4.3 LASER FOR MEASUREMENT OF ACCELERATION

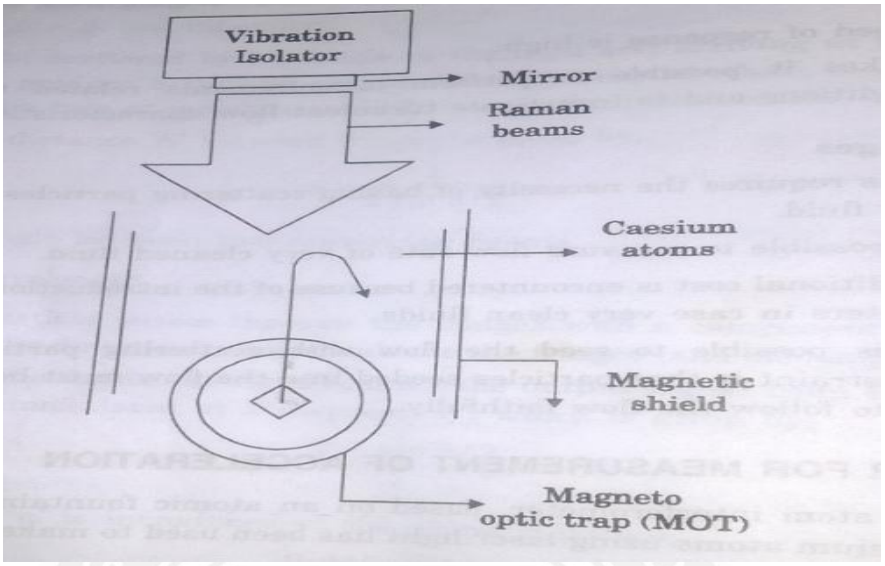

Figure 4.3.1 Laser based Acceleration Measurements

[Source: "Optical Fibre Communications" by J.M.Senior, Page:526]

An atom interferometer based on an atomic fountain of laser cooled caesium atoms using laser light has been used to make a very accurate measurement og 'g'

Principle

In this interferometer, the frequency of the light is changed in a phase continuous way so that it remains resonant with the transitions as the atoms accelerate under the influence of gravity. As a consequences, the phase difference between the two paths in the interferometer is proportional to the gravitational attraction.

Basic atom Interferometer:

Caesium atoms are extracted from a low pressure back ground vapour and loaded into a magneto optical trap during a 600 ms period. The magnetic field is turned off and the captured atoms are launched into the atomic fountain of this sensor using a specialized technique known as moving polarization gradient optical molasses.

During this period, further cooling of the 'launched' atoms occur, using resonant techniques. In the final stage of the launch, the laser intensities are reduced to zero in 400μs so that the atoms are cooled. The launched atoms are subjected to a series of pulses that place the atoms in a specific internal state with an effective internal temperature of 10nK.

This low velocity spreads leads to a high fringe contrast over a period of about 150 ms. The interferometer measurements occur in a magnetically shielded region. This type of device is capable of measuring 'g' better than a part per billion accuracy.

