Relativity

Special Theory & General Theory

Lecture 12

The idea of Relativity deals with space, time and motion. It centers around the attempt to understand the universe as operating under the same natural laws.

It is not a new concept, Aristotle and Galileo contemplated space time relationships as well as relative motion.

This idea had been around for a while when Einstein began to work on it.

Central idea

Observers in different frames of reference will observe and describe different specific events but ultimately have the same laws governing them.

Einstein used “gedanken” or thought experiments like the “light clock” to consider how objects might behave in more extreme frames of reference.

Velocity has a reference point.

A speeding car has a relative speed

It is going ___mph as you stand stationary.

That speeding car is going faster towards you if you are moving towards it.

Or slower if you are moving away from it.

These sorts of ideas applied to light is really where a lot of the examples and discussion of relativity is interesting.

Expanding Newtonian ideas with geometry

- Space is uniform and unchanging by the objects in them and they cause the attractive force on each other

Relativity expects that space is warped by mass of objects and that is what actually creates the attractive force

(in essence it alters how we view gravity)

The theory of relativity is split into two :

Special relativity applies only to frames of reference that are not accelerating, they are only in uniform motion.

General relativity applies to all frames, accelerating or not.

In both cases, it is assumed that light travels at the same speed in all frames.

Predictions of Special Relativity

- Clocks running in moving frames of reference run slower than those in stationary frames. (Time dilation)
- When objects move they contract (along the direction of motion)
- Moving objects are more massive
- $E=mc^2$ energy and mass are interrelated and conversion can supply one from the other

Experimental Confirmations

- Particle accelerators confirm routinely that the mass of accelerating particles increase
- Particles also contract as they accelerate
- Nuclear power reactors demonstrate the equivalence of mass to energy

Tests of General Relativity

- Precise shape of Planetary orbits
- Black holes
- Light bending
- Red shift

Confirmations of General Relativity

Perihelion shifts with each orbit (result of the mass of the sun)