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Derivation of new Generalized General Relativity and its cosmological model

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Abstract

Theoretical physics having two separate parts Special Relativity (SR) and General Relativity (GR).The reasons for this division is that Einstein presented special relativity in 1905, while general relativity published in 1916, second that special relativity in the world of microscopic physics and general relativity in the world of astrophysics and cosmology and third reason is that physicists accepted and understood special relativity and became a working tool for theorists, but for general relativity most of its applications were on astronomical scales and cosmological side.

***Keywords:** Cosmological model; Energy-momentum tensor; Isotropic*

Introduction

General relativity was considered a respectable subject not for physicists but for pure mathematicians and philosophers around 1960. It is be important in 1977 by Sir Arthur Eddington [1-3].

Einstein published papers on gravitation in 1912, he realized that the gravitational field equations were bound to be nonlinear, for example light has a uniform velocity since its path is curved by the presence of mass or energy. The general relativity asserts that space itself not just on object in space can be curved, and furthermore the space of general relativity has 3 space like dimensions and one time dimension [4].

Word general relativity comes from local inertial frame (arbitrary global frame) i.e. it is possible to transform our equations under general coordinate transformation which is called the principle of general covariance and general formed the law of special relativity to apply for space time [5,6].

The mathematics of tensor analysis and tensor calculus is truly the language of physics, after an introduction to the behavior of vector and tensor components under coordinate transformations in three-dimensional space. Four-vectors and four-tensors defined and their behavior under coordinate transformations in four dimensional space-time.

Research Problem

General relativity suffer from noticeable setbacks. It is a singular theory that suffer from horizons, stars evolution, flatness, entropy problems were solved by Generalized General Relativity (GGR) but unfortunately GGR suffer some weakness in its derivation.

Literature Review

The conditions of star equilibrium are discussed on the basis of the relation between pressure and gravity forces. The pressure expression was found first by using Gibbs and quantum laws. This leads to an equilibrium radius that depends on particle and mass density. The star explode on requires the energy to positive in this case thermal energy exceeds gravity potential. When the generalized special relativistic energy is negative contraction takes place when gravity energy exceeds the thermal one. Star equilibrium requires the radius to have critical value typical to that of black hole and the critical mass to be less than a certain critical temperature dependent mass.

In this work the generalized field equation was used to relate energy to momentum for radial and angular motion. This expression reduces to that of special relativity in free space. Using this relation beside the dual nature postulate a quantum gravity equation for static field was found. This equation shows that the energy is quantized. It also predicts the existence of gravitational waves and gravitons.

Using the expression of Lorentz force of the electron a useful expression for Lorentz transformation of the special relativity theory was found. The Lorentz transformation in a curved space which account for the effect of fields is also found. This relationship resembles that of generalized special relativity and reduces to that of Einstein special relativity in the absence of fields.

Using generalized special relativity together with Newton's laws of gravitation and treating particles as quantum strings a useful expression for self-energy was found. The critical radius of a star when particles are created is that of a black hole. The critical radius and mass are dependent on the speed of light and gravitational constant. For mass formation the radius and mass should be small which agrees with the fact that elementary particles have very small mass and radius. The formation should also take place at Planck time which also conforms with that proposed by big bang model.

Aim of the Work

The aim of the work is to derive perfect GGR that can be capable of snaring with GR and GGR their success by predicting nonsingular theory that can be compatible with astronomical observations.

The thesis consists of chapters. Chapter one is the introduction and literature review. Chapter two and three are concerned with general relativity, generalized standard cosmological model and GGR model. Chapter four is the contribution.

The principle of special relativity applies only to bodies moving with constant velocity. This principle is no longer valid in case of accelerated bodies, i.e when the velocity is not constant. Einstein has tried to extend the scope of the principle of relativity to accelerated bodies. The starting point of his reflection was equivalence principle, this principle referred to two different categories phenomenon gravitation and inertia.

To determine this curvature requires a specific metric theory of gravity, Einstein put ten field equations and in 1960 C-H brans & Robert Dicke. Developed a metric theory for additional gravitational field.

Gauss first conceived a metric space that includes abroad class of ordinary and non-ordinary curved spaces and which allows in an infinitesimally small region, the possibility of finding a locally Euclidian coordinate system.

The axiom made by gauss to be the basis of a non-Euclidian geometry resembles the equivalence principle which admits the possibility of finding a locally inertial system at any point in space. The two dimensional space of gauss used in determing metric. Functions were expanded to n-dimensions and the complicated problem related to it was solved by Bernhard Riemann who established a complete geometry of space.

