Introduction:

The theory of relativity consist of two main parts:

*. The special (restricted) Theory of relativity and *. The general Theory of relativity.

The SRT was presented by Einstein in 1905 and the GTR in 1916. The STR had its origin in the development of electrodynamics and the GTR is the relativistic Theory of gravitation. The STR of relativity deals with object or system which are either moving at constant velocity with respect to one onother (an-accelerated system) or which are not moving at all (with a constant velocity = zero).

The general theory treats object or system which are spreading up on slowing down w.r. to one another (i.e. acceleration system). The special theory is really a particular case of the general theory, since system moving constant velocity can be thought of as having acceleration zero.

The general theory of relativity leads to a satisfactory solutions of two obvious problem ~~the~~ which were left untouched STR.

The assumption that the laws of phisics can be expressed in a form which is independent of co-ordinate system is called

The principle of covariance and the actual hypothesis by which gravitational consideration are introduced into the development has been named as the principle of equivalence.

Principle of covariance

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In accordance with the principle of covariance, the general laws of phisics (nature) can be expressed in a form which is independent of the choice of the space-line co-ordinate. In other word, the laws of phisics remain covariant independent of the frame of reference.

The tensor form of the line-element is given by

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu \longrightarrow (1)$$

where $g_{\mu\nu}$ is the fundamental tensors (covariant tensor of rank 2)

Now $g_{\mu\nu}$ obeys the law ~~of~~

$$\bar{g}_{ij} = \frac{\partial x^\mu}{\partial \bar{x}^i} \frac{\partial x^\nu}{\partial \bar{x}^j} g_{\mu\nu}$$

where the quantities carrying by corresponds to the new co-ordinate system.

As an example that the linear form of a law follows the general covariance principle. We consider a certain law of nature in a system of variables x and is represented by the tensor equation

$$A^{\mu}_{\nu} = B^{\mu}_{\nu} \longrightarrow (2)$$

Then the law when transformed to new system of variables $\bar{x}$ may be written as

$$\bar{A}^{\mu}_{\nu} - \bar{B}^{\mu}_{\nu} = \frac{\partial \bar{x}^{\mu}}{\partial x^{i}} \frac{\partial x^{j}}{\partial \bar{x}^{\nu}} A^{i}_{j} - \frac{\partial \bar{x}^{\mu}}{\partial x^{i}} \frac{\partial x^{j}}{\partial \bar{x}^{\nu}} B^{i}_{j}$$

$$= \frac{\partial \bar{x}^{\mu}}{\partial x^{i}} \frac{\partial x^{j}}{\partial \bar{x}^{\nu}} \left(A^{i}_{j} - B^{i}_{j} \right)$$

$$= 0$$

$$\therefore \quad \bar{A}^{\mu}_{\nu} - \bar{B}^{\mu}_{\nu} = 0$$

$$\Rightarrow \bar{A}^{\mu}_{\nu} = \bar{B}^{\mu}_{\nu} \longrightarrow (3)$$

Equation (3) has exactly the same form as equation (2). Thus the laws of nature when expressed in the form of tensors eqn. follow the general covariance principle. Hence according to general covariance principle the laws of nature must be expressed in the tensorial equation.

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