SHORTER CONTRIBUTION

Cosmic rays latitude survey at solar minimum[1]

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Introduction

The nucleonic component of the cosmic rays has been studied during two voyages on the German research vessel *Meteor* (Fig. 1). The measurements were carried out from 10.8.1965 to 16.12.1965 (Atlantic Expedition IQSY, 1965) and from 1.8.1966 to 14.9.1966 (Greenland Expedition, 1966) at solar minimum activity. The investigations have been made using a IGY neutron monitor of standard device with BF_3-counters (Simpson *et al.*). The monitor was electronically separated into two equivalent sections. The counting rates of each section were printed out every 15 minutes. The total counting rate of the monitor at high latitudes amounts to 11,600 events/h.

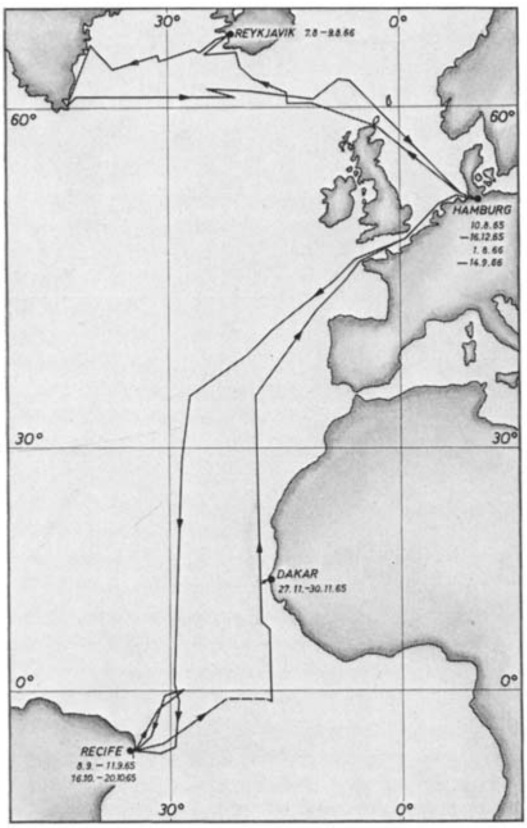

Fig. 1. The route of *Meteor* during the Atlantic Expedition IQSY 1965 and the Greenland Expedition 1966.

Results

Fig. 2 shows the measured results of the nucleonic component during the two expeditions in a rigidity range from 0.2 GV to 14 GV. The 15 minute values have been summed up to three hour values, which have been corrected to the standard pressure of 1013 mb using the pressure coefficient $\alpha = -0{,}72\,\%/\text{mb}$ (Simpson *et al.*). From the corrected three hour values we derived half day mean values in the unity cpm. The error for a mean half day value is smaller

[1] An extent description of the measurements including a table of the determined intensities will be published 1969 in the "*Meteor*-Forschungsberichte, Reihe B, Heft 3, 50 pages" (edited by the Deutsche Forschungsgemeinschaft, published by Gebrüder Bornträger-Verlag, Berlin).

