that resulted was not the amount that should have resulted. If there was more energy leftover after work than there should have been, then it would result in the effect of a closed universe, because there would be an excess of mass, compared to the correct amount of energy that there should have been based on perfect energy conservation. If the result was that there was too little mass, then the result would be of an open universe, where the outcomes of propagating waves would diverge.

The third scenario where energy conservation could be violated is one that focuses on the Q function as convergence occurs and how this is related to the placement of energy as time evolves based on the equation $E_1 - E_2 = Q - W$.

If the value of Q, calculated by the mathematics of GR, is greater than it should be, it would result in a closed universe. If it is less than it would result in the outcomes of an open universe.

Because the work of the TD piston is conserved perfectly into the volume expansion, the outcome of work will always travel in the straight lines as if this was the case.

The questions pertaining to the flatness of the universe were resolved by summarizing the questions as misunderstandings of the correlations that exist between functions of a thermodynamic system.

The next issue pertaining to the expansion of the universe is the observation of large-scale temperature uniformity across vast distances. This issue is the horizon problem. (36) This issue influenced the development of the Big Bang theory. Light could not travel fast enough between vast distances to explain the temperature equilibrium occurring. Subsequently, the Big Bang theory and the theory of cosmic inflation start out with universal expansion from a localized starting point.

Alan Guth's theory of cosmic inflation provides an answer for why there is a uniform temperature at the beginning of the quark epoch. The inflation that occurs is from a small patch of uniform temperature itself and allows the uniformity of the energy that has arisen within the volume of spacetime from the process of inflation. (37)

Conclusion

The resolution to the problem of time is sought after to provide the context to correctly interpret the structure of reality that dictates time evolution and the outcomes of quantum experiments. The main goal to resolve this problem is to define a system from a valid starting point that would allow one to define time. Issues with merging QM and GR pertaining to time do not allow a valid starting point from either theory to establish a system that would enable this.

The alternative interpretation of Bell's experiment based on deterministic local realism is on equal footing as the Copenhagen interpretation if the measure is defining a system capable of producing the results of the experiment.

The theory of TD is founded on the concept that deterministic local realism defined in terms of the volume of spacetime is a starting point to define the physical framework that correlates QM and GR.

It was found possible to implement the concept of deterministic local realism to construct two mathematical concepts that led to the ability to sensibly speak of an energy conservation argument using only the particles that exist within the volume of spacetime to account for both the gravitational energy and the divergent energy usually attributed to the cosmological constant.

The TD system must exist if one considers the deterministic local realism interpretation. TD is an alternative to the QFT of the Copenhagen interpretation in terms of its ability to produce the experimental results of Bell's experiment. The deterministic realism interpretation was found to be consistent with a form of thermodynamic determinism, when preset conditions result in what could be seen as heat flow that initiates the time evolution of the universe. This evolution according to perfect energy conservation allows one to reconsider the flatness problem as simply an exercise where one considers possible energy conservation violations.

The clarification that real energy evolves at the cost of work, while possible energy conservation violations do not cost energy to evolve, allows one to resolve the vacuum catastrophe. Instead of predicting the energy level of the universe by evolving a Lagrangian that includes every single possible energy conservation violation possible, one calculates the change in energy level in the universe in terms of the time rate associated with the energy level established by volume over the interval of the background clock set as the center frame observer of a Minkowski spacetime diagram.

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