ARRIVAL DIRECTIONS OF MEDIUM ENERGY COSMIC RAYS IN THE SOUTHERN HEMISPHERE

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by

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Contents

Summary

As the study of cosmic rays enters its ninth decade of investigation, several facets of this field, most notably the origin of these high energy particles, remain at least partially unresolved. Investigations into the arrival directions of these particles (and also of Ultra-High-Energy (U.H.E.) γ-rays) provide one line of investigation through which these problems may be resolved, or at least limited to some extent. Unfortunately, the arrival directions of charged cosmic ray particles are effectively randomised by the galactic magnetic field producing an *almost* isotropic flux of primary cosmic rays.

This thesis presents the results of an investigation into the anisotropy of the arrival directions of cosmic rays of energies between 3×10^{14}eV and 10^{17}eV, recorded by the Buckland Park Extensive Air Shower Array at a latitude of 35°S, over the period June 1984 to May 1989. In addition to this work, the Buckland Park Array was also upgraded by the author to improve the array performance for future anisotropy investigations.

The introductory chapters of this thesis briefly review the history of cosmic ray research and the current status of investigations into the various properties of the primary cosmic ray flux, followed by a more detailed discussion of the initiation, development, and detection of Extensive Air Showers, which are the avenue through which these high energy cosmic rays are indirectly detected.

Chapter 3 describes in detail the instrument used in this investigation, the Buckland Park Extensive Air Shower Array. The components of this array, together with the development, data collection and analysis for the period 1984 to 1989 are discussed, with particular emphasis on the analysis carried out by the author on data collected over this period in fitting shower parameters to each event. The design and implementation of modifications to the array carried out during 1989 and 1990 by the author are then described and preliminary results of the modified array behaviour are presented which were found to be in line with both computer simulated results and design specifications.

The history of, and analysis techniques commonly employed in investigations of the anisotropy of the primary cosmic ray flux are reviewed in detail in Chapter 4. Following this, the results of the analysis of the 1984 to 1989 data set for anisotropy in the primary cosmic ray flux are presented in Chapter 5, including a detailed discussion of the techniques employed in attempting to remove external effects from the data. After identifying and removing a portion of data found to be severely contaminated with an apparently artificial effect of unknown origin, which could not be effectively removed from these data, no significant anisotropy amplitudes were found in the remaining data, and appropriate upper limits, consistent with previous determined results were calculated over the energy range 3×10^{14}eV to 10^{17}eV. In addition to these results, remarkable agreement of first harmonic phases with previous results was found, which is surprising in the absence of any significant amplitude measurements.

In recent years, U.H.E. γ-ray astronomy has become a major part of cosmic ray research, and in Chapter 6, the results of recent searches using data collected by the author over the period March 1988 to May 1989 for U.H.E. γ-rays from several sources including SN1987A are presented, as part of the on-going U.H.E. γ-ray program at Buckland Park.

The concluding chapter summarises the results presented in this thesis, and makes suggestions for future work.