Einstein proceeded to combine the strong principle of equivalence with the general covariance. The laws of nature have to be described by generally covariant tensor equations, thus the law of gravitation has to be a covariant relation between mass density and curvature.

Because Einstein's principle of equivalence is in a deep analogy with gauss and Riemann geometry we wanted conceive of gravitation as a manifestation of geometry or equally of the curvature of space as an indication of matter distribution in this space. Equivalence principle teaches us, the laws of physics showed by equivalent not only among inertial systems of coordinates but also among accelerated ones which means that the proper line interval is invariant under transformation and it says that the equation of physics is called generally covarianty, if it holds the absence of gravitation as well as in its presence.

Suppose we have two points and consider vector Xr and the component of the vector dxr, if we want to connect these component with another component in different dxs coordinates system then we must use the following formula

$$d\bar{x}^r = \frac{d\bar{x}^r}{d\bar{x}^s} dx^s \quad (1)$$

$$\bar{T}^r = T^s \frac{\partial \bar{x}^r}{\partial x^s} \quad (2)$$

$$T^{rs} = T^{mn} \frac{\partial x^r}{\partial x^m} \frac{\partial \bar{x}^s}{\partial x^n} \quad (3)$$

Newton could not answer the question of how to identify the inertial frame which at rest relative to this absolute space.

Riemann realized that Euclidean geometry was just a particular choice suited to flat space but not correct in the space which is filled with fields. Einstein finally drew the conclusion and replaced the flat Euclidean three – dimensional space with curved Mikowskian four-dimensional space.

Gauss made a great emphasis on the inner properties of surface these properties for a cylinder is the same as that for a plane but it is different for spherical surfaces (metric function is different).

Gauss first conceived a metric space includes curved space this admits the possibility of finding a locally inertial system at any point in space , this expand to N-dimensions and the complicated problem related to it was solved by Riemann who established a complete geometry of space.

The three dimensional space are not invariant under Lorentz transformation, their values being different to observer in different frames so to find invariant replace them by the four dimensional space time of Hermann minkowski (x, y, z, ct). the distance between two events in three dimensional space dL is generalized to four dimensional space time distance ds

dt = proper time

$$|dL/dt| \leq c \quad (4)$$

Since the Einstein equation built from the metric tensor, therefore we will look for the solution in terms of space coordinate for this purpose we choose the simplest form with space symmetry and independence of time, i-e static metric, in this metric the gravitational field will depend on the rotational invariants and the invariant proper time interval should be the same for all points in symmetrical positions.

By using the spherical coordinates, that one can come to the following:

$ds2 = -g_{\mu v}\, dx\mu\, dxv$

The Schwarzschild solution has its limitation in strong field region, i.e it gives singularity and gravitational collapse and black holes.

The singularity at the origin is real since physically there is no point mass whose gravitational field is infinite and its coordinate un removable by the use of any coordinate transformation. One can prove the nonzero curvature invariant at r = 2Mc so this singularity is not real and infinite force crushes the collapsing body to infinite density .This imply the laws of physics break down near the singular point including the general relativistic law. That mean GTR is not the right model for strong gravity.

The universe is homogeneous and isotropic in three dimensional Space and will always remain so .Due to Newton's static universe the total number of stars could not be infinite because then their attraction would also be infinite, making the static universe unstable and we can say finiteness was considered equivalent to bounded ness, and infinity to un bounded ness. Newton's concept of an absolute space is not correct, since motion still had to be referred to some frame of rest.

Ernst mach proposed replacing absolute space by cosmic field and cosmic frame because motion is relative and it was left to Einstein to take the full step of studding the laws of physics as seen by observers in inertial frames in relative motion with respect to each other. Einstein found the only solution is static universe until, he met Hubble in 1929.

The universe is globally homogeneous and isotropic, i.e (the curvature of space is entirely constant). This belief which conforms to observation is called the cosmological principle which means the universe is both homogenous and isotropic. Homogeneity is the property of being identical everywhere in space, while isotropy is property of looking the same in every direction. The universe is clearly not exactly homogenous if we take individual design the structure is clearly in homogenous but on scales larger than each unit it is homogenous ex(Radiation, microwave).

Newton's first law state that a system on which no forces acts is either at rest or in uniform motion. Such system is called inertial frames. Accelerated or rotating are not inertial frames.

The velocity distributions of galaxies would also look the same in all directions that mean the universe expanding if velocity change or increase. So the static case is different if we consider the universe as a whole. According to the cosmological principle no point preferred, and therefore there exists no centre around which bodies can gravitate in steady state orbits. Thus the universe is either expanding or contracting, the static solution being unstable and therefore unlikely.

