COSMIC RAY INTENSITY MEASUREMENTS AT BANGALORE 3° N. (mag.)

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Received May 29, 1950
(Communicated by Prof. H. J. Bhabha, F.R.S.)

§ 1. Introduction

In continuation of the programme of the Tata Institute of Fundamental Research initiated by Dr. H. J. Bhabha in 1945, to measure and study the variation of the intensity of the different components of cosmic radiation with altitude at different latitudes throughout India,[1,2,3] the authors have conducted a number of balloon flight experiments at Bangalore 3° N. (mag.) during the months of February and March, 1950. Seven successful flights were made and some of them reached altitudes as high as 27·5 km. corresponding to a pressure of 30 mb. Quadruple-coincidence telescopes were used: (1) with single-counter trays and 10 cm. of lead absorber; (2) with double-counter trays and 10 cm. of lead absorber; (3) with double-counter trays without absorber. The intensity of the vertical penetrating component was measured by (1) and (2), and the total vertical intensity by (3). The geometry of the telescopes is given in Figs. 1 (*a*), (*b*), (*c*). Figs. 1 (*a*) and (*b*) show the end views of the single and double counter tray quadruple-coincidence telescopes respectively and Fig. 1 (*c*) represents the side view of the telescopes which is the same for both. The shaded areas indicate the position of the lead absorbers.

The technique of telemetering the signals from the air-borne apparatus to the ground receiving station is the same as that used in the previous flights,[1] except that a single ultra-high-frequency radio carrier was used to transmit the quadruple-coincidences, atmospheric pressure, and the temperature inside the gondola. The pressure and temperature signals were transmitted as pulses with a width of the order of 0·5 sec. whereas the cosmic-ray quadruple-coincidence pulses were about 1/5th the width of the former. There was thus no possibility of confusing the different pulses. The pulses were recorded automatically on a moving paper tape at the ground receiving station. The temperature inside the gondola which contained the apparatus was maintained above + 10° C., even at the highest altitudes reached, by using the " greenhouse effect ".

