

Dissertation on  
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Dedicated to the Memory of my father

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## S T A T E M E N T

In January 1959 the author undertook the maintenance of a neutron monitor which was already in operation at the Physical Research Laboratory, Ahmedabad. This neutron monitor was of the standard IGY design and had two independent but identical sections, each having 3 enriched  $\text{BF}_3$  counters. The counting rate of the neutron monitor was about 12500 counts/2 hours. It was decided to expand this neutron monitor and increase its counting rate so that small changes in the cosmic-ray intensity can be reliably studied on a day-to-day basis. For this purpose enriched  $\text{BF}_3$  counters were purchased from the Atomic Energy Establishment, Trombay, India. Due to limitations of space in the existing building a new geometry of the neutron pile was tried in which there were two layers of  $\text{BF}_3$  counters separated by 2" of lead. A 16-counter neutron monitor was set up in the above design. This was divided into two independent sections each having 8  $\text{BF}_3$  counters (4 upper + 4 lower). The total counting rate of this neutron monitor was about 50,000 counts/2 hours. Reliable data from this neutron monitor were obtained for the years 1962 and 1963.

On account of the geometry of the neutron monitor differing from the standard IGY instrument, the barometric pressure coefficient was experimentally determined and

was found to be about  $-0.86\%/mm$  of Hg. The variations in the pressure corrected monthly mean counting rate were compared with the data from Mt. Norikura neutron monitor. A part of the variation seems to be due to the atmospheric temperature effect on the nucleonic component.

With the existing facilities it was not possible to further increase the counting rate of the Ahmedabad neutron monitor. However, with the beginning of the IJSY, several high counting rate neutron monitors started functioning at various locations. A study of the modulation of the galactic cosmic-ray intensity was therefore made by using the data from these neutron monitors. It is well known that the electromagnetic conditions of the interplanetary space, relevant to the modulation of the intensity of galactic cosmic-rays are under solar control. In order to relate the ground based cosmic-ray measurements with the conditions in the interplanetary space and those on the sun, a study was undertaken to establish statistical relationships between the solar coronal intensity at  $5303 \text{ \AA}^0$ , solar wind velocity measured in the interplanetary space and the intensity of galactic cosmic-rays observed at the earth. The solar coronal intensity was particularly chosen since it seems to be closely related to the conditions in the solar corona which are relevant to the solar wind velocity.



The data on  $\lambda$  5303 intensity have been obtained from the maps of the sun, supplied by the Fraunhofer Institute, Freiburg, while the data on the solar wind velocity, measured on Mariner-2 and IMP-1, have been made available by the respective investigators.

The above study includes the following investigations:

- (1) The 11-year variation of the galactic cosmic-ray intensity is compared with the average  $\lambda$  5303 intensity at each  $5^\circ$  heliolatitude for the period 1957-1967.
- (2) Using cross-correlation analysis, an empirical relationship between  $\lambda$  5303 coronal intensity and solar wind velocity, as measured on Mariner-2 and IMP-1 is established.
- (3) The 11-year variation of the solar wind velocity, confined to low heliolatitudes ( $\pm 5^\circ$ ), is estimated for the period 1957-1967 by using (a) the empirical relationship between  $\lambda$  5303 intensity and solar wind velocity and (b) by using the available data on the temperature of the inner corona following Parker's polytrope model of the expansion of the solar corona.
- (4) An empirical relation is established between the long-term variation of cosmic-ray intensity and solar wind velocity at low heliolatitude ( $\pm 5^\circ$ ). In terms of the diffusion-convection model of Parker, the

empirical results are used to estimate (a) the cosmic-ray intensity in the nearby interstellar space and hence the residual modulation at the solar minimum in 1965; (b) radial gradient of galactic cosmic-rays and diffusion coefficient,  $K_{11}$ , along the interplanetary magnetic field direction and their rigidity dependence.

- (5) Distributions of cosmic-ray intensity perpendicular to the ecliptic plane are empirically estimated by using the distributions of  $\lambda$  5303 intensity in heliolatitude. Following Subramanian and Sarabhai (1967), numerical calculations are carried out to estimate the diurnal and semi-diurnal anisotropy of the cosmic-ray intensity resulting from these distributions for assumed value of the interplanetary magnetic field strength.
- (6) Longitudinal distributions of long-lasting active regions in the solar corona and long-lived Ca plages are studied in relation to the 27-day recurrent variations of (a) isotropic intensity of galactic cosmic-rays measured on the earth (b) anisotropic characteristics of galactic cosmic-ray intensity (c)  $K_p$  and (d) low energy cosmic radiation observed by satellites and space probes.

The present study represents perhaps one of the few attempts to quantitatively analyse the relationships of solar activity with conditions in interplanetary space and their effects that are measurable on the earth through cosmic-ray modulation and geomagnetic changes. The results provide interesting insights relevant to the models of the modulation of the galactic cosmic-rays through changes of the electromagnetic conditions of the interplanetary space.



