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III-1-11. Heavy Primary Cosmic Radiations Observed on 11 Sept., 1957, at Prince Albert, Canada*

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A systematic investigation on the heavy primary cosmic radiation is made on the basis of extensive analysis of the Prince Albert Stack. The main results, part of which were already reported elsewhere[1], are:

1. The general shape of the rigidity spectrum, common to all components. is found to have had broad maximum which fell around 2.2 *GV* with a width of about 0.6 *GV* on 11 Sept., 1957.

2. The flux values above the atmosphere of various heavy primary components are given in Table 1, the extrapolation to the air-top having been made by means of the set of parameters given in Table 2, which are very near to those given by Waddington in his review article[2].

3. The flux values of medium and heavy nuclei are found to be considerably lower than those of the solar-calm period for all the rigidity region up to$\sim$10 *GV*.

4. Carbon and *Fe*-group elements are overabundant as compared with their abundances in normal stars, while the relative abundance of the elements between *N* and *Si* are very similar to that in planetary nebulae.

5. The flux ratios of light and heavy nuclei, respectively, to medium nuclei are given in Table 3. The flux ratios in higher rigidity region agree fairly well with those obtained for $R \geqq 4.5$ *GV* by Bristol, Torino and Chicago group,[3] when re-calculation of the extrapolation to the air-top is made using the parameters given in Table 2. The flux

Table I. Integral flux values in the Prince Albert Project (with ascent correction)

	$1.3 \leqslant R \leqslant 2.7$	$R \geqslant 2.7$ GV	$200 \leqslant E \leqslant 700$	$E \geqslant 700$ MeV/nucleon
He	40.6±5.2	81.1±7.2	40.6±5.3	80.1±7.2
L (LiBeB)	1.15±0.13	1.61±0.15	1.35±0.14	1.34±0.13
M (CNOF)	3.64±0.32	6.37±0.80	3.64±0.32	6.37±0.80
H ($Z \geqslant 10$)	1.24±0.16	1.87±0.18	1.24±0.16	1.87±0.18

Table II. Set of parameters used in extrapolation to air-top.

Collisions mean free paths in air (g/cm²)

λ_H	λ_M	λ_L
19.0	27.1	31.6

Pragmentation parameters in the air

Parent \ Daughter	H	M	L
H	0.30	0.33	0.15
M		0.15	0.25
L			0.15

* This paper was not read due to lack of time.

Table III. (a) Charge ratios in the Prince Albert Project.

	$1.3 \leqq R \leqq 2.7$	$R \geqq 2.7$ GV	$200 \leqq E \leqq 700$	$E \geqq 700$ MeV/nucleon
L/M	0.32±0.05	0.25±0.04	0.37±0.05	0.21±0.03
H/M	0.34±0.05	0.29±0.05	0.34±0.05	0.29±0.05

(b) Charge ratios for $R \geqq 4.5$ GV

	Bristol	Torino	Chicago
L/M	0.25±0.04	0.25±0.03	0.30±0.04
H/M	0.36±0.05	0.51±0.07	0.41±0.06

(c) Charge ratios for $E \geqq 1.5$ Gev/nucleon

	Bristol	Torino	Chicago
L/M	0.21±0.03	0.21±0.02	0.25±0.03
H/M	0.36±0.05	0.51±0.07	0.41±0.06

ratios show no significant dependence on rigidity, while, if expressed in terms of energy per nucleon, the light to medium ratio is significantly higher in lower energy region than in higher energy region, the heavy to medium ratio showing no significant energy dependence.

6. The collision mean free paths in *G*5 emulsion and the fragmentation parameters for $N_h \leqq 7$ events show, in the zero-th approximation, no significant energy dependence in the energy region between several hundred MeV/nucleon and several GeV/nucleon. On closer examination, however, there is some indication that the collision mean free paths for $E \sim 500\ MeV$/nucleon are somewhat longer than those for $E \sim 3\ GeV$/nucleon.

For details of our work, such as the method of measurement, the reader is referred to our report which appeared just before the Kyoto Conference in Suppl. Prog. Theor. Phys.[4]

References

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