at Minneapolis at that time. The direction of sound arrival at Washington points to the region north of the great lakes during that storm.

Bhavsar: It will be very interesting to study such relation between low frequency sound waves and electron precipitation in the atmosphere. We shall be very glad to part with our results to interested workers.

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I-4-P1 Theory of Auroral Bombardment*†

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An auroral theory is developed from the point of view of particle orbits in an inhomogeneous plasma confined