T.E.M.S Journal
ISSN: 2456 8368
Volume 3: Issue 1: August 2021 : PP: 138-139
https://journals.wingsofaero.in

Geiger-Muller counter (GM-Counter)

Promita Ghosh,
Editorial member : T.E.M.S Journal

Abstract:

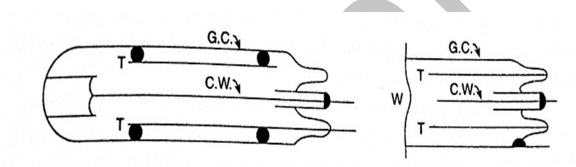
This article is about the Geiger-Muller counter which is the most versatile instrument for detecting the ionizing radiations.

If the electrodes of a gas filled counter are so shaped that there exists a high field near one of them even when a moderately high DC voltage is applied to it, then the amplification of an ionic charge reaches, in the region of high voltage, an avalanche condition. Practically, all of the gas present in the local volume of the electrode gets ionized. This results in a much larger voltage pulse on the electrode. The pulse height is independent of the amount of ionization originally produced by the particle. It depends only on the counter potential and increases with it. Only a single ion reaching the vicinity of the high voltage electrode may trigger the process. This counter is very simple to construct and is extremely sensitive to the passage of charged particles.

Apparatus:

It consists of a hollow cylindrical metallic tube TT inside which is fitted a fine tungsten wire CW, stretched along its axis and is mounted inside a glass tube GC.

Two common types of GM-counter is shown in the figure. In the first, the particle enters the counter through the glass envelope, while in the second



Two common types of GM-counters

type, called end window GM counter, the tube has a thin mica sheet W at one end to serve as a window. The former is used for counting penetrating particles, the latter for less penetrating part ones. In the window types the central wire CW does not extend throughout the length of the tube, but terminates at a point. The counter is filled with an inert gas at a pressure of few cm of Mercury, together with a trace of polyatomic organic vapour acting as a quenching agent that quenches the initial discharge soon after it is initiated. The diameter of the tube varies, depending on the purpose of its use, from 1 to 5 cm and its length from to 2 to 100 cm.

Action:

The central CW acts as the anode and is mounted and so high a positive potential about 1000 V, with respect to

T.E.M.S Journal
ISSN: 2456 8368
Volume 3: Issue 1: August 2021 : PP: 138-139
https://journals.wingsofaero.in

the metallic cylinder TT that acts as the cathode, that a discharge just not sets. Then even a single ion pair formed by a single incident particle can produce an electric discharge. The important fact is that the electric pulse produced in this discharge is the same, no matter what is the energy of the incident particle. The central wire is very thin, the electrical field in its vicinity is very high.

Let an ionizing particle or gamma ray enter the GM tube and produce one single ion pair in the volume enclosed by the outer cylinder. The resulting electron would be rapidly accelerated towards the central wire and reach a relatively high velocity producing rapidly a large number of additional ion pairs by repeated collisions. The new electrons are also accelerated and may in turn produce more ion pairs. The process is cumulative and an avalanche occurs. A very large number of electrons reaches the anode which get surrounded by the massive slow moving positive ions seath. The initial formation of a single ion pair results in a very large pulse of current to the anode. Geiger counters thus acts as its own amplifier for detection. The current may be made to cause an audible click in a small loudspeaker.

Some free electrons on collision with argon atoms merely excite them which on return to the normal state emit photons. If a photon is absorbed by another excited atom, it may get ionized releasing electrons which produce further avalanches. The avalanche thus spreads rapidly in the entire volume of the counter and an amplification as high as 10^8 is a attained. The total number of ions is now independent of the initial number of ions formed by the incoming particle.

In a short time~1µs, the space charge becomes enough dense to cancel the field round the anode, discharged and ionization stops, positive ions and drawn to the cathode and the ionization restarts. The time interval during which the ionisation remain suspended is known as the dead time of the counter as it is not then ready to receive another incident particle.

References:

Modern atomic and nuclear physics- AB Gupta