Two postulates underlie special relativity. The first, the principle of relativity, states:

1.The laws of physics are the same in all inertial frames of reference.

2.The speed of light in free space has the same value in all inertial frames of

reference.

This speed is 2.998 108 m/s to four significant figures.

Albert A. Michelson (1852–1931)

was born in Germany but came to the

United States at the age of two with

his parents, who settled in Nevada. Michelson’s speciality was high-

precision measurement, and for many decades his successive

figures for the speed of light were the best available.The Michelson-Morley experiment set the stage for Einstein’s

1905 special theory of relativity, a theory that Michelson him-

self was reluctant to accept. Indeed, not long before the flow-

ering of relativity and quantum theory revolutionized physics,

Michelson announced that “physical discoveries in the future

are a matter of the sixth decimal place.” This was a common

opinion of the time. Michelson received a Nobel Prize in 1907,

the first American to do so.

TIME DILATION

A moving clock ticks more slowly than a clock at rest

If someone in a moving spacecraft finds that the time interval between two events

in the spacecraft is t0, we on the ground would find that the same interval has the

longer duration t. The quantity t0, which is determined by events that occur at the same

place in an observer’s frame of reference, is called the proper time of the interval

between the events. When witnessed from the ground, the events that mark the be-

ginning and end of the time interval occur at different places, and in consequence the duration of the interval appears longer than the proper time. This effect is called time

dilation

The time interval between ticks

is the proper time t0 and the time needed for the light pulse to travel between the

mirrors at the speed of light c is to2. Hence to=2Lo/c

Because the quantity is always smaller than 1 for a moving object, t is

always greater than t0. The moving clock in the spacecraft appears to tick at a slower

rate than the stationary one on the ground, as seen by an observer on the ground.

Exactly the same analysis holds for measurements of the clock on the ground by

the pilot of the spacecraft.

DOPPLER EFFECT

Why the universe is believed to be expanding

We are all familiar with the increase in pitch of a sound when its source approaches

us (or we approach the source) and the decrease in pitch when the source recedes from

us (or we recede from the source).

The expansion apparently began about 13 billion years ago when a very small, in-tensely hot mass of primeval matter exploded, an event usually called the Big Bang.

As described in Chap. 13, the matter soon turned into the electrons, protons, and neutrons of which the present universe is composed.

LENGTH CONTRACTION

Measurements of lengths as well as of time intervals are affected by relative motion.The length L of an object in motion with respect to an observer always appears to the observer to be shorter than its length L0 when it is at rest with respect to him. This contraction occurs only in the direction of the relative motion. The length L0 of an object in its rest frame is called its proper length.

TWIN PARADOX:-

A longer life, but it will not seem longer

The nonsymmetric aging of the twins has been verified by experiments in which accurate clocks were taken on an airplane trip around the world and then compared with identical clocks that had been left behind. An observer who departs from an inertial system and then returns after moving relative to that system will always find his or her clocks slow compared with clocks that stayed in the system.

ELECTRICITY AND MAGNETISM

Relativity is the bridge:

Electric charge is relativistically invariant. A charge whose magnitude is found to be Q in one frame of reference is also Q in all other frames.

Let us look at the two idealized conductors shown in Fig. 1.12a. They contain equal numbers of positive and negative charges at rest that are equally spaced. Because the conductors are electrically neutral, there is no force between them. Figure 1.12b shows the same conductors when they carry currents iI and iII in the same direction. The positive charges move to the right and the negative charges move to the left, both at the same speed as seen from the laboratory frame of reference. (Actual currents in metals consist of flows of negative electrons only, of course, but the electrically equivalent model here is easier to analyze and the results are the same.) Because the charges are moving, their spacing is smaller than before by the factor 1 2c2

Since is the same for both sets of charges, their spacings shrink by the same amounts, and both conductors remain neutral to an observer in the laboratory. However, the conductors now attract each other.\