Exploring geospace and the heliosphere by cosmic rays

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INTRODUCTION

Since cosmic rays consist of charged particles having their origin in galactic space, the particles are affected by spatial magnetic fields encountered during their transport to Earth. These particles have to enter the heliosphere by penetrating the boundary region where the solar wind is terminated by an opposite interstellar wind pressure. After diffusing through the heliospheric interplanetary space, the particles arrive eventually at the geomagnetic field region, the magnetosphere. The geomagnetic field acts as a magnetic spectrometer, deviating the lower energy particles to the polar regions. Owing to the rotation of the Earth, the cone accepting entrance of these cosmic ray charged particles to the location of a ground level detector, has a directional sweeping effect in sidereal time.

SANAE is located uniquely in the sense that no other cosmic ray detector on Earth looks into outer space in the same direction. For that reason there was and still is a continuous demand by the international community for cosmic ray data from SANAE since the first recordings in 1964. Cosmic ray data collected at SANAE is therefore used and recognized in many papers on cosmic rays. The opposite is also true. South African researchers have in exchange almost free access to data collected at ground level and also by satellites and space crafts for their research projects. Many of the research papers testify then this international communial data accessibility.

EXPLORING GEOSPACE

When neutron monitor recording of cosmic rays at SANAE started in February, 1964, the first aim was to learn to understand the effect of the atmosphere and the geomagnetic field on the transport of cosmic rays. Therefore, during the first period of research a large effort was put into latitude surveys. A neutron monitor on the ms *RSA* recorded cosmic rays on all journeys since 1962.

The results from these latitude surveys helped to show that the vertical cutoff rigidity, when calculated from particle trajectory tracing in the International Geomagnetic Reference Field (IGRF), may be related uniquely to the integral intensity spectrum of galactic cosmic rays. This result was very important for recording in the South African region because of the Brazilian and Cape Town Geomagnetic Anomalies (Van der Walt *et al* 1972; Gledhill 1971; Van der Walt *et al* 1970; Van der Walt and Stoker 1990).

Much attention had to be given to atmospheric effects on the counting rates of the SANAE neutron monitor and the neutron monitor on the ms *RSA*, in order to relate the counting rates to the intensity of cosmic rays arriving on the top of the atmosphere. This study led to the development and design of the so-called neutron moderated detector (NMD) (Stoker and Mischke 1973). The first prototype was put into operation at SANAE in May 1972, in time to record, together with the standard super neutron monitor at SANAE, the solar flare proton event of 1/2 September 1971. This prototype detector was replaced by the so-called 4NMD during takeover in January 1974. Important contributions have since been made on recording solar flare proton events by these two detectors with different sensitivities to primary cosmic ray energies (Stoker and Makgamathe 1990).

EXPLORING THE HELIOSPHERE

By comparing the sea level latitude surveys during solar minimum activity years 1964, 1976 and 1986 with similar surveys along and across the North American Continent in 1953 and 1964, it was possible to identify for galactic cosmic ray spectra during solar minimum periods a 22-year variation (Moraal *et al* 1989). This very important result may be related to the 22-year period in the solar magnetic cycle, implying that during each half-period of 11 years the drift of galactic cosmic ray particles during transport through the heliosphere is affected differently. This drift effect has been explored in several recent papers by H Moraal, M S Potgieter and J A le Roux.

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