Preface

Most of the energetic Cosmic Ray particles appear to be atomic nuclei. Cosmic Ray air shower observations so far have reported a number of events (eight to ten) in which the primaries had an energy greater than 10^{20} eV . Understanding the origin of charged Cosmic Ray particles has been difficult owing to the presence of a magnetic field in the Galaxy. Consequently , the Cosmic Ray origin problem has remained unsolved even though the study of Cosmic Rays began about a century ago. Recently , a great need has been recognised to observe emission of neutral particles (for example photons) from a number of discrete point sources which have been identified as candidate sources of Cosmic Rays , in addition to observing isotropic Cosmic Ray particles. This is also the thrust of the North Bengal University (NBU) extensive air shower (EAS) project which was started in 1980. The EAS detector array at a site on the NBU campus measures EAS arrival direction , size , muon distribution with a view to identifying the nature of the primary particles from various directions and also from the directions of the some specified discrete sources.

The author of the thesis joined the NBU project in 1992 holding a UGC junior research fellowship and has contributed to the expansion , development and operation of the EAS array in the following respects

1) Rearrangement of the detector array and resetting the individual detectors
2) Modernising the data-handling system
3) The calibrations of the detectors
4) Operation and day-to-day maintenance of the set-up
5) Data taking
6) Development of computer programs and analysis.

The analysis includes the following :

1) Reconstruction of the shower parameters from the observed shower data (Chapter 2)
2) Determination of arrival direction of individual showers (Chapter 2)
3) Study on shower front curvature and the time spread of the particles in the shower front.(Chapter 2)
4) Estimation of errors (Chapter 2)

5) Determination of the angular resolution of the array (Chapter 2)

6) Study on general characteristics of the observed showers (Chapter 3)

7) Study on shower parameters (Chapter 3)

8) Determination of the 'effective area' of the Aray (Chapter 3)

9) Search for excess air showers from the direction of four potential discrete point sources (Cygnus X-3 , Hercules X-1 , Crab Nebula and Geminga) (Chapter 3)

10) Phase analysis of the event times of the showers from two discrete point sources (Cygnus X-3 and Hercules X-1) (Chapter 3)

The previous work of other workers on emission of gamma-ray photons from discrete sources has been re-examined together with the present analysis and, the following features have been found in the present work:

1) The high muon content and high shower 'age' value of the excess showers from the direction of discrete point sources , as observed in a number of observations , may not be independent characteristics of the directional showers.

2) The high 'age' value of the directional showers can not be explained in terms of zenith angle.

3) No statistically significant excess of EAS from any of the observed sources has been found.

4) The phase analysis of the event time of EAS from the direction of Cygnus X-3 shows an excess of 2.11 σ in one phase bin.

As an additional support to the candidature , the author submits the following published papers to which the author has contributed.

1) An analysis of Cosmic Ray Air Showers for the Determination of Shower Age , Sanyal S. , Ghosh B. , Sarkar S.K. , Bhadra A. , Mukherjee A. and Chaudhuri N. , Aust. J. Phys. , 46 (1993) 589

2) A New lateral Distribution Function for Electrons in Extensive Air Showers (EAS) Detected near Sea Level. , Bhattacharyya B. , Bhadra A. , Mukherjee A. , Saha G. , Sanyal S. , Sarkar S. , Ghosh B. , and Chaudhuri N. , IL Nuovo Cimento , 18C (1995) 325

3) Measurement of the Charge Ratio of High Energy Muons in Cosmic Ray Extensive Air Shower (EAS) , Sarkar S.K. , Ghosh B. , Mukherjee N. , Sanyal S. , Bhadra A. , Mukherjee A. and Chaudhuri N. , in Proc. 23 rd International Cosmic ray Conference , Calgary, 4 (1993) 335

4) A study on the Cosmic Ray Age parameter , Sanyal S. , Ghosh B. , Sarkar S.K. , Mukherjee A. , Bhadra A. , and Chaudhuri N. , in Proc. 23 rd International Cosmic ray Conference , Calgary, 4 (1993) 339

5) Studies on the lateral Distribution of the Soft Component in the EAS , Bhattacharyya B. , Ghosh B. , Sarkar S.K. , Sanyal S. , Bhadra A. , Mukherjee A. and Chaudhuri N. , in Proc. 23 rd International Cosmic ray Conference , Calgary, 4 (1993) 331

6) Study of Electrons Simultaneously with Muons in Extensive Air Showers (EAS) initiated by Primary Cosmic Rays of Energy 10^{14} - 10^{16} eV., Chakrabarty C. , Chanda D. , Saha G. , Mukherjee A. , Bhadra A. , Sanyal S. , Sarkar S.K. , Ghosh B. and Chaudhuri N.,in Proc. 24 th International Cosmic ray Conference , Rome, 1995 , HE 3.2.5 .

7) A Search for Anistropy in the Arrival Direction of EAS by Cosmic Rays from Discrete Sources. , Chakrabarty C. , Chanda D. , Saha G. , Mukherjee A. , Bhadra A. , Sanyal S. , Chettri R. , Sarkar S.K. , Ghosh B. and Chaudhuri N., in Proc. 24 th International Cosmic ray Conference , Rome, 1995 , HE 3.3.14 .

8) Low and High Energy Muons in Extensive Air Showers of Size 10^4 to 10^6 Particles. , in Proc. 24 th International Cosmic ray Conference , Chakrabarty C. , Chanda D. , Saha G. , Mukherjee A. , Bhadra A. , Sanyal S. , Chettri R.K. , Sarkar S.K. , Ghosh B. and Chaudhuri N.,Rome, 1995 , HE 4.1.17 .

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