

## PREFACE

The Primary Cosmic Ray energy spectrum extending over the range from  $10^9$  to  $10^{20}$  eV and the primary composition at various energy bands in this spectral range have been the subject of investigation for more than 30 years now. The status of our knowledge concerning the primary composition is more unsatisfactory even from  $10^{12}$  eV onwards . The integral primary flux steepens at around  $10^{15}$  eV and flattens at around  $10^{19}$  eV and these features are called the "knee" and the "ankle" of the primary spectrum . No "toe" of the primary spectrum indicating the end of the spectrum has been found in the experiments so far . At the "ankle" not more than 10 air shower events have been detected to date in the Extensive Air Shower observatories . The proposed Pierre Auger Observatory aims to detect statistically significant Primary Cosmic Ray events at the "ankle" and above.

The direct observations of the primary nuclei with nuclear emulsion stacks have provided evidence that the nuclei heavier than the proton are present in the Primary Cosmic Rays up to energy  $10^{14}$  eV , but the proportion of such nuclei heavier than  $\text{He}^4$  remains unconfirmed as yet and is less than that expected from lower energy data .

The aim of the present work is to extract information about the primary composition at the "knee" energy region from the detailed study of both low and high energy muons in smaller air showers detected near sea-level . In this thesis we present all the results on the electron and muon components in air showers in the size range  $10^4$  -  $10^6$  particles and examine these results critically together with the results of previous air shower studies to derive conclusion on the primary composition in the knee energy region.

The candidate , a Senior Research Fellow at the High Energy and Cosmic Ray Research Centre holding a University fellowship for a tenure of 5 years from December 1993 has worked with other workers of the group . His contribution to the work during this period is stated below :

(1) Calibration of the detectors

- (2) Rearrangement of the array and resetting the detectors
- (3) Operation and day-to-day maintenance of the set-up
- (4) Data taking
- (5) Development of computer programs and analysis

As an additional support to the candidature the reprints of papers published as listed below are submitted with the thesis .

### **Published papers**

(1) Study of electrons simultaneously with muons in Extensive Air Showers (EAS) initiated by Primary Cosmic Rays of energy  $10^{14}$  -  $10^{16}$  eV.

C.Chakrabarti , D. Chanda , G.Saha , A.Mukherjee , A.Bhadra , S.Sanyal , S.Sarkar , B.Ghosh , N.Chaudhuri .

24th International Conference on Cosmic Rays , Rome , 1(1995)387

(2) Low and high energy muons in Extensive Air Showers of size  $10^4$  to  $10^6$  particles.

C.Chakrabarti , D. Chanda , G.Saha , A.Mukherjee , A.Bhadra , S.Sanyal , S.Sarkar , B.Ghosh , N.Chaudhuri .

24th International Conference on Cosmic Rays , Rome , 1(1995)569

(3) A search for anisotropy in the arrival direction of EAS by cosmic rays from discrete sources.

C.Chakrabarti , D. Chanda , G.Saha , A.Mukherjee , A.Bhadra , S.Sanyal , S.Sarkar , B.Ghosh , N.Chaudhuri .

24th International Conference on Cosmic Rays , Rome , 1(1995)462

(4) A new lateral distribution function for electrons in Extensive Air Showers (EAS) detected near sea level.

B.Bhattacharyya , A. Bhadra , A.Mukherjee , G.Saha , S.Sanyal , S.Sarkar , B.Ghosh and N.Chaudhuri.

IL Nuovo Cimento , 18C(1995)325

### **Submitted paper**

(1) An experimental study of Primary Cosmic Rays at the knee energy region by observation of Extensive Air Showers(EAS)