CHAPTER II

EXPERIMENTAL DETAILS

(II.a) Detection of Ground Level Cosmic Ray Stars by Nuclear Emulsion.

Eighteen of Ilford G.5 Nuclear Research Emulsion plates were used in this program. The date of manufacture was 11$^{th.}$ December 1961, the date of arrival at Bangkok from England was 29th December 1961. They were kept under lead absorber 0.3 cm. thick for a time. Six plates were processed on 31$^{st.}$ January 1962 to determine cosmic ray events during transporation and during the time kept in the Department of Physics. The rest of them were devided into packets each of which consisted of 6 plates, and exposed along east-west direction. One packet was shielded on the east side and above, the other was shielded on the west side and above, under the lead blocks of 7.2 cm. thick as shown in Fig. 2. There plates in each packet were processed on 20$^{th.}$ February and the rest were processed on 3$^{rd.}$ April.

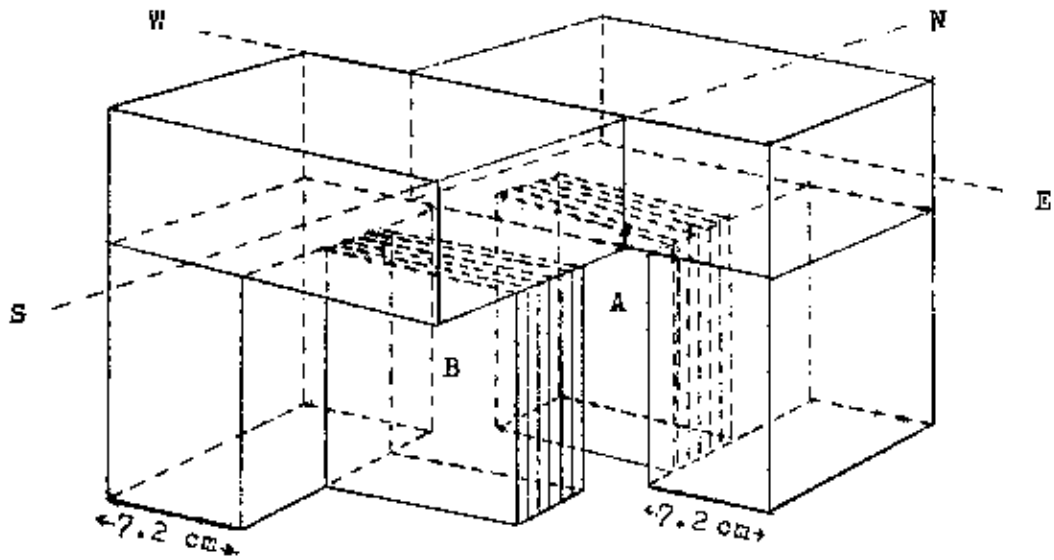
(II.b) Development Technique.

The method of development used is based on temperature development of Dilworth, Occhailini and Payne (21) for the plates of 300 microns thick as shown below.

Preparations:

1 Developer : ("Brussels amidol" developer)

Fig.2 Experimental arrangements



A = plates exposed to cosmic ray from westerly direction.

B = plates exposed to cosmic ray from easterly direction.

1	liter	distilled water
35	gms.	boric acid
19	gms.	sodium sulphite anhydrous
8	c.c.	10% potassium bromide solution
4.5	gms.	amidol Johnson.

The preparation of developer may be done step by step as follows :

Suppose 1 liter of developer was needed.

(a) 35 gms. of boric acid and 9.5 gms. of sodium sulphite are disolved in $\frac{500\ c.c.}{4}$ distilled water at 60°C. This solution was cool down to 20°C.

(b) 4.5 gms. of amidol and 9.5 gms of sodium sulphite was disolved in $\frac{500\ c.c.}{4}$ distilled water at the temperature lower than 20°C.