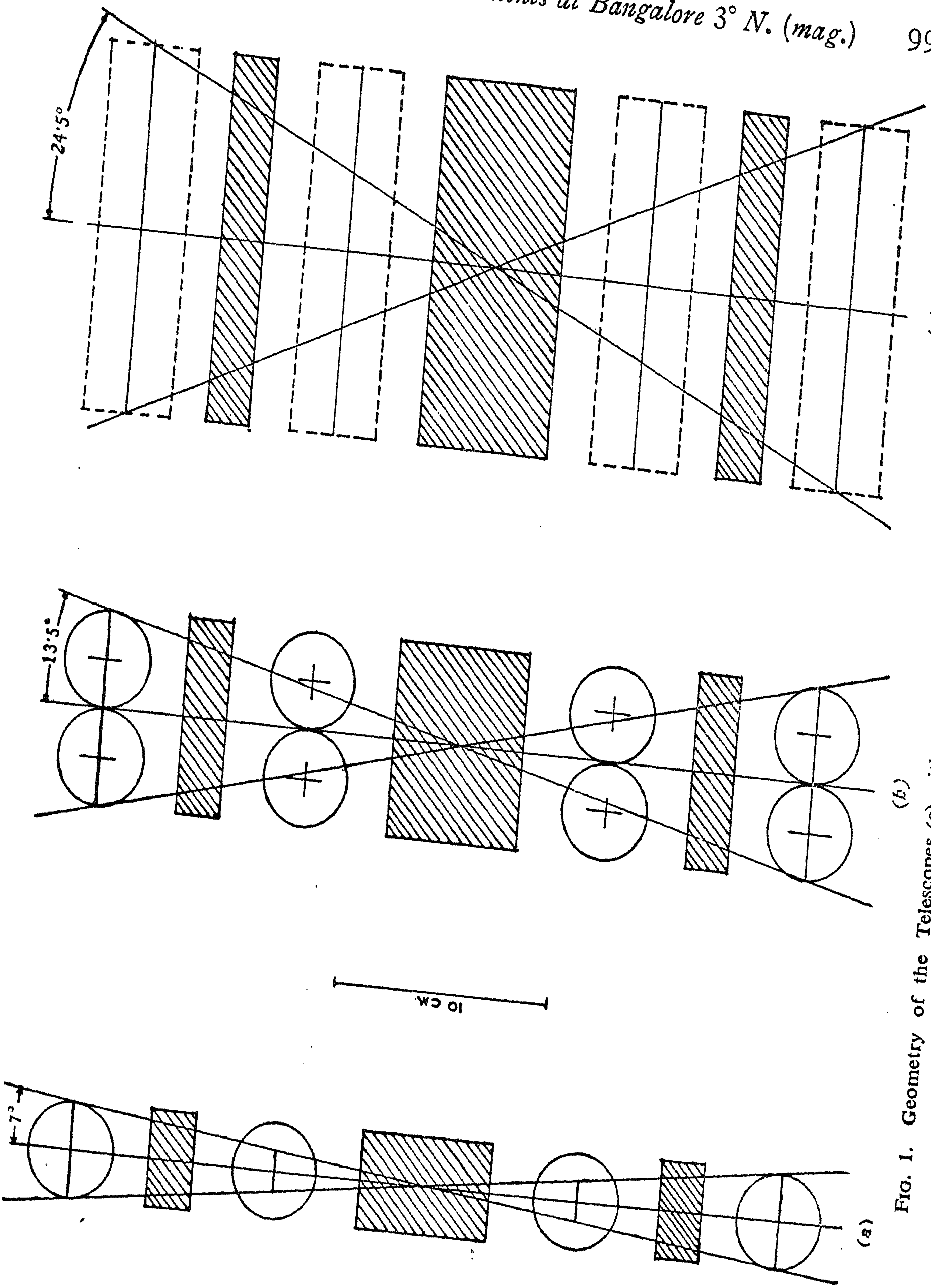

FIG. 1. Geometry of the Telescopes (*a*) with single counters (*b*) with double counters (*c*) side view.

§ 2. Measurement of the Total Vertical Intensity

The total vertical intensity of cosmic radiation as a function of altitude was measured up to a height of 27·5 km., corresponding to a pressure of 30 mb., using a quadruple-coincidence telescope with double-counter trays. The results thus obtained are given in Fig. 2. The root-mean-square devia-

