B.Sc. Part-I

Paper-I

Theory of Relativity

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Einstein's Second Postulate:

The Second Postulate upon which einstein based his Theory of Special relativity deals with the speed of light. Late in the 19th Century, the major tenets of classical physics were well established. Two of the most important were the laws of electricity and magnetism and newton's law. In Particular, the laws of electricity and magnetism Predict that light travels at $c = 3.00 \times 10^8$ m/s in a vacuum, but they do not specify the frame of reference in which light has this speed.

There was a Contradiction between this Prediction and Newton's Laws. In which velocities add like simple vectors. If the latter were true, then two observers Moving at different would see light traveling at different speeds. Imagine what a light ~~were~~ wave would look like to a Person traveling along with it at a speed c. If such a Motion were Possible then the wave would be stationary relative to the observer. It would have electric and Magnetic fields that varied in strength at various distances from the observer but were constant in time. This is not allowed by Maxwell's equations.

So either Maxwell's eqn's are wrong; or an object with mass cannot travel at speed C. Einstein concluded that the latter is true. An object with mass cannot travel at speed C. This conclusion implies that light in a vacuum must always travel at speed c relative to any observer. Maxwell's eqn's are correct, and Newton's addition of velocities is not correct for light.

Investigations such as young's double slit experiment in the early-1800s had convincingly demonstrated that light is a wave. Many types of waves were known, and all travelled in some medium. Scientists therefore assumed that a medium carried light, even in a vacuum, and light travelled at a speed c relative to that medium. Starting in the Mid-1880s, the American Physicist A.A. michelson, later aided by E.W. Morley, made a series of direct measurements of the speed of light. The results of their measurements were startling.

Note: The michelson morley experiment demonstrated that the speed of light in

a vacuum is independent of the motion of the earth about the sun.

The eventual conclusion derived from this result is that light, unlike mechanical waves such as sound, does not need a medium to carry it. Furthermore, the Michelson-Morley results implied that the speed of light c is independent of the motion of the source relative to the observer. i.e everyone observes light to move at speed c regardless of how they move relative to the source or one another. For a ~~no.~~ number of years, many scientists tried unsuccessfully to explain these results and still retain the general applicability of Newton's law.

It was not until 1905, when Einstein published his first paper on special relativity. That the currently accepted conclusion was reached based mostly on his analysis that the laws of electricity and magnetism would not allow another speed for light, and only slightly aware of the Michelson-Morley experiment. Einstein detailed his second postulate of special relativity.

Note - The speed of light c is a Constant independent of the relative motion of the source.

Deceptively simple and counterintuitive. This and the first Postulate leave all else open for change. Some fundamental concepts do change. Among the changes are the loss of agreement on the elapsed time for an event, the variation of distance with speed, and the realization that matter and energy can be converted into one another. You will read about these concepts in the following sections.

Note - MISCONCEPTION ALERT -

The speed of light is a constant $c = 3.00 \times 10^8$ m/s in a vacuum. If you remember the effect of the index of refraction from the Law of Refraction, the speed of light is lower in matter

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Section Summary —

* Relativity is the study of how different observers measure the same event.
* Modern relativity is divided into two parts, : special relativity deals with observers who are in uniform motion, whereas general relativity includes accelerated relative motion and gravity. Modern relativity is correct in all circumstances and in the limit of low velocity and weak gravitation. gives the same predictions as classical relativity.
* An inertial frame of reference is a reference frame in which a body at rest remains at rest and a body in motion moves at a constant speed in a straight line unless acted on by an outside force.
* Modern relativity is based on Einstein's two postulates. The first postulate of special relativity is the idea that the laws of physics are the same and can be stated in their simplest form in all inertial frames of reference. The second postulate of special relativity is the idea that the speed of light C is a constant. Independent of the relative motion of the source.
* The Michelson - Morley experiment demonstrated that the speed of light in a vacuum is independent of the motion of the Earth about the Sun.