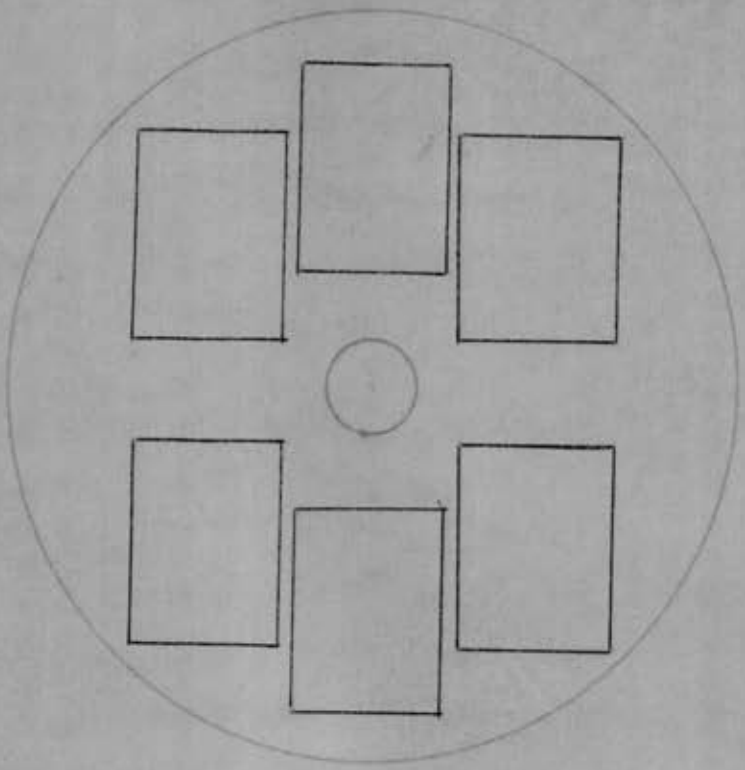
(c) the solution in (a) was poured in the solution in (b) gentlely.

(d) 0.8 gm of potassium bromide was added in the solution (c), then cool down to 5°C.

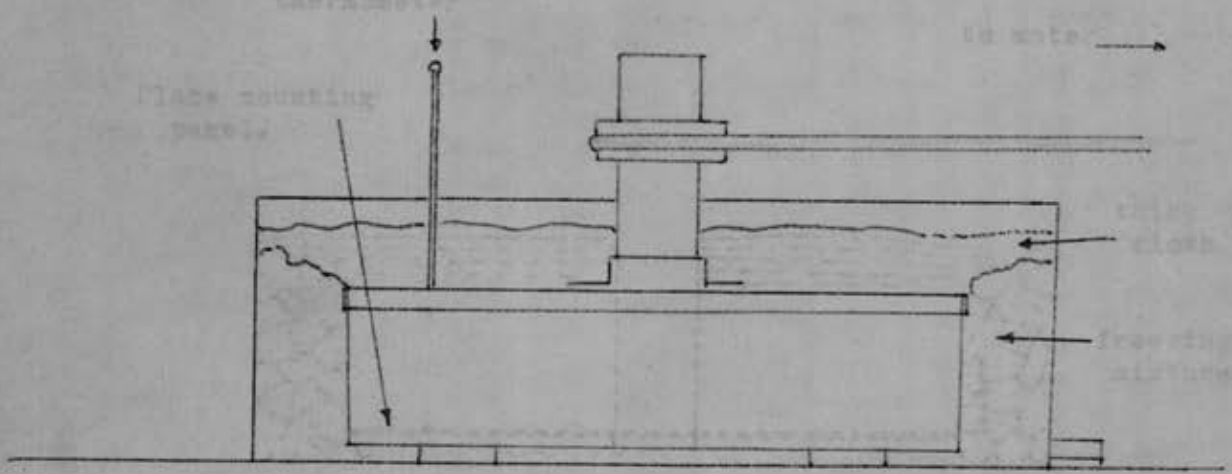
2. stop bath : 0.2 - 0.5% acetic acid.

3. fixing solution : hypo 400 gms.
   sodium bisulphite 30 gms.
   water add to 1000 mls.

4. hypo indicator: distilled water 180 c.c.
   potassium permanganate 0.3 gms.
   sodium hydroxide 0.6 gms.
   water added to 250 c.c.



a. The top view of plate counting panel.



b. The side view of the complete arrangement of the processing tank

Fig. 3

5. glycerine solution 0.5 - 1 %

The processing apparatus is a circular black plastic tank, containing a circular plate mounting panel, as shown in Fig. 3.

The development was done step by step as follows :-

Step 1 : The plates were soaked in distilled water at 5°C for 75 minutes.