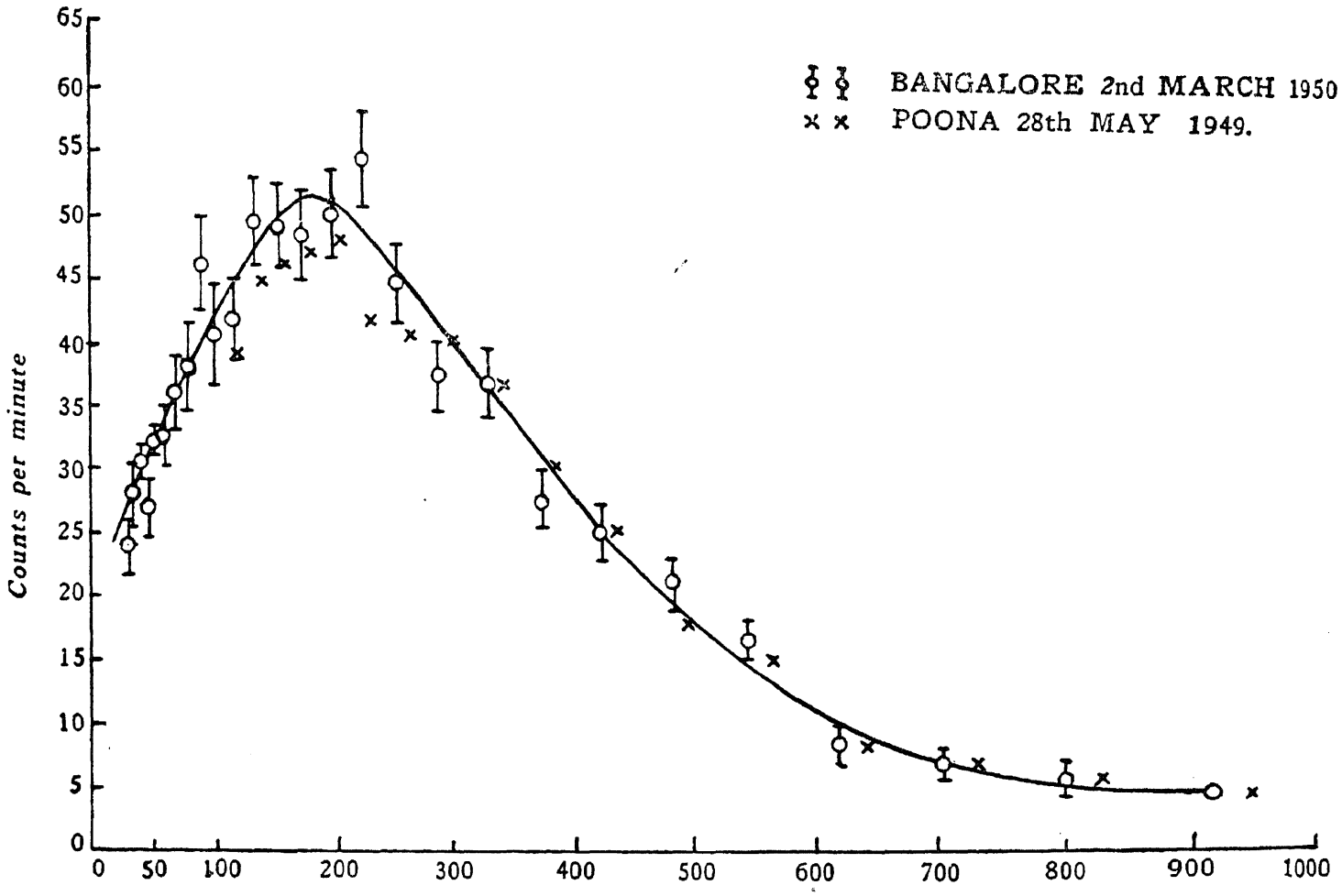

Fig. 2. Total vertical intensity of cosmic radiation.

tion is given for each point. The total vertical intensity obtained at Poona in our previous flights with a similar telescope is also indicated on the same curve. The two sets of observations agree very well with each other, showing that there is no detectable difference in the total vertical intensity between Bangalore 3° N. (mag.) and Poona 9° N. (mag.), which also confirms Neher and Pickering's observations.[4]

§ 3. Measurements of the Vertical Penetrating Component

(*a*) *Single-counter trays.*—The vertical intensity of cosmic radiation penetrating 10 cm. of lead was obtained in four flights with identical quadruple-concidence telescopes with single-counter trays. The semi-angles of the telescopes were 7° × 24·5°. Two typical curves showing

intensity *vs.* pressure in millibars are given in Fig. 3 with the root-mean-square deviation given for each point. Although the scatter of the points