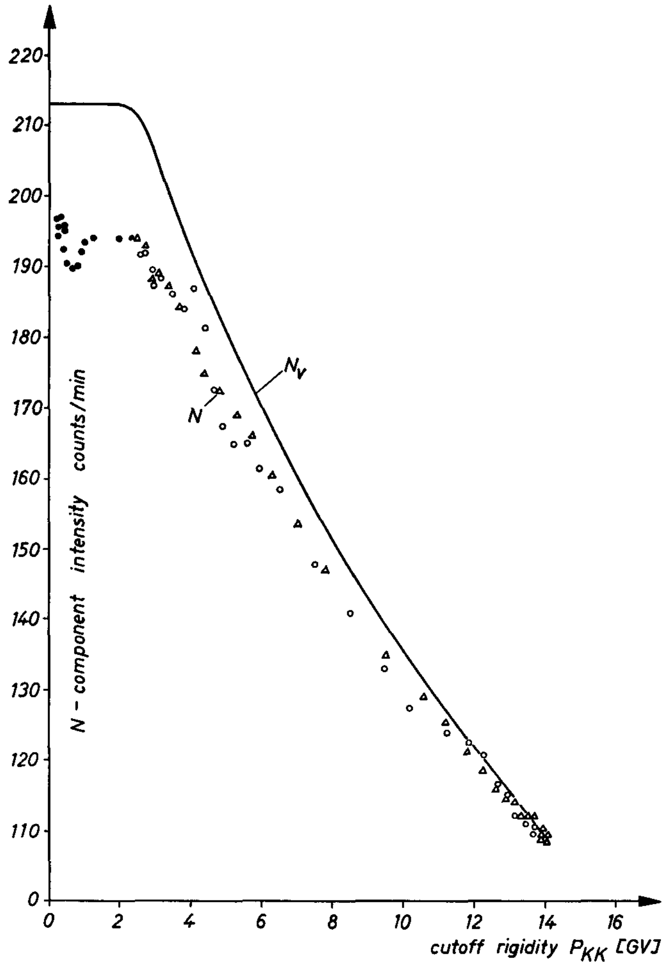

Fig. 2. Magnetic rigidity dependence of the nucleonic intensity. N is the omnidirectional counting rate and N_v is the counting rate due to primary particles from vertical direction normalized at 14 GV. ○ *Meteor* 1965, IQSY-Expedition, outbound voyage at 30°W; △ *Meteor* 1965, JQSY-Expedition, homeward voyage at 19° W; ● *Meteor* 1966, Greenland Expedition.

than 0.5%. The fact, that we treated the data not with a latitude dependent but a constant pressure coefficient has been regarded in the above mentioned intensity error. The counting rates of the Greenland Expedition in 1966 have been normalized to the time of the IQSY Expedition 1965 by means of the monitor stations of Kiel and Lindau. A correction for short-time world-wide variations was not employed, because the intensity variations of the monitor stations at Kiel and Rome did not exceed the error of the *Meteor* measurements. The data of the Greenland Expedition are only plotted until the 27 August 1966, because there happened a Forbush effect in the beginning of September.

There are various authors, who have computed a grid of vertical rigidity values at the earth's surface (Störmer, Quenby *et al.*, Kondo *et al.*, Shea *et al.*). The best fit of the measured intensities to the calculated rigidity values is established by the computations of Kondo *et al.*

These rigidity values correspond to those of Shea *et al.* At low rigidity values there seems to exist a discrepancy (Fig. 3). In the rigidity region of 0.8 GV the measured values deviate from the expected constant intensity. This de-

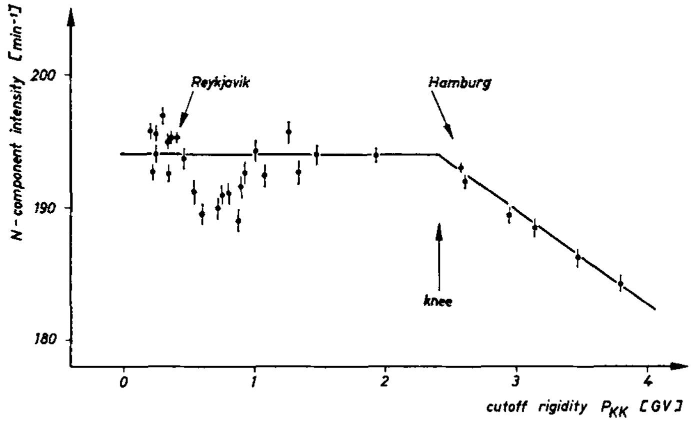

Fig. 3. Magnetic rigidity dependence of the nucleonic intensity at high geomagnetic latitudes.