Cold Atom Gradiometer

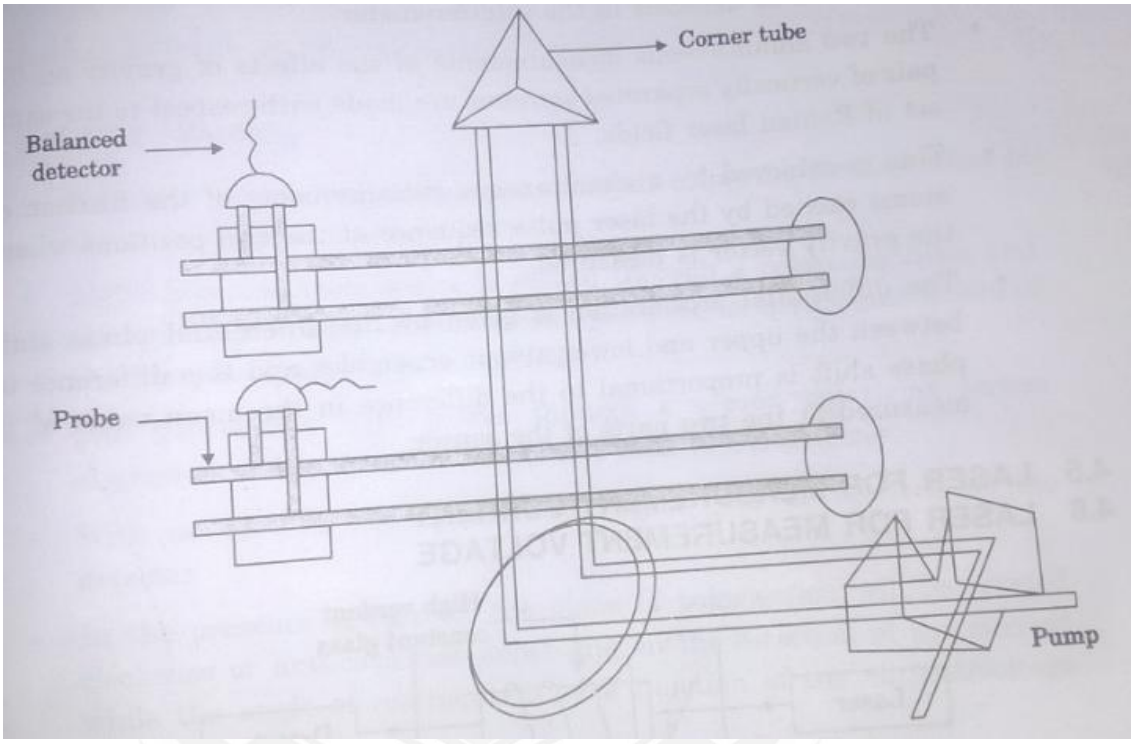

Figure 4.3.2 Cold Atom Gradiometer

[Source: "Optical Fibre Communications" by J.M.Senior, Page:528]

An atom interferometry technique has been used to create a gravity gradiometer using two laser cooled and trapped sources of caesium atoms and a pair of vertically propagating laser beams. The device is arranged so that two independent measurements of acceleration can be made using the two vertically separated ensembles of caesium atoms in free fall under the influence of gravity.

Working:

The caesium atoms are launched into a vertical trajectory form the magneto-optical trap and conditioned to be in a particular internal state using optical and microwave techniques. These atoms are then suitable for interacting with the gravity vector and then changes in the atomic states due to gravitational acceleration which can be detected in the interferometer.

The simultaneous measurements of the effects of gravity on the pair of vertically separated sensors are made with respect to the same set of Raman laser fields. This is achieved by a simultaneous measurements of the fraction of atoms excited by the laser pulse sequence at the two positions where the gravity vector is measured.

The differential acceleration is given by the differential phase shift between the upper and lower atomic ensembles and this difference in phase shift is proportional to the difference in phase shift is proportional to the difference in the mean value of 'g' measured at the two part of the sensor.

LASER FOR MEASUREMENT OF CURRENT AND VOLTAGE

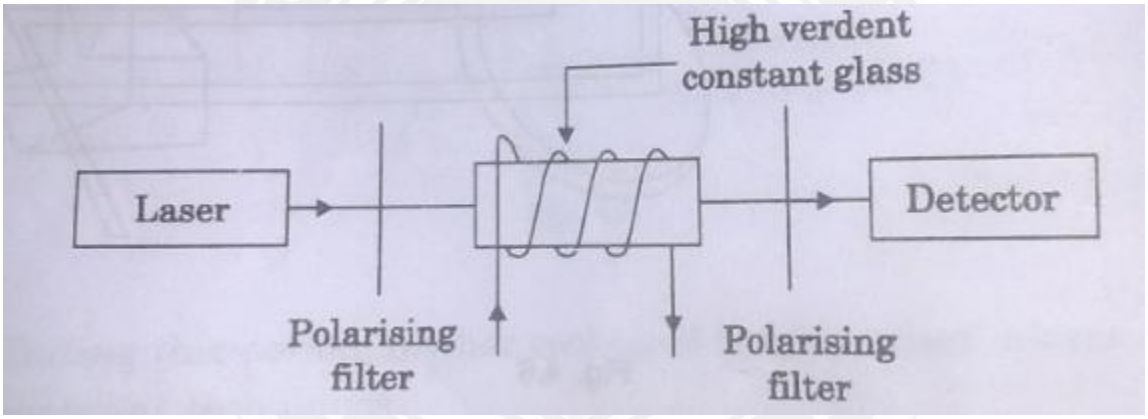

Figure 4.3.3 Laser based measurement of Current and Voltage

[Source: "Optical Fibre Communications" by J.M.Senior, Page:530]

Principle:

If polarized light is passed along a magnetic field of strength H, the plane of polarization is rotated by an amount given by,

$$\Phi = VNI$$

Working:

A system for current/voltage measurement using the faraday effect. Light from the laser source is passed through a polarizing filter and then through a high verdet constant glass rod in the magnetic field of current and voltage to be measured. The transmission to the first screen and then to the detector. With no current flowing, a steady signal will be received at the detector. In the presence of current, the plane of

polarization will be rotated clockwise or anticlockwise depending on the direction of the current while the angle of rotation will be a function of the current & voltage magnitude.