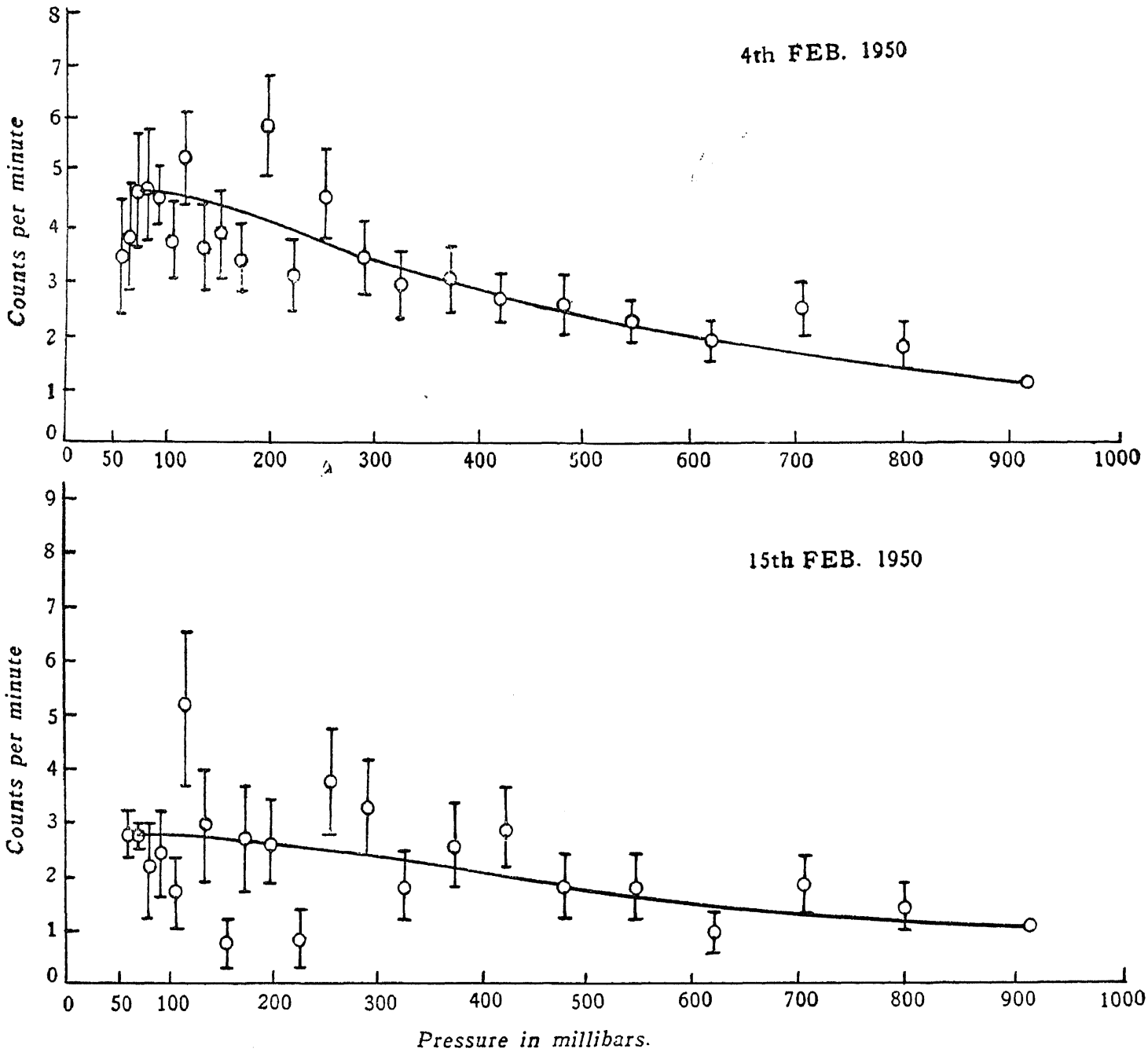

FIG. 3. Vertical intensity of cosmic radiation penetrating 10 cm. of lead (Quadruple coincidences with single-counter trays).

is rather large owing to the relatively low counting rate, all the curves show qualitative agreement in their general features, namely that the intensity increases monotonically with decreasing pressure up to the lowest pressures reached by the apparatus. However, they differ quantitatively in that the ratios of the intensity at 100 mb. level to that at ground level in the four flights are 2·7, 4·0, 2·4 and 4·2 respectively even though all four telescopes were standardised and showed rates on the ground which were 1·05, 1·04, 1·07 and 1·09 respectively.

(*b*) *Double-counter trays.*—In order to reduce statistical fluctuations in the counting rates, telescopes with two counters in parallel in each tray, with 10 cm. of lead absorber, were sent up in two flights to measure the intensity of the penetrating component. The semi-angle of the telescope was $14° \times 24 \cdot 5°$. The intensity *vs.* pressure curves of the two flights are given in Fig. 4. These curves are similar to those obtained with single-counter

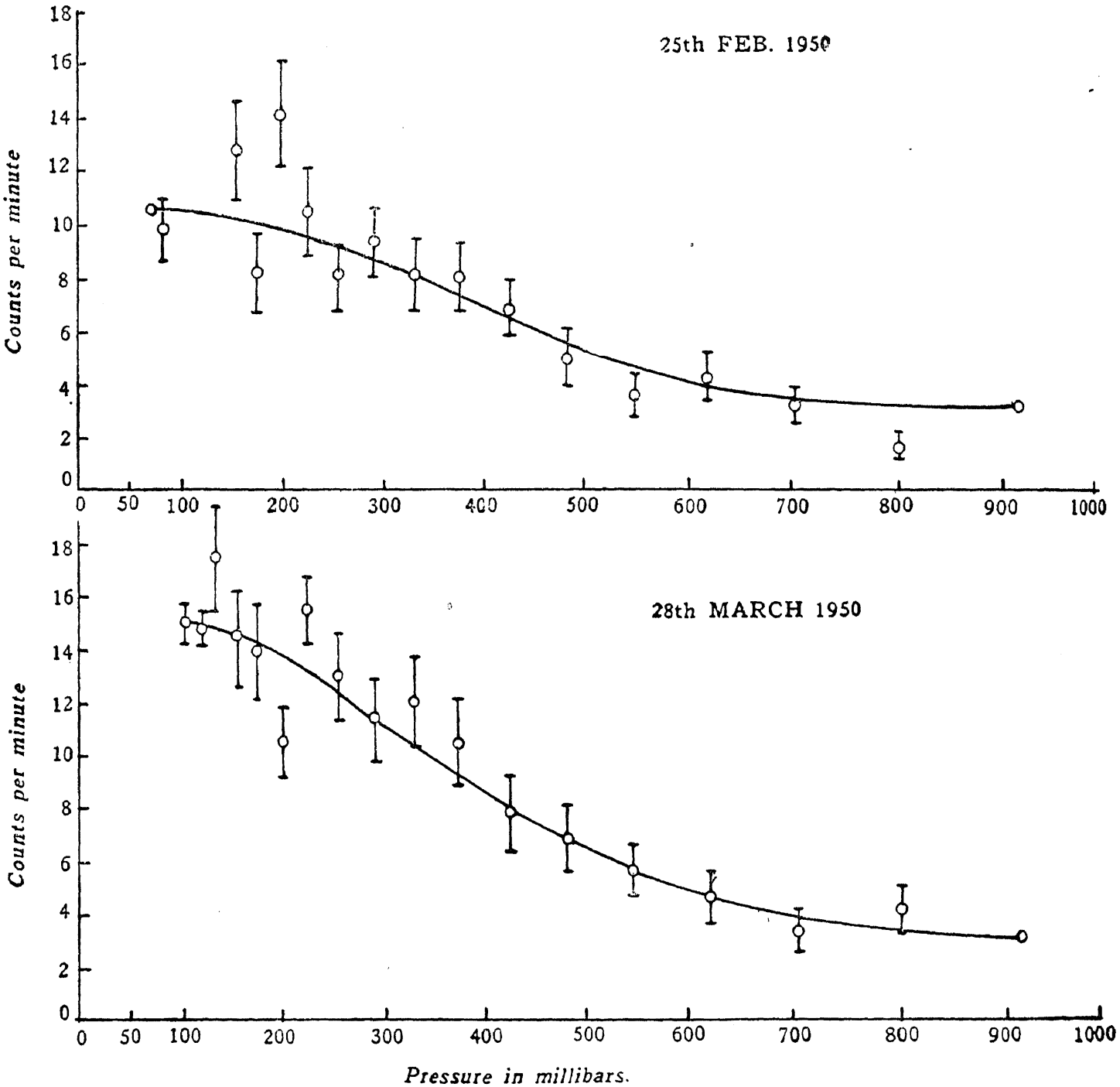

FIG. 4. Vertical intensity of cosmic radiation penetrating 10 cm. of lead (Quadruple coincidences with double-counter trays).

trays, with the same lead absorber. In both of these double-counter tray flights, the intensity increases gradually with decrease of pressure up to the

minimum pressures reached by the apparatus, but again the two curves do not agree quantitatively. The ratios of the intensity at 100 mb. level to that at ground level are 4·6 and 3·4 respectively.

§ 4. Discussion

Every telescope was individually tested on the ground for about 12 hours before it was sent up, to make sure that it was dependable. The average ground counting rates of the four telescopes with single-counter trays with 10 cm. of lead absorber, were all between 1·04 and 1·09 showing that the geometry and efficiency must have been closely similar in all cases. The two telescopes with double-counter trays were also closely alike in geometry and efficiency, and gave ground counting rates of 3·20 and 3·28. In spite of this, the rate of increase of intensity with altitude varies greatly from flight to flight. In view of the care taken to ensure that the telescopes were behaving as nearly as possible identically, and the nearly constant temperature maintained in the gondola we find it difficult to ascribe the variations in the rate of increase of intensity with height solely to instrumental causes. These differences are large, and appear even in the flights made with double-counter trays, which are more reliable statistically. It has been suggested to us by Dr. H. J. Bhabha that these variations may be caused by variations in the temperatures of the atmosphere at very great heights. For a change in the extension of the uppermost layers of the atmosphere would considerably alter the intensity of the observed penetrating component, if this were produced by the primary cosmic rays indirectly through a very short-lived intermediate link. Further experiments will be conducted in the near future to see if these differences in the rate of increase are real and significant. It is also proposed to study the temperature variations of the upper atmosphere from day to day to see whether they show any correlation with the variations in the intensity of the penetrating component.

The authors acknowledge indebtedness to the Government of Mysore for the facilities provided for the flights and especially to Mr. T. V. Ramachandra Ayer, Meteorologist to the Government of Mysore, Bangalore, and to his staff, for their co-operation and help. It is a great pleasure to thank the India Meteorological Department for the supply of hydrogen, and Mr. S. P. Venkiteswaran, Meteorologist, Poona Meteorological Department, for the supply of F. type meteorographs.

We wish to express our gratitude to Prof. H. J. Bhabha for his invaluable guidance and encouragement throughout the progress of this work.

§ 5. Summary

A number of balloon flight experiments were conducted at Bangalore 3° N. (mag.) to measure and study the variation of the different components of cosmic radiation with altitude. Total vertical intensity was obtained with quadruple-coincidence telescopes with double-counter trays up to an altitude of 27·5 km. The vertical intensity of cosmic radiation penetrating 10 cm. of lead was measured by quadruple-coincidence telescopes with single-counter trays and with double-counter trays. The intensity of the penetrating component increases monotonically with altitude in all the flights, but the ratio of the intensity at 100 mb. level to that at ground level differs by as much as 50% from flight to flight, although the ground intensity agrees in all cases to within 3%, and the measurements were made with standard telescopes.

§ 6. References

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