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EINSTEIN'S THEORY OF GRAVITATION

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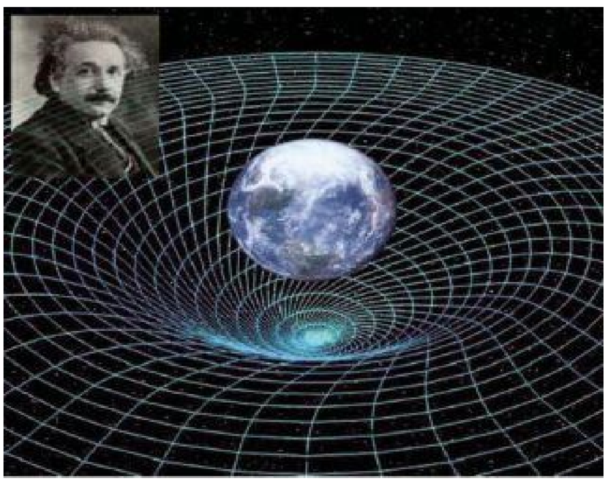

Abstract :

Einstein's theory of relativity is based on the fundamental idea of relativity of all kinds of motion. The special theory of relativity formulated by Einstein (1905) makes the restricted use of this general idea since it merely assumes the relativity of uniform translatory motion in a region of free space where gravitational effects can be neglected. As it fails to study relative motion in accelerated frames of reference and is not applicable to all kinds of motion. Taking into account of these limitations, Einstein (1916) generalized the special theory of relativity and foot forth general theory of relativity or Einstein's theory of gravitation. Einstein arrived at a novel concept which says that gravitation has a basic relationship with the space-time in which it is always present. The theory of general relativity or Einstein's relativistic theory of gravitation is a more accurate and comprehensive description of gravitation than Newtonian theory.

KEYWORDS :
fundamental idea, general relativity

INTRODUCTION:

Einstein's theory of gravitation is based on Riemannian metric tensor g_{ij} which describes not only the gravitational field but also the geometry. This theory of gravitation has great formal beauty and mathematical elegance and is found to lead to a complete theory of gravitational action. In the development of general relativity Einstein was mainly guided by three basic principles: principle of equivalence; principle of covariance and Mach's principle.

PRINCIPLE OF EQUIVALENCE

This principle is the actual hypothesis by which gravitational considerations are introduced into the development of general relativity. It says that no physical experiment can distinguish whether the acceleration of a free particle is due to gravitational field or it is due to the acceleration of a frame of reference. Thus, this leads to an intimate relation between metric and gravitation. Principle of equivalence is classified into two: the strong equivalence and the weak equivalence. The strong equivalence principle states that the observable laws of nature do not depend upon the absolute values of the gravitational potentials while the weak equivalence principle implies equality of inertial and gravitational masses of a closed system. Einstein mostly used the strong equivalence principle.

PRINCIPLE OF COVARIANCE

This principle helps us to write the physical laws in covariant form so that their form remains unaltered in all systems of coordinates. This implies that the physical laws should be expressed in tensor form.

MACH'S PRINCIPLE

The importance of this principle is that it can be used to determine the geometry of the space – time and there by the inertial properties of a test particle from the information of the density and mass energy distribution in its neighborhood. According to this principle:

i. The inertia of a body must increase when ponder able masses are piled up in its neighborhood.
ii. A body must experience an accelerated force when neighbouring masses are accelerated and, in fact, the force must be in the same direction as that of acceleration.
iii. A rotating hollow body must generate inside of itself a "Coriolis field", which deflects moving bodies in the sense of the rotation, and a radial centrifugal field as well.

Einstein's general theory of relativity has been very successful in describing gravitational phenomena. In this theory the space – time is described by the pseudo Riemannian metric.

$$ds^2 = g_{ij}\,dx^i dx^j \;\; ; \;\; i,j = 1,2,3 \text{ and } 4 \qquad \text{..........(1)}$$

and the components of the symmetric tensor g_{ij} act as gravitational potentials. The gravitational field manifests through the curvature of the space – time and the general field equation's which govern the gravitational field are given by

$$G_{ij} \equiv R_{ij} - \frac{1}{2}Rg_{ij} + \Lambda g_{ij} = -8\pi T_{ij} \qquad \text{........(2)}$$

Where G_{ij} is the Einstein tensor, R_{ij} is the Ricci Tensor, R is the Scalar curvature and T_{ij} is the energy momentum tensor due to matter and is the cosmological constant (the velocity of light c in vacuum and the Newtonian Gravitational constant G are taken to be unity in this thesis). This cosmological constant was introduced by Einstein, while studying static cosmological models and was later discarded by him saying "It is the greatest blunder of my life". In this connection, it may be mentioned that, in recent years, the cosmological constant is coming into lime light and attracting many researchers in general relativity but comes as a variable and not as a constant. However we are not includingin our discussions.

Since the Einstein tensor G_{ij} is divergence free, the field equations (2) yield

$$T^{j}_{i;j} \equiv 0 \quad \text{..........(3)}$$

which can be considered as the energy momentum conservation equation and which also gives us the equations of motion of matter.

The general theory of relativity yields results which are in good agreement to a great degree of accuracy with the experimental results. It is well known that Einstein's theory has served as a basis for the study of cosmology and cosmological models of the Universe. Hence, in the following section, we briefly describe, cosmology and cosmological models of the universe.

CONCLUSION

The special theory of relativity formulated by Einstein makes the restricted use of this general idea since it merely assumes the relativity of uniform translatory motion in a region of free space where gravitational effects can be neglected.

Taking into account of these limitations, Einstein generalized the special theory of relativity and foot forth general theory of relativity or Einsteins theory of gravitation.

The theory of general relativity or Einsteins relativistic theory of gravitation is a more accurate and comprehensive description of gravitation than Newtonian theory.

In the development of general relativity Einstein was mainly guided by three basic principles: principle of equivalence; principle of covariance and Machs principle.

The strong equivalence principle states that the observable laws of nature do not depend upon the absolute values of the gravitational potentials while the weak equivalence principle implies equality of inertial and gravitational masses of a closed system.

REFERENCES

1. A. Pradhan, P. K. Singh, and K. Jotania, Czech. J. Phys. 56, 641 (2006).
2. B. Ratra and P. J. E. Peebles, Phys. Rev. D 37, 3406 (1988).
3. Chatterjee,S. ,Banerjee, A.&Bhui,B. Phys.Lett.A Vol.l49(1990)
4. D. R. K. Reddy, Astrophys. Space Sci. 286 (2003) 365.
5. E. R. Harrison, Phys. Rev. Lett. 30, 188 (1973).
6. G. P. Singh, Nuovo Cim. B 110, 1463 (1995); Pramana-J. Phys. 45, 189 (1995).
7. Iseral, W., Stewart, Phys. Lett. Vol.A 58, 213(1976).