Copy of paper published by the author in collaboration with Dr. V. A. Sarabhai and Dr. U. D. Desai.
Cycle of World-Wide Changes in the Daily Variation of Meson Intensity

V. Sarabhai, U.D. Desai and D. Venkatesan

(Copy of article appeared in Physical Review, October 15, 1954).

Abstract

The study by Sarabhai and Kane of the world-wide changes in the daily variation of meson intensity has been extended by an analysis of unpublished Carnegie Institution data supplied by Dr. Forbush. Comparison of Carnegie Institution measurements at Huancayo and Cheltenham for the period 1937 to 1952 reveals high correlation between changes of the time of maxima at the two stations. The changes of amplitudes of the daily variations are not equally consistently related. The change of intensity of the coronal 5303Å emission line exhibits the major features seen in the change of the daily variation of meson intensity. Both follow the usual 11-year solar cycle of activity.

Sarabhai and Kane, in a paper later referred to in this article as I, have shown, by an examination of the Carnegie Institution data for the period 1937 to 1946, large world-wide changes in the amplitude and the time of maximum of the daily variation of meson intensity, corrected for barometric pressure. These changes were found to follow the broad pattern of the eleven-year solar cycle. In a later
II

communication, Thambyahpillai and Elliot\textsuperscript{3} have drawn attention to the progressive change, from 1940 to 1952, of the time of maximum of the daily variation to earlier hours. They have compared data from different types of instruments at different periods and have suggested a twenty-two-year cycle of change.

Directional studies made at Stockholm and Manchester and recent work at Ahmedabad clearly reveal the dependence of the time of maximum $M\Phi^D$ and the amplitude $M^D$ of the diurnal component of the daily variation of mesons on the sensitive cone of the measuring instrument and its orientation. The treatment of results from ionization chambers and counter telescopes on a directly comparable basis therefore appears questionable. A test of this, and further extension of our earlier studies have now been made possible by the supply of unpublished data covering 1946 to 1953 from the Carnegie Institution stations, through the kind generosity of Dr. Forbush.

Figures 1 (a) and (b) show the changes of $M^D$ and $M\Phi^D$ computed from the annual mean daily variation centered at successive bimonthly epochs. Unlike the treatment in I the present authors have not smoothed out their results by taking moving averages over three successive bimonthly values. Uninterrupted data are available for Huancayo and Cheltenham from 1936 to 1953, while for Christchurch there is a large gap from 1st July 1942 to 30th April 1946 due to
irregular stoppages.
An examination of Fig. 1 reveals that:

(1) The changes in the amplitude $M^D$ at the different stations do not appear to be well correlated except during the period 1940-1946. For Christchurch and Cheltenham which are sea-level stations at comparable latitudes south and north of the equator, respectively, the changes in amplitude are better related than between either station and Huancayo. The prominent disturbance in 1943 followed by a quiet period in 1944 is strikingly revealed in all curves.

(2) The changes in time of maximum $M^D$ at all stations are highly correlated. For the entire fifteen-year period, the correlation between Huancayo and Cheltenham is 0.93.

The change in the annual mean relative sunspot number $R$, centered at successive bimonthly epochs, is shown in Fig. 1(c). Alongside are also given corresponding values of the total solar emission of the coronal line 5303A. These have been computed, after interpolating at bimonthly intervals, from the observations of Waldmeier$^4$ at different epochs. It is clearly seen that changes of $M^D$ follow the normal solar cycle, there being no evidence for a twenty-two year period. While the mechanism of solar control is still obscure, we have earlier interpreted the new results as indicative of continuous solar emission of cosmic rays and changes of $M^D$ as caused by magnetic bending of the trajectories of charged...
solar particles. The consistent world-wide character of changes of $M_{1D}$ is then not surprising.

Coronal emission in 5303A is the most satisfactory index we know for activity in solar cosmic-ray emission. This is demonstrated strikingly in 1943, and in the pronounced shift of $M_{1D}$ in 1947 to later hours. Therefore, Simpson's observations with neutrons relating to low-energy primaries and the daily variation of mesons related to a more energetic primary component both lead to the same conclusion. They must focus our attention on the solar corona for an understanding of the processes of continuous cosmic-ray emission from the sun.

We are deeply indebted to Dr. S. E. Forbush and to Professor Waldmeier for furnishing the unpublished data which have made the present study possible. It is a pleasure to acknowledge assistance from Mr. K. A. Gidwani, Mr. Duggal and Mr. Bhatt and support from the Atomic Energy Commission of India.