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Solar Zenith Angle Dependence of Sudden Cosmic Noise Absorptions

S. B. S. S. Sarma and M. C. Sharma

Radio Science Division, National Physical Laboratory, New Delhi, 110012, India.

Abstract

The zenith angle dependence of the flare-time absorption of SCNAs (sudden cosmic noise absorptions) is investigated experimentally using riometer data at five widely spaced stations. A $\cos^n\chi$ dependence is found with $n = 1\cdot4 \pm 0\cdot04$.

During solar flares there is a sudden increase in the cosmic radio noise absorption, which is referred to as a sudden cosmic noise absorption (or SCNA). These occur mainly in the *D* region of the ionosphere, but also occasionally in the *F* region for very intense flares only. The statistics of the morphology of SCNAs has been extensively investigated in the past, from which deductions have been made concerning the physics and chemistry of the ionosphere. In the present communication we consider a usually neglected aspect of SCNAs, namely the variation of the flare-time absorption with the solar zenith angle. This aspect has not been thoroughly examined previously, mainly owing to the difficulty of collecting data on SCNAs for the same flare, at the same frequency (preferably with identical receiving systems) and at different locations that cover a sizable range of zenith angles.

Results and Discussion

The simple Chapman theory (Appleton 1937) predicts that the absorption A should vary with zenith angle χ as

$$A \propto \cos^n\chi, \qquad \text{with} \qquad n = 3/2.$$

However, many former investigators of pulse absorption data have obtained values for n that were much smaller than 3/2, and in fact were less than unity. But, at the operating frequencies (VHF) of riometer absorption studies, the quasilongitudinal approximation of the Appleton–Hartree equation is more likely to apply than in the pulse absorption case. Under these circumstances, we would expect the value of n obtained from riometer studies to be nearer the predicted value of $1\cdot5$.

From 30 MHz riometer data for SCNAs observed on 15 April 1963 at five stations, Horewitz and Goldman (1963) reported a value of $\sim 1\cdot5$ for n. This was for a single isolated event. Abdu and Degaonkar (1966) also reported a value of $\sim 1\cdot5$, but this was derived from data at two nearby stations (zenith angle range only 6°) possessing different receiving systems with different characteristics—a serious limitation for deriving a dependable value for n.

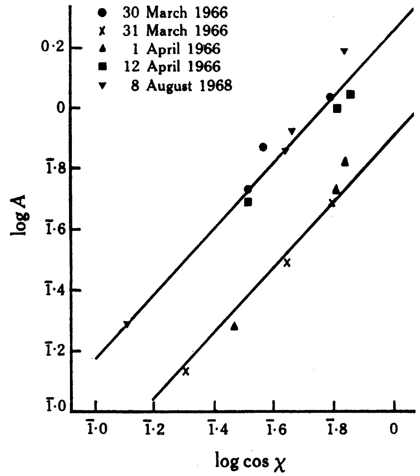

Fig. 1. Logarithmic plot of the variation of cosmic noise absorption A with solar zenith angle χ for five typical SCNAs.

In the present investigation we examined five SCNAs, using riometer data from the following five stations: Thule and Godhavn in Greenland; Bedford, Mass., U.S.A.; Sao Paulo, Brazil; New Delhi, India. The results for five typical SCNAs are shown in Fig. 1, which is a logarithmic plot of absorption versus $\cos\chi$. It is seen that the data follow closely a straight line of slope $1 \cdot 4$, the least squares fit giving an error in the slope of only $\pm 0 \cdot 04$. Thus this derived value for n of $1 \cdot 4$ is more dependable than any previously obtained, and is furthermore in good agreement with the theory as well as with the results of earlier investigators.

References

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