

Reply to J. M. Bullen and G. A. M. King's "Comments on a Paper 'Auroral Sporadic-*E* Ionization' by Robert D. Hunsucker and Leif Owren"

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The comments of Bullen and King [1963] on the paper "Auroral Sporadic-*E* Ionization" by Hunsucker and Owren [1962] cover two main points. The first point concerns questions of taxonomy in connection with auroral-zone ionograms and the second, the relationship between zenithal auroral luminosity and the thickness of the associated auroral *E* layer as indicated by ionosonde records.

With regard to the first point, our paper was concerned with the relationship of observed *E* top frequencies to visual zenithal aurora, and definitely not with details of taxonomy. In fact, we stated that "The approach in this paper is to study the radio reflecting properties of the *E* layer, notably as indicated by the value of fEs and its variation, at times when the occurrence and degree of visual auroral activity is known from simultaneous observations without regard to classification details. Therefore we are concerned with the auroral sporadic *E* ionization in the wider, physical sense rather than the restricted type designated by the too inclusive term *Es*-auroral."

The term "auroral sporadic *E* ionization" was therefore used in a general way, including rather than excluding the "night *E*" layer. The reason why the term "night *E*" does not appear anywhere in the paper is simply that we have followed the practice of the National Bureau of Standards for at least this auroral zone station in calling most nighttime *E* ionization seen on ionograms "sporadic *E*." The designations of the individual ionograms appearing in the figures 3 through 10 are those assigned by the local scaler according to the instructions received from the National Bureau of Standards.

Bullen and King are certainly justified in classifying most of these ionograms as "night *E*" if they so prefer, and want to use the term "sporadic *E*" in a narrow sense. This part of their comment is of value in demonstrating again the difficulties, including semantic, involved in scaling and interpreting auroral zone ionograms, as has been done before by many other investigators [see K. Davies, 1956]. But their taxonomic discussion affects in no way our conclusion regarding the relationship between observed *E* top frequency and zenithal aurora.

The second point raised by Bullen and King concerns the relation between the critical frequency of a "thick" ionospheric layer in the *E* region and the auroral luminosity. Their comment illustrates how easy it is to overinterpret auroral-zone soundings. On the basis of the ionogram in figure 10 of our paper, they conclude that considerable auroral luminosity, in the form of an overall glow, must be present in the sky, although we listed the all-sky camera record as showing "no auroral activity." Their conclusion is based on the work of Omholt [1955] and their own preliminary studies. Omholt found a correlation between photon emission within the negative nitrogen band (4278 Å) from zenithal aurora and the electron density of the associated *E* layer. It should be noted that in an effort to deduce critical frequencies at zenith only, he *selected* traces which showed multiple reflections from the E_a layer, or an *F* layer above the critical frequency of the E_a layer.

The history of auroral activity during the night of 8–9 December 1958 which we deduced qualitatively from the all-sky camera records, can be confirmed quantitatively from the simultaneous patrol observations with the Huet spectrograph operated by Romick [1961] at College, Alaska, during IGY. The Huet spectrograph plate for the night in question is shown in figure 1, and the spectrograph scale giving the time marks and wavelength calibration is shown in figure 2. It is apparent that the negative nitrogen line (4278 Å) as well as the other lines in the auroral spectrum show maximum intensity between 2100 and 2200 150° WMT corresponding to the maximum auroral activity indicated in the all-sky camera photograph of figure 9 in our paper. At the time of the all-sky camera photograph in figure 10, Romick confirms from the spectrographic record that there was no visible auroral emission in the sky (private communication). The change in the character of the ionograms from figure 9 to figure 10 should be noted and compared with Omholt's criteria.

Thus it appears that for the auroral display of 8–9 December 1958 the all-sky camera, spectrographic and ionosonde data presented by the authors are in agreement with Omholt's results but not with Bullen and King's *interpretation* of Omholt's results.

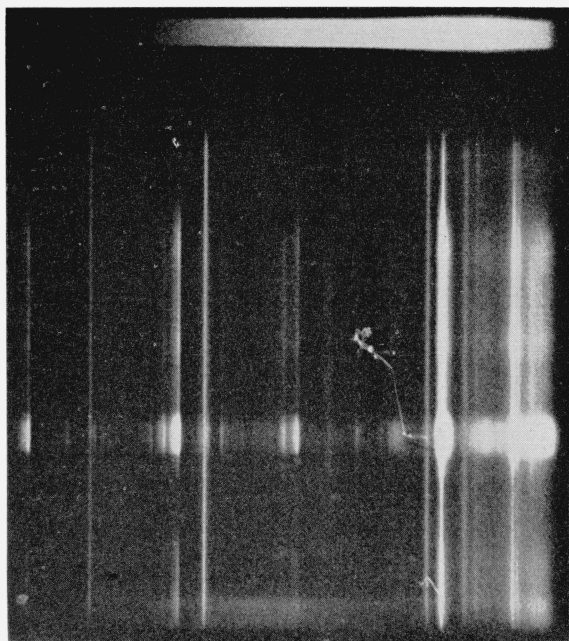


FIGURE 1. *Huet spectrograph plate for night of 8-9 December 1958.*

References

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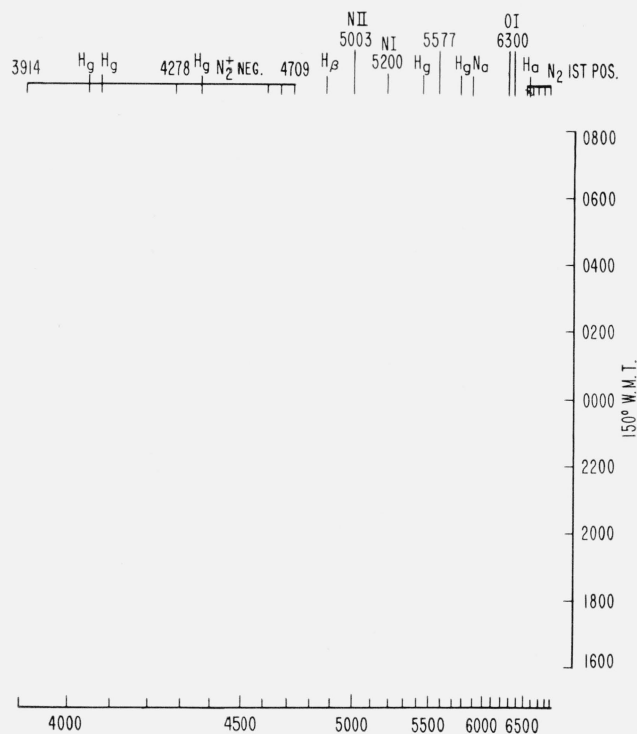


FIGURE 2. *Scale for Huet spectrograph plate.*

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