(VIKRAM A. SARABHAI)



( P.N. PATHAK )

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# C O N T E N T S

## CHAPTER I. INTRODUCTION

1.1	Time variation of Cosmic-ray intensity ..	1
1.2	Primary Cosmic rays .. ..	1
1.21	Composition and Energy Spectrum ..	1
1.22	Geomagnetic effect .. ..	2
1.23	Asymptotic Directions .. ..	2
1.3	Secondary Cosmic rays . ..	3
1.31	Production .. ..	3
1.32	Atmospheric effects .. ..	4
1.4	Relation of variation in secondary to variation in Primary Cosmic-ray intensity.	5
1.5	Experimental Evidence on the Time variation of Cosmic-ray intensity .. ..	7
1.6	Models of Plasma and Magnetic Field in the Interplanetary Space .. ..	8
1.7	Direct measurements of Solar wind and Interplanetary Magnetic Field .. ..	11
1.8	Indirect Methods for the Observation of Interplanetary Plasma .. ..	16
1.81	Comet Tail Observations .. ..	16
1.82	Geomagnetic Observations . ..	17
1.83	Optical Observations .. ..	17
1.84	Radio Astronomy Observations ..	18

1.9	Cosmic-ray Modulation Theories	..	19
1.91	Modulation by Static Electric and Magnetic Fields	..	19
1.92	Solar Corpuscular Beam Modulation	..	20
1.93	Modulation by Inverse Fermi Mechanism		21
1.94	Diffusion through irregular magnetic fields	..	22
1.95	Diffusion - Convection Model	..	22
	(a) Radial Gradient	..	26
	(b) Anisotropic Diffusion	..	27
1.96	Modulation of galactic Cosmic rays and Power Spectrum of the inter-planetary magnetic field	..	30
1.97	Theories of Diurnal Variation	..	32

## CHAPTER II.

PART I:	<u>EXPERIMENTAL TECHNIQUE AND PROCESSING OF DATA</u>	..	..	..	39
2.11	The Nucleonic component of Cosmic rays				39
2.12	Neutron detection	..	..		39
2.13	Detection of Cosmic-ray nucleonic component	..	..	..	40
2.14	Neutron pile geometry at Ahmedabad				41
2.15	Electronic circuits	..	..		43
2.16	Test Procedure and Practical Precautions	..	..	..	54
2.17	Processing of Data	..	..		55
PART II:	<u>RESULTS OF THE ANALYSES</u>	..	..		61
2.21	Introduction	..	..	..	61

2.22	Estimation of the standard error	..	61
2.23	Determination of the pressure coefficient		63
2.24	Changes in Mean intensity during 1962-1963		66
2.25	Temperature Correction	..	70
2.26	Daily variation during 1962-1963	..	71

CHAPTER III.     SOLAR CORONAL INTENSITY, INTERPLANETARY  
WIND AND COSMIC-RAY INTENSITY

3.1	Introduction	..	76
3.11	$\lambda 5303$ Coronal Intensity data	..	77
3.12	Coronal Index	..	79
3.2	Solar wind velocity and $\lambda 5303$ coronal intensity	..	80
3.21	Introduction	..	80
3.22	Analysis of the data	..	81
3.23	Summary of the results	..	96
3.24	Discussion	..	97
3.25	11-year variation of solar wind velocity	..	102
3.3	Long-term modulation of Galactic Cosmic-ray Intensity and $\lambda 5303$ intensity	..	109
3.31	Introduction	..	109
3.32	Long-term variation of $\lambda 5303$ intensity at different helio-latitudes	..	110
3.33	Correlation of 11-year variation of Cosmic-ray intensity with $\lambda 5303$ intensity	..	114

3.4	11-year Variation of Cosmic-ray intensity and Solar Wind Velocity .. ..	117
3.41	Introduction .. ..	117
3.42	Empirical relationship between solar wind velocity and cosmic-ray intensity .. ..	118
3.43	Estimation of Residual modulation at Solar minimum in 1965 ..	120
3.44	Estimation of Radial Gradient of Galactic Cosmic-ray intensity and $K_{11}$ .. ..	129
3.5	Distribution of Cosmic-ray intensity as a function of Heliolatitude .. ..	130
3.51	Introduction .. ..	130
3.52	Distribution of $\lambda 5303$ intensity in heliolatitude .. ..	131
3.53	Distribution of Cosmic-ray intensity in heliolatitude .. ..	133
3.54	Anisotropy of Galactic Cosmic rays arising from its latitudinal distribution .. ..	136
3.55	Method of Numerical calculation of Cosmic-ray anisotropy from given distribution .. ..	138
3.56	Results .. ..	140
3.6	27-day recurrent changes in Cosmic-ray intensity and coronal intensity ..	147
3.61	Introduction .. ..	147
3.62	Long-lasting active regions in the solar corona and their relationships with the 27-day recurrent variations in Geophysical parameters ..	149



3.63	Cross-correlation analysis between $\lambda 5303$ intensity and parameters measured on the Earth related to Interplanetary conditions ..	158
3.64	Study of 27-day Recurrent variations using the method of Factor analysis ..	161

#### CHAPTER IV. DISCUSSION AND CONCLUSIONS

4.1	Solar Wind Velocity and $\lambda 5303$ intensity	172
4.2	Long-term modulation of Galactic Cosmic-ray intensity and $\lambda 5303$ intensity	176
4.3	11-year Variation of Cosmic-ray intensity and solar wind velocity ..	177
4.4	Distribution of Cosmic-ray intensity as a function of heliolatitude ..	185
4.5	27-day recurrent variations of Cosmic-ray intensity and coronal intensity ..	187
References	.. .. (i) to (xii)	