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Coincidence Counting-Apparatus for Cosmic-Ray Work

By

LENNART SIMONS

The purpose of the apparatus is the registration of simultaneous particles of radiation of so-called β—γ coincidences and γ—γ coincidences. The construction is such that not just any particle by itself is counted, but a particle is registered as one if it passes along a definite path through two counters or if two particles appear in their respective counters within a given time τ. This interval τ is the resolving time of the apparatus and for the minimization of statistical coincidences, i.e. accidentals of two irrelative particles, it should be made as short as possible.

The apparatus consists of the following main parts: two *G-M* counters adapted for the particular radiation studied, two parallel NEHER-HARPER amplifier circuits, a ROSSI circuit consisting of two tubes, and an output stage to work the mechanical recorder. The stabilized high-voltage for the *G-M* counters, and the heater and plate currents are supplied from a separately housed rectifying unit. The complete circuit-diagram is shown in Fig. 1. In the main the construction of the apparatus is of the usual type with just minor differences in details and it is thus unnecessary to give a more comprehensive explanation here. The apparatus is housed in three separate units appearing in Fig. 2.

Careful alignment of the apparatus is of great importance and in this respect the apparatus has been thoroughly tested. The two NEHER-HARPER circuits are tested separately by themselves. After this the grid-voltages on the ROSSI tubes are adjusted by the help of a fre-

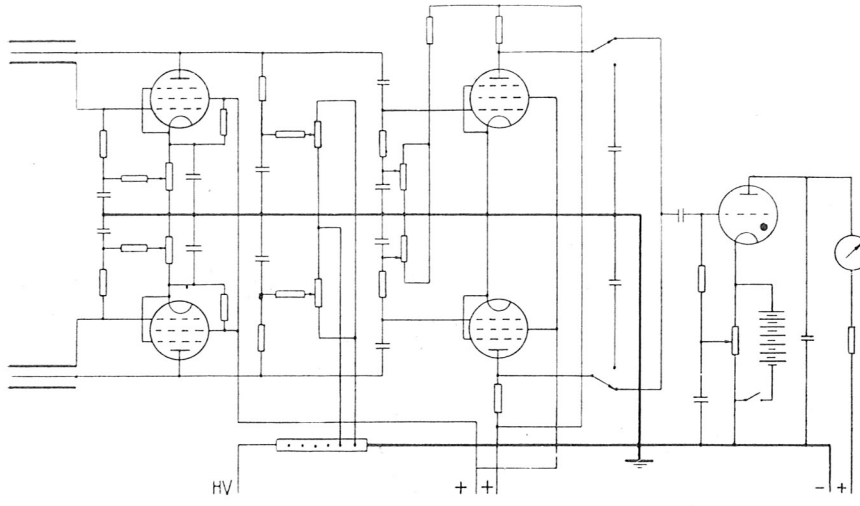

Fig. 1

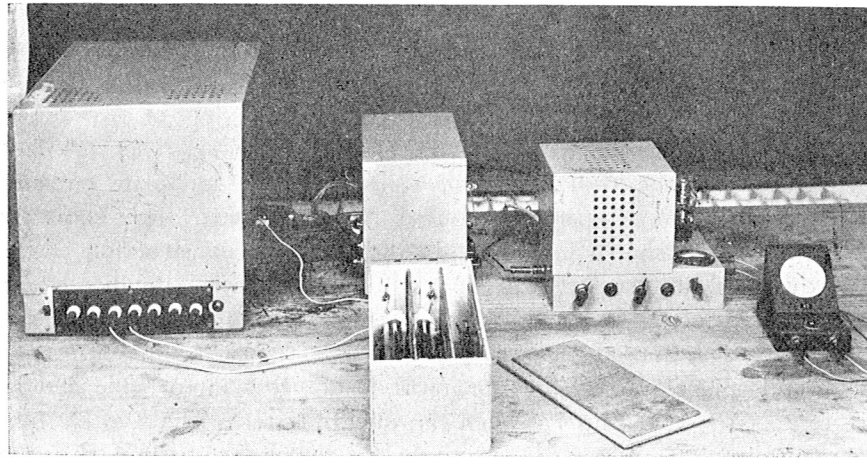

Fig. 2

quency-oscillator and oscilloscope so that both branches work, each by itself and also coincidence coupled, identically. It is of importance at this stage to have all stray-capacity effects eliminated.

To check the reliability of the coincidence counting the following experiment was performed. The two *G-M* counters, placed at a suitable distance one behind the other and well shielded from stray electrons, were exposed to a collimated ray of electrons (Fig. 3). The apparatus will be aligned when the number of particles entering the second counter will be equal to the number of coincidences registered.

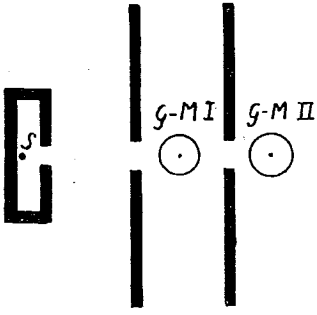

Fig. 3

For this experiment we used two argon-alcohol filled *G-M* counters with 0.1 mm thick outer glass-walls. As a source of β-rays we used radioactive phosphorus placed in a small glass tube.

If the number of impulses per minute from *G-M* counter II is N_2, in which the background N_0 is included, and the number of coincidenses is N_c, for which the background is N_{co}, then $N_c = N_2 - N_0 + N_{co}$. Therefore, if the apparatus is to be considered as reliable, then $N_c : (N_2 - N_0 + N_{co})$ should be equal to one or very nearly so.

Below the results obtained with the above apparatus are presented.

$$\begin{aligned} N_c &= 86{,}1 \pm 0{,}5 \text{ per minute} \\ N_2 &= 164{,}1 \pm 1{,}0 \quad » \quad » \\ N_0 &= 78{,}9 \pm 0{,}5 \quad » \quad » \\ N_{co} &= 0{,}3 \pm 0{,}01 \quad » \quad » \end{aligned}$$

$$\frac{N_c}{N_2 - N_0 + N_{co}} = 1{,}00 \pm 0{,}02.$$

The resolving time τ is determined in the following manner. Two radioactive sources are placed close to respective *G-M* counters. The number of accidental coincidents per minute N_z and the rates N_1 and N_2 at which the *G-M* counters are registering separately are determined.

The equation $N_z = 2\tau N_1 N_2$ then gives the value for τ. Below the resolving time calculated from the results obtained with the above apparatus is given.

G-M counter I	$N_1 =$	910 ± 9 per minute
G-M counter II	$N_2 =$	2447 ± 23 » »
Accidental coincidents	$N_z =$	$16{,}5 \pm 0{,}4$ » »

$$\tau = 4 \cdot 10^{-6} \pm 0{,}2 \cdot 10^{-6} \text{ sec.}$$

The above apparatus was constructed for cosmic-ray measurements to be done in Helsingfors. I wish to take the advantage and thank Prof. MANNE SIEGBAHN, Stockholm, for the radioactive phosphorus obtained from the cyclotron at the Nobel Institute for Physics.