The large scale phenomena of the universe are strongly affected by the gravitational interaction. Since gravity is the dominating interaction.GR should be able to give as it noted before a full description of the universe. Therefore what is needed is to find a model of the universe as a whole, which constitutes a solution of Einstein's equation. The solution of the cosmological problem within the framework of GR consists of determining a large scale metric of the four-dimensional world and a corresponding large-scale matter distribution satisfying Einstein's equation. Theoretical cosmologists always make the idealizing assumption that, on sufficiently large scale, matter can be considered to homogeneously and isotropically distribute.

This means that the energy-momentum tensor of matter in the universe is exemplified by that of a perfect fluid. On a sufficiently large scale the gross features of the universe, such as the mass density, indicate that the universe is homogeneous and isotropic. The modern cosmological theory is built on the cosmological principle, i.e. the hypothesis that the universe is spatially homogeneous and isotropic. The space-time metric of such a universe is given.

This means that the initial universe consist of at least 10^{84} 10^{84}

Isolated light sphere. Since the maximum propagation of fields and physical interactions are that of light speed, one expects these light sphere to be not interacting with each other. Thus these large number of spheres are co usually disconnected. This means that they have different temperatures and densities as far as the matter and energy have no enough speed to retard themselves to be uniform. This means that the universe is no homogeneous or isotropic at early times. This is in conflict with observed homogeneous and isotropic universe. This problem is called horizon problem.

Following this was a period of Hibernation (1920–1960) during which

Astronomical discoveries (quasars, pulsars, cosmic background radiation) and new experiments pushed GR to the forefront. Experimental gravitation experienced a Golden Era (1960–1980). The period began with an experiment to confirm the gravitational frequency shift of light (1960) and ended with the reported decrease in the orbital period of the binary pulsar at a rate consistent with the general relativity prediction of gravity-wave energy loss (1979). The results all supported GR, and most alternative theories of gravity fell by the wayside.

Many of the remaining interesting weak-field predictions of the theory are extremely small and difficult to check, in some cases requiring further technological development to bring them into detectable range. Examples include the use of laser-cooled atom and ion traps to perform ultra precise tests of special relativity; the proposal of a “fifth” force, which led to a host of new tests of the weak equivalence principle; and recent ideas of large extra dimensions, which have motived new tests of the inverse square law of gravity at sub-millimeter scales. Several major ongoing efforts also continue, principally the Stanford Gyroscope experiment, known as Gravity Probe-B. Instead, much of the focus has shifted to experiments which can probe the effects of strong gravitational fields.

At one extreme are the strong gravitational fields associated with Planck-scale physics. Will unification of the forces, or quantization of gravity at this scale leave observable effects accessible by experiment? Dramatically improved tests of the equivalence principle or of the inverse square law are being designed, to search for or bound the imprinted effects of Planck-scale phenomena. At the other extreme are the strong fields associated with compact objects such as black holes or neutron stars. Astrophysical observations and gravitational-wave detectors are being planned to explore and test GR in the strong-field, highly-dynamical regime associated with the formation and dynamics of these objects.

There are a number of common grounds between the gravitational and electromagnetic phenomena, first there is a certain correspondence between the metric tensor components and the potential of the electromagnetic field, second the inverse square law of Newtonian gravitational and Colombian electrostatic is a common feature between gravitational and electromagnetic interaction in the weak field areas.

Mathematically there is a difference that the gravitational equations describe a tensor field are nonlinear and physically the gravity influences its source where as Maxwell's equation describe a vector field are nonlinear in the field variables and electric charge is not affected by its field. Due to analogy between gravity and electromagnetism quadratic lagrangians one recommended to be a basis for gravitational equations which may improved the general relativity theory to be quantizable similar to electromagnetic if a quadratic term is included in the lagrangians.

Discussion

The second constant term may stand for constant background vacuum energy density. This scenario is compatible with the GR model where the expansion of the universe is accompanied with decrease of energy density. The radius dependent terms, may presumably stands for matter energy density.

For negative curvature parameter, the energy density resembles that of GR radiation era with constant vacuum background. It is important to note that the size of k is not related to the expansion or contraction of the universe within the framework of the GGR. This is related to the fact that the expression of the energy density consists of an additional terms representing gravitational field energy.

Conclusion

The new GGR is proved to be successful, where it cure the defects of GGR. Moreover it is reduces to GR in the weak field limit, thus it shares GR all it success. It also predict inflation thus it is free from flatness, horizon and entropy problem. It is also non-singular and predict the existence of vacuum energy and quantum effects in the early universe.

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