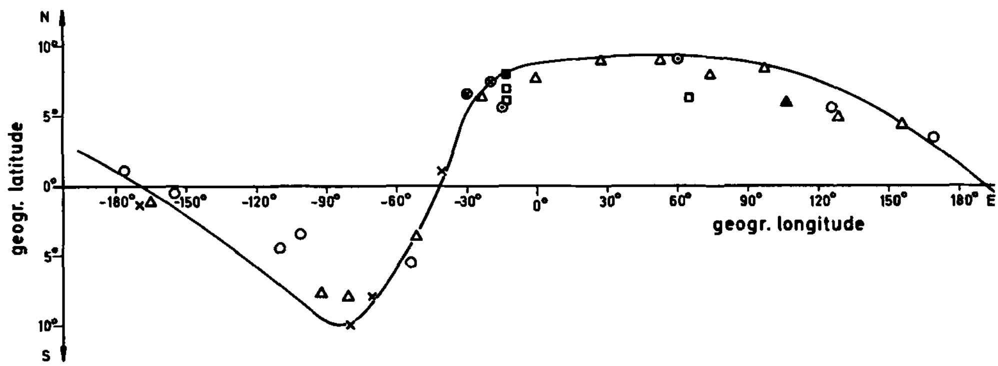

Fig. 4. Experimental and calculated cosmic ray equator. ⊗ *Meteor* 1965, sea-level; ⊙ Skorka 1956/57, sea-level; □ Pommeranz 1958/59, sea-level; ■ Pommeranz 1956, sea-level; △ Katz 1956, 18,000 feet; ○ Coxell 1959/60, 12,000 feet; × Kenney 1964, 35,000 feet; ▲ Fukushima 1956/61, sea-level; — cosmic ray equator calculated by Kondo, Kodamdo.

viation is statistically significant and cannot be explained by world-wide short-time intensity variations. The discrepancy may be due to an insufficient knowledge of the earth's magnetic date in this region.

Two positions of the cosmic ray equator have been determined. The geographical positions are $(6.5 \pm 1)°$ N 29.7° W and $(7 \pm 1)°$ N 19° W. The position of the cosmic ray equator was determined by the method of least square fit, using polynomials of the second, third and fourth order. Although our points of measurements south of the cosmic ray equator is confined to a latitude region of 10–15 degree, the position of the cosmic ray minimum is not sensitive to the magnitude of the latitude region we take north of the equator for the fitting.

Discussion

The present determined positions of the cosmic ray equator can be compared with the theoretical curve and other measurements (Fig. 4). Our measured points agree well with the calculated curve by Kondo *et al.*

There exist different latitude surveys at solar minimum activity and solar maximum activity (Fig. 5). For comparison we use the measurements of Fukushima *et al.* (second *Soya*-expedition). The *Soya*-intensities were calibrated to *Meteor*-conditions by means of the Rome-monitor. Using the method of calculation developed by Webber and Mathews *et al.* the degree of modulation of the primary cosmic rays during the last solar cycle was determined from these two latitude surveys (Fig. 6).

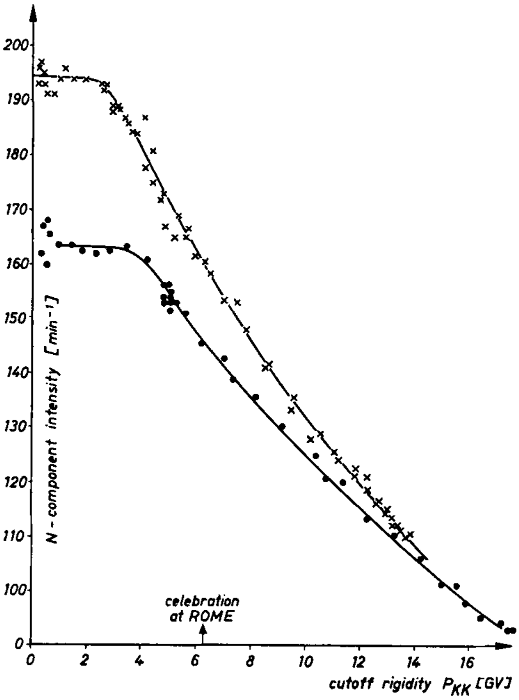

Fig. 5. Latitude surveys at solar maxima activity (*Soya II* 1958/59) and at solar minima activity (*Meteor* 1965). ● *Soya II* 1958/59, solar maxima; × *Meteor* 1965, solar minima.

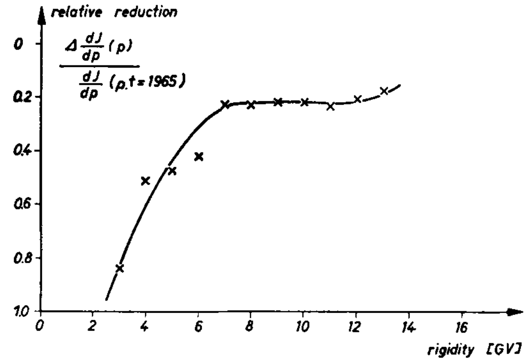

Fig. 6. Fractional decrease in primary cosmic ray flux plotted as function of rigidity.

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