CHAPTER: 20
NUCLEAR RADIATIONS:

WILSON CLOUD CHAMBER:

Wilson cloud chamber is used to observe the path of ionizing particles. It helps to examine the mechanism of ionization of various ionizing radiations and the product of their interaction with the material inside the chamber.

CONSTRUCTION:

It consists of a closed cylindrical chamber with transparent glass top T and a movable piston P light at the bottom. On the sides near the top the cylinder is provided with glass windows L for light and an inlet I for the ionizing particles or radiations. The piston can be moved up or down by a lower attached to it before making the enclosed space above the piston airtight enough quantity of low boiling point liquid such as water or alcohol is introduced in the space to produce its saturated vapours. A small quantity of the liquid stay on the piston.

PRINCIPLE:

It works on the principle of condensation of vapours on ions or any other particles which are present or formed by the passing of ionizing particles. (such as $\propto$, β and γ). These particles or ions acts as the centers of condensation.

WORKING:

The piston is moved down suddenly (i.e adiabatically) so that the saturated vapours in the chamber becomes super saturated. At the same time an ionizing particle is allowed to enter the chamber through in let I. the particle produces ions all along its path. The super saturated vapours condense on the ions in such a way that the ions acts as the centers of condensation. This track can be seen and photograph form the top if a beam of light is projected in to the chamber through the window L.

1. An $\propto$ particle is highly ionizing the ions produced are so numerous that it tracks is a thick and continuous line.
2. β particle is much less ionizing its track is therefore a thin and broken line.
3. γ rays are photons emitted in a widening cone of some angle. They produce ionization by photo electric effect distributed over a wide space. Some of the photoelectrons ejected by then give tiny line tracks in random directions like the β particles and scattered dots are produced the γ do not produce well defined.

IN THE MAGNETIC FIELD:

If the cloud chamber is placed in a magnetic field the charged particle are deflected by noting down the length and curvature of the path additional information about the charged and uncharged nature the magnitude of the charge the charge to mass ratio $\frac{e}{m}$

etc of the incident particle or the particle produced by their interaction with atoms can be obtained. By this very method a number of particles have been discovered.

GEIGER COUNTER:

Geiger counter is a portable device which is widely used for the detection of ionizing particles or radiations.

CONSTRUCTION:

It consists of a hallow metal cylinder one end of which is closed by an insulating cap. At the center of the cap is fixed a stiff straight wire along the axis of the cylinder. A thin mica or glass disc closes the other end which also serves as the entrance window for the ionizing particles or radiations. The sealed tube usually contains a special mixture (air, organ, alcohol etc) at a low pressure of 50 to 100 millimeters of mercury. A potential difference of the order of one thousand volts is applied between the metal cylinder and the axial

wire through a suitable series resistor R (about 109 ohms). The potential difference is only slightly less than that necessary to start a discharge between the wire and the cylinder.

WORKING:

When an ionizing particle enters the tube through the window it ionizes some gas molecules in it. These ions are accelerated by the strong radial electric field producing more ions by collision with the atoms and causing the ionization current to build up rapidly. So $\propto$ momentary surging current flows between the wire and the cylinder and through resistor R producing a momentary potential difference across R. the ends of R are connected to a loud speaker or an electronic counter. Thus each time a particle enters the counter an ionization current pulse occurs which gives a click in the loudspeaker or a count in the electronic counter. The ionization current however decay rapidly in small fraction of a second since the circuit has a small time constant and the counter is ready to register another particle almost immediately.

In the case of ionizing radiations the number of counts registered by the counter measures the intensity or ionizing power of the incident radiation.

SOLID STATE DETECTOR:

It is a device which is used to detect the ionizing particles.

CONSTRUCTION:

It consists of a semi conductor diode (i.e the p-n junction) a resistor and a battery. All the components are connected in series as shown in the figure. The connections are made in such a way that the p-n junction is reverse biased.

WORKING:

When a energetic ionizing particle or radiation passes through the junction it ionizes the atoms of the region due to which a reverse current pulse passes through the diode. As a result of this current a potential difference is produced across the resistance R. the current pulse is amplified and then applied to a loud speaker or an electronic counter which can register the number of clicks or counts respectively.

ADVANTAGES:

Following are the advantages of solid state detector over the Geiger counter.

1. Small cheap and light intensity
2. It works at low voltage upto 9 volts.
3. No earthling is required as required by the Geiger counter.
4. It can detect particles having energy only a few electron volts.