Relaxation Time and Conductivity at a Rural Station: Raichur

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ABSTRACT

An examination of decay and growth rates of electric field near the ground during total solar eclipse of 16 February 1980 was made to study the electrical relaxation time and conductivity at Raichur. The values obtained i. e., 1320 seconds and 67.1163×10^{-16} mhos m^{-1} of the two parameters were in fair agreement with the reported ones at the rural locations.

I. INTRODUCTION

Although divergent views (Manohar et al., 1985) about the effect of solar eclipse (partial / total) on surface electric parameters are expressed, a majority of them report the time related decline and restoration of electric field during the event of an eclipse when other meteorological conditions are favourable. The above feature is more prominent and clearly noticeable specially during a mid–day total solar eclipse when the weather and other conditions are extremely suitable (Srivastava et al., 1982) and also provide an opportunity to study the phenomena in details. On one such occasion our observations of electric field during the eclipse period not only recorded the usual feature but also an "a nomalous behaviour" of the field in the "neighbourhood of totality". While the anomalous behaviour was studied in our earlier work (Manohar et al., 1985), we now make an assesement of the calculation of relaxation time (Nizamuddin et al., 1982) and conductivity near the ground by examining the observed decay and growth rates of electric field during the event of the eclipse.

II. OBSERVATIONS AND METHOD OF ANALYSIS

Atmospheric electric field was recorded one meter above ground level in the campus of the University of Agricultural Sciences (UAS) at Raichur (16°12′N, 77°21′E, 389.5 m ASL) on 16 February 1980 during the entire period (1425–1654 IST) of total solar eclipse. Details of the recording system, its accuracy as well as the particulars of eclipse are described elsewhere (Manohar et al., 1985). The rural environment of UAS where observations were taken was free from obstructions and pollution effects and also the entire period of the eclipse was marked with clear sky and light to calm wind conditions (Srivastava et al., 1982). Electric field for each minute during the eclipse period was plotted and a smooth curve was drawn through the data points (Figure 1) to eliminate the small period fluctuations arising out of eddy motions caused by the eclipse conditions (Anderson et al., 1972).

III. DISCUSSION

The total solar eclipse is an event when the earth's atmosphere in the path of the totality is temporarily cut–off from the solar radiation which again is restored following the obscuration and release respectively of the sun's disc. It is known that the cosmic radiation is

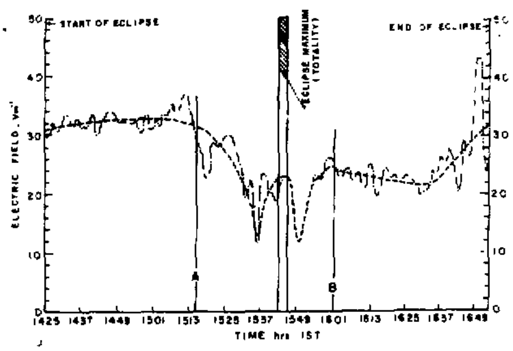

Fig.1. Plot of average electric field obtained during total solar eclipse of 16 Feb. 1980. (– • – • – • average electric field; ——— smooth curve through data points).

a primary source of ionisation of the earth's upper atmosphere (Chalmers, 1957; Israel, 1971). The electrical relaxation time T, of the atmosphere is defined (Gunn, 1935; Chalmers, 1957; Israel, 1971) as the time required for the charge placed in the atmosphere to either lose or gain the initial charge value by a factor of 2.718 i.e., 37% decrease and 271% increase respectively when the charge transfer takes place purely by ionic processes. In the present situation, since the electric field decayed and grew with change in time, it may be reasonable to consider such decay and growth rates as the outcome of the relaxation times of electric field in its two phases.

IV. RESULTS

Consistent with the definition of the electrical relaxation time in the present context, the field variation shown along the smooth curve drawn through the data points is examined in the study (Figure 1). In this figure the vertical bars A and B are drawn at 1516 IST and 1601 IST when only the only initial steady field, $32\ Vm^{-1}$, in the first phase started declining, reaching minimum $12\ Vm^{-1}$ near the totality (1545 IST) and again reached an initial maximum value of $26\ Vm^{-1}$ respectively, in the second phase.

It is noticed that the fall in the field value (from $32\ Vm^{-1}$ to $12\ Vm^{-1}$) occurred in 29 minutes and that this fall was 37.5% of the initial value $32\ Vm^{-1}$. The gain in the field value (from $12\ Vm^{-1}$ to $26\ Vm^{-1}$) occurred in 16 minutes and this rise was 225% of the initial value $12\ Vm^{-1}$. The decay and growth of field thus suggest that while the relaxation time, 29 minutes, obtained during the decay process very much satifies the definition, the value obtained, 16 minutes, during the growth process corresponds to 225% increase in field value rather than 272%. However, it is felt that the mean of the two relaxation times obtained for the decay and growth phases i.e., 22 minutes may perhaps be a reasonble representation of the net sittuation.

Using the value of T(1320 S) in the formula $\sigma = \frac{1}{4\pi T}$, where σ is the conductivity, the value obtained for σ comes to 67.1163×10^{-16} mhos m^{-1}. The values of T and σ appear to be comparable with such other rural locations (Israel, 1971).

V. CONCLUSION

The values obtained of the conductivity and the relaxation time by the above method appears to be nearly comparable with the values reported for unpolluted / rural environments. Is is thus suggestive that the derivation of relaxation time and conductivity by this method under such circumstances, favoured by the event of solar eclipse, is a reasonable approach.

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REFERENCES

Anderson, R. V. and Dolezelak, H. (1972), Atmospheric electricity measurements at Woldrof–Maryland during the 7 March 1970 solar eclipse, *J. Atmos. and Terr. Phys.*, **34:** 561–566.

Chalmers, J. A. (1957), *Atmospheric Electricity* (Pergamon Press, London).

Gunn, R. (1935), The electricity of rain and thunderstorms, *Terr. Magnetism and Atmos. Electricity*, **40:** 79–106.

Israel, H. (1971), *Atmospheric electricity*, Vol.I, (Program for Scientific Translation, Jerusalem).

Manohar, G. K., Kandalgaonkar, S. S. and Ramana Murty, Bh. V. (1985), Anomalous behaviour of electric field in the neighbourhood of totality of solar eclipse, *Indian J. of Radio and Space Physics*, **14:** 80–81.

Nizamuddin, S., Ramanadham, R., Rao, A. M., Khera, M. K., Makhadoumi, B. A., Rafiqui, A. R., Raina, B. N., Reddy, V. N. R. Goel, R. K., Pathak, P. P., Raj, J. and Varshneya, N. C. (1982), Variations in atmospheric electrical parameters during solar eclipse, *Proc. Indian Natl. Sci. Acad. Part A*, **48:** 262–270.

Srivastava, G. P., Srinivasan, V. and De, A. K. (1982), Measurements of atmospheric electricity parameters during the total solar eclipse of 16 Feb. 1980, *Proc. Indian Natl. Sci. Acad. Part A.*, **48:** 271–279.