Step 2 : Then the plates were soaked in "Brussels amidol" developer at 5°C for 75 minutes. In this step, the developer is allowed to penatrate through emulsions and the maximum penatrating power of the solution is approximately at 5°C. The chemical reaction did not occur at this temperature because of lowtemperature.

Step 3 : The developing action was set to work by warming up the solution to 23 - 25°C by putting the tank in hot water. This is known as "hot stage method". The time for hot stage was about 60 minutes.

Step 4 : The plates were cooled down to 5°C for 30 minutes.

Step 5 : The plates were transfered to stop bath at 5°C and left for 1 hour.

Step 6 : The stop bath was removed by washing in slow running water at 5°C for 1 hour.

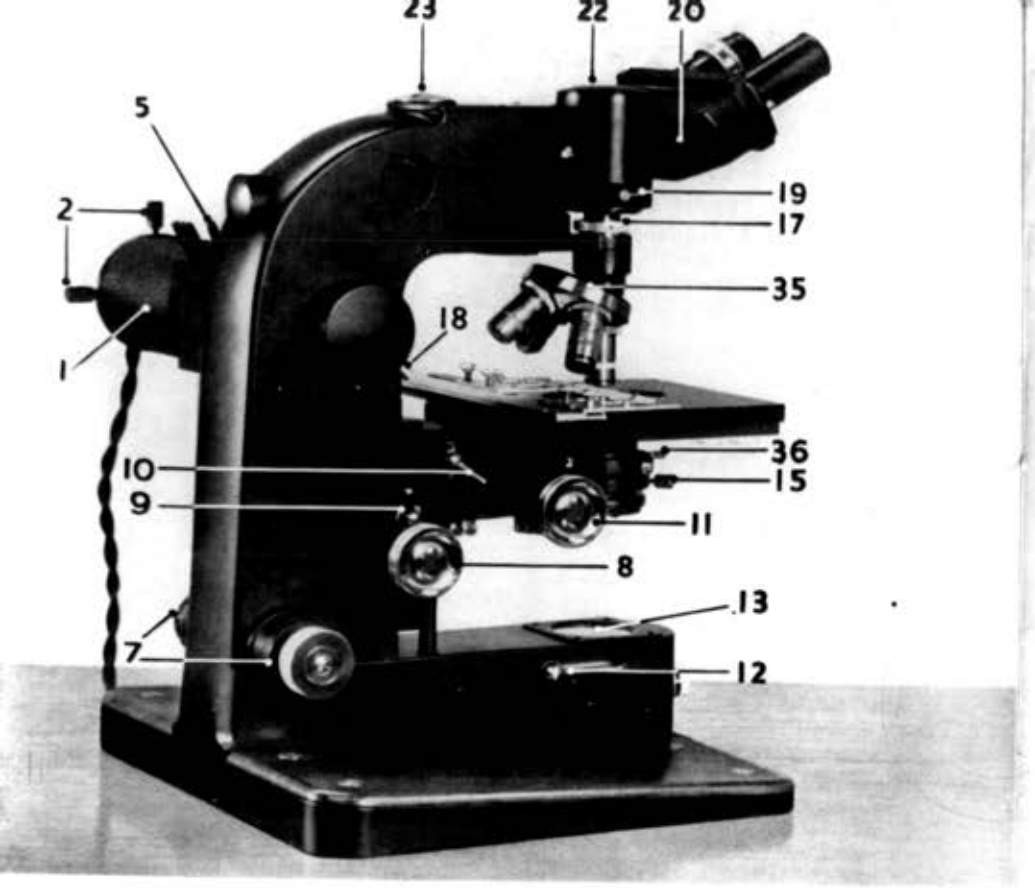
Step 7 : The unexposed silver bromide was removed by soaking the plates in fixing solution at 10 - 15°C , with agitation. The time for fixing was 14 hours.

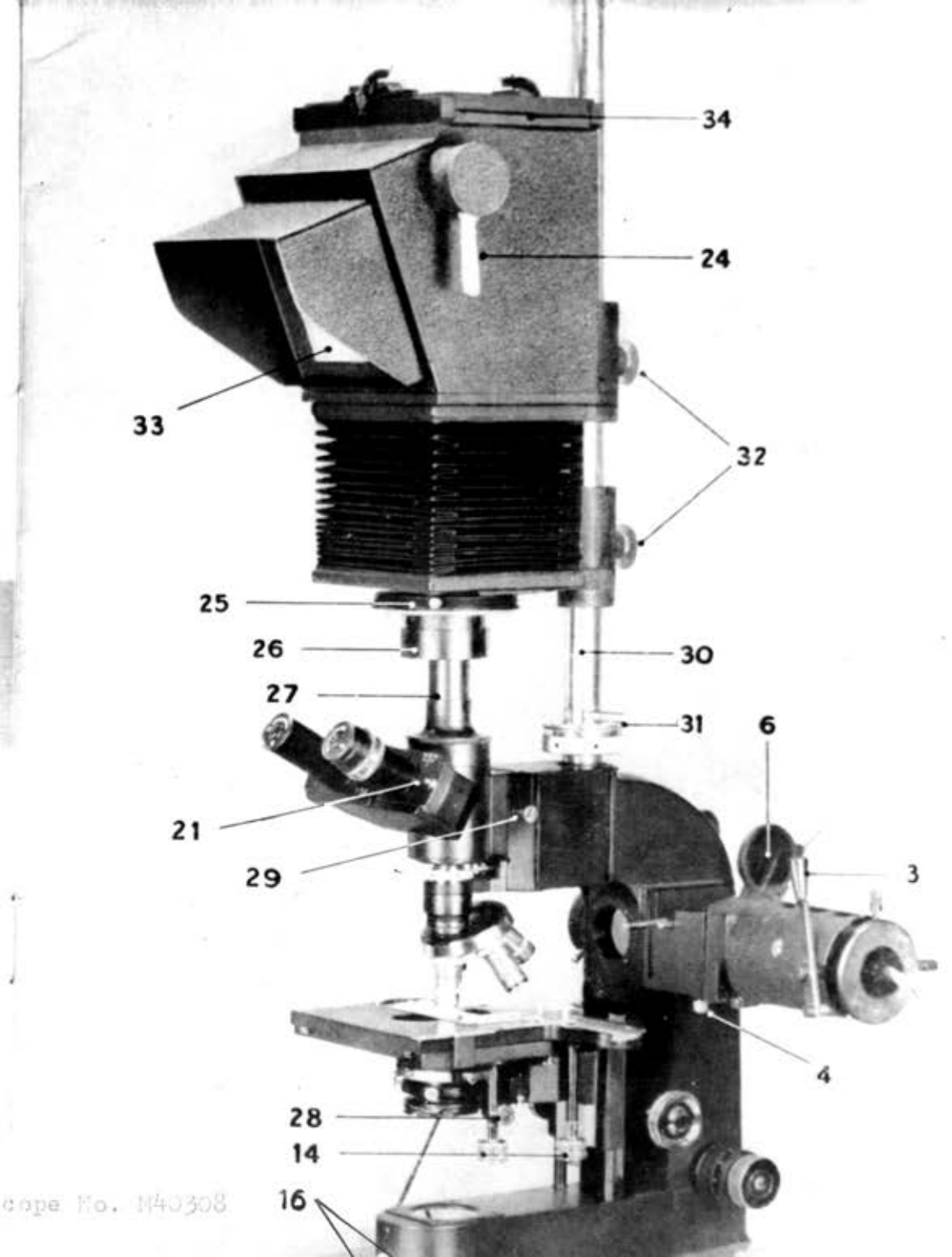
Step 8 : The plates were removed from the fixing bath and washed in slow running water 10 - 15°C for 24 hours. The hypo was completely removed to prevent later fading of the developed image so that the hypo indicator was used to assure complete removal. Several drops of this solution, ordinarily violet in colour, when added to a sample of water containing hypo will turn to orange in less than a minute. On the contrary with large hypo concentrations, the result will be a yellow coloration]

Step 9 : Since the silver bromide was removed during fixing stage, a large shrinkage in thickness occured. The emulsions were impragnated with sufficient glycerine after processing so that the final thickness may be brought to the original if desired. The time required for this step was 45 minutes.

Step 10: The plates were kept horizontally in a desicator, containing calcium chloride to dry for 3 days and were left completely dried in air for 4 or 5 days.

As a result of high concentration of silver bromide in nuclear emulsions and its partial solubility in the





REFERENCES

1 Lamp housing
2 Lamp centring screws
3 Focusing lever for lamp
4 Clamp securing lamp unit
5 Lamp iris control
6 Hinged filters
7 Fine focusing adjustment
8 Vertical adjustment to stage
9 Clamp to 8
10 Clamp for additional height adjustment to stage
11 Substage focusing adjustment
12 Control for additional condenser for low powers
13 Window for transmitted light beam
14 Stage controls
15 Condenser centring screws (2)
16 Mirror adjusting screws
17 Ring for securing objective changer and incident illuminator
18 Switch for changing illumination from transmitted to incident
19 Switch for changing from visual to photographic
20 Binocular body
21 Inter-ocular adjustment
22 Removable cap for insertion of straight photographic tube
23 Removable plug in place of camera pillar
24 Reflex switch
25 Shutter
26 Light trap
27 Straight photographic tube
28 Clamp to transverse stage control
29 Clamp for securing interchangeable body
30 Camera pillar
31 Clamp for securing camera axially
32 Clamps for securing camera vertically
33 Reflex screen
34 Plate holder
35 Quadruple objective changer
36 Screw securing condenser

Fig. 4 Picture showing the various parts of the microscope No. M40308

developer, a thin film of silver is usually formed on the surface of the emulsions during development. Silver deposits were removed in final washing by the use of a wet chamois or, preferably, the finger tips. Alternatively, when the emulsion was completely dry, the microscope immersion oil and lens tissue may be used to wipe the silver off, and cleans off the microscope immersion oil by cotton moistened with alcohol or xylene.

(II.c) Apparatus and Experimental Procedure.

Optical Instrument:

A high power microscope with an oil emersion was used in the scanning. The type used was a Cooke - Troughton Nuclear Emulsion Microscope type M40308 using an objective of 10 magnifications. To analyse the coincident tracks of stars an objective of 42 magnification was sometimes used. With a pair of x 15 compensating eye-pieces.

Alignment of Microscope:

(1) A pair of x 15 eye pieces were selected in scanning. The x 10 objective was inserted at the apertures marked 1 for the lowest power objective.

(2) The plate was placed upon the microscopa stage with the number edge being at the bottom, and brought into focus by the motion which raised and lowered the stage.

(3) The condenser iris was closed and it was brought into focus by the condenser focusing adjustment. The iris aperture was set to the centre of the field of view of the eye piece by means of the two condenser centring screws.

(4) The condenser iris was opened and the lamp iris was closed. The field iris was brought into focus by the condenser focusing adjustment. The iris aperture was set to the centre of the field of view by the two mirror adjusting screws in the base at the front of the instrument.

(5) The filament of the lamp was brought into focus by means of the lever, and brought to the centre of the field of view by the two lamp centring screws.

(6) The lamp was moved outward or inward until the field was evenly illuminated. If the light beam was not direct axially into the condenser, the track would appear to twist. Such misalignment can cause great eyestrain.

(7) Adjustment for the interpupillary distance.

The separation of the two eyepiece tubes can be varied by sliding the inter-ocular adjustment inwards or outwards. A millilimeter scale is provided by means of which the observer can note the correct setting after the adjustment has once been made. The adjustment was tested by alternately observing the eyepieces and by alternately closing the eyes. After one eye had been closed, an impression remains for a part of a second, and if the other eye is uncovered immediately, it is possible to become conscious of the two fields simultaneously.

If each eye is seeing completely, the adjustment is practically correct.

(8) A final adjustment was made in order to compensate for differences in strength between the right and left eyes. This adjustment was made by focussing the microscope so that it was sharp for left eyes, then the left eyepiece was covered, while the right one was adjusted, by rotating the knurled ring locating on it, until the image was equally sharp for the right eye. Both eyes should then see the image equally well.

Scanning Procedure.

The plate was scanned by adjusting the x-axis to a fixed point co-ordinate value and varying the y-axis between the prescibed limits, from one field of view to the adjacent one.

The way to move the plate to right and left along the axis is called x-axis and the right angle to this is called y-axis. The co-ordinate of events "x" and "y" were recorded to avoid the duplication of data by recording the same events more than once. In the case of more than one event in a field the depth should be noted. The immages of big stars were recorded with the total number of tracks and those of dense tracks. The total number of 2 prong stars, 3 prong stars, --- and soon, were counted. The results are shown in Table[&]I ----- in the next chapter.