CHAPTER --II.--

EXPERIMENTAL ARRANGEMENT

2.0 We shall now describe the equipment which was used for collecting the cosmic-ray meson intensity data at Gulmarg, partly during the IGY programme. Gulmarg is a hill station at a height of 9000 ft., and a geomagnetic latitude of 24.7°N. The Gulmarg Research Observatory is situated on a hill clear of all surroundings, and communication with the Observatory is very difficult, especially during the winter months. The diesel electric supply is not fully dependable when data has to be collected without a break.

In view of this difficulty, all the electronic circuits had to be designed for battery operation and consequently miniature tubes were used. We designed the quenching, coincidence, discriminator and the scaler circuits.

The G-M counters used were also constructed in the laboratory of the Department of Physics, Aligarh Muslim University, Aligarh.

Details of all this equipment are given below :-

2.1 G-M COUNTERS

Self-quenching G-M counters were used with
dimensions shown in Fig. 1. Pyrex glass envelope had an outside diameter of 1.65 inch and a thickness of 0.06 inch. The effective length of the copper cathode was 23.0 inches and its diameter was 1.5 inch. Tungsten anode of 3 mil diameter was used. An appropriate apparatus for evacuation and gas filling was set up.

2.2 CONSTRUCTION OF THE TELESCOPE

The meson cubical telescope which was constructed at Gulmarg Research Observatory was similar to the standard meson cubical telescope recommended by the cosmic-ray sub-committee of the International Union of Pure and Applied Physics to study the time-variation of meson intensity in the lower atmosphere during the International Geophysical year 1957-58.

The arrangement of G-M counters with their associated electronic units is shown in schematic form in Fig. 2. The telescope consisted of forty five G-M counters and these were arranged in three trays which were electronically coupled in triple coincidence arrangement. The trays were arranged one above the other and the top and bottom trays were separated by a distance of 23 inches. The counters were placed
FIG. 2.
ARRANGEMENT OF G.M. COUNTERS WITH THEIR ASSOCIATED ELECTRONIC UNITS.
with their axes parallel to the E-W plane, the
telescope having a semi-angle 45° in the E-W plane
as well as in the N-S plane.

Two slabs of lead, each 5 cm. thick, were
placed between the counter trays in order to cut off
the soft component, and allow essentially the μ mesons
to be recorded.

The whole of the telescope together with the
high tension batteries was enclosed in a temperature
controlled cabinet maintained at 27°±1°C. The temper-
ature of the cabinet was maintained with the help of a
mercury thermo-regulator.

The average counting rate of the telescope was
about 45,000 three fold coincidences per hour. The
count was recorded at hourly intervals by photographing
the telephone call recorder. Between the recorder and
the triple coincidence circuit there was a scaling factor
of 128.

Leaving aside the end counter as an independent
quenched unit the rest of the fourteen counters were
divided into seven sets of two counters each, and each
set of two counters was connected to one quenching unit.
In this way eight quenching units (Q) were put in each
tray as shown in Fig. 2. The pulses from these quenching
units were connected in parallel and fed to the coincidence unit (C), which in conjunction with the discriminator (D) supplied triple coincidence pulses to the scaler (S).

2.3 ARRANGEMENT FOR NARROW-ANGLE TELESCOPES

The cubical telescope described above was divided into three narrow-angle telescopes, Fig. 3(a), having semi-angles 4°, 7° and 14.5° in the N-S plane and 45° each in the E-W plane. It may be noted that these telescopes consisted of one, two and four counters each.

Three separate coincidence units were employed for these narrow-angle telescopes and the output of the coincidence discriminator combination of each circuit was recorded separately after introducing a scale of four, Fig. 3(b). The telephone call recorders connected with the narrow angle telescopes were also put near the main recorder for being photographed every hour.

2.4 ELECTRONIC CIRCUITS

The quenching units and the coincidence units, which were wired on the same chassis were placed on the counter trays, while the scalers and the power supplies were put in a separate cabinet shown in photograph 1.
Photograph 1 - The cabinet to the right contains counter trays. The power supply and the scalers are to the left.
The counters were checked from the back door of the telescope cabinet by taking the counting rate of the individual counters with the help of a commercial scaler, and the pulses were checked on an oscilloscope. The testing of the counters was done every morning and night.

In time variation experiments where reliable operation of the counters over a long period of time is essential, the use of quenching units improves the flatness of the plateau and prolongs the life of the quenched counters by suppression of multiple discharges. Therefore, a quenching circuit, Fig. 4, was used.

In order to simplify the wiring, conserve power from the batteries and minimize pulse attenuation, the quenching and coincidence units were wired on the same chassis. The coincidence circuit for the cubical telescope and the narrow-angle telescopes are almost the same except for the grid resistance which is different in the two cases. The circuit diagram is shown in Fig. 5.

The scaling unit consists of five circuits: (i) discriminator, shown in Fig. 6, and (ii) pulse-shaper (iii) scaler (iv) amplifier and (v) Recorder drive shown in Fig. 7. The circuit of the scaler used with the narrow telescopes is shown in Fig. 8.
FIG. 6 QUENCHING CIRCUIT
Fig. 5 Coincidence Circuit
Fig. 6  DISCRIMINATOR CIRCUIT
The positive pulses from the coincidence circuit were fed to a discriminator whose output was a square positive pulse corresponding to the coincident event. This pulse was given a correct shape to suit the scaling circuit which required 4-volt negative pulses to operate satisfactorily. The scaler could function properly when it received up to $2 \times 10^5$ pulses per second. The output of the scaler was amplified and it operated the mechanical recorder.

The negative voltage of about -900 volts which was applied at the cathode of the G-M counters was taken from Minimax type Eveready dry batteries. The unregulated D-C voltage of about 200 volts was provided by alkali cells and the regulated +8 volts, to all the electronic circuits mentioned above were supplied through a voltage regulator tube.

2.5 PHOTOGRAPHIC ARRANGEMENT

The photographic arrangement is shown in Fig. 9. The four telephone call recorders as well as the watch and date arrangement were fixed in a wooden box. At one end of this box, the 35 mm. camera was attached. Four 6 volts bulbs were fixed inside the wooden box to provide the flash for the photograph. Every hour the bulbs were lighted and a photograph of the recorders, watch and the
Fig. 9  Photographic Arrangement

- Clock
- Relay 1
  - To Motor
- Relay 2
  - To Flash Bulb
  - 6 V.
- Camera
  - 6 V.
  - Battery
  - To Motor
date was taken. After five minutes the film was wound by a motor bringing a fresh frame in position ready for the next exposure.

The clock was corrected each day with the Greenwich time signal relayed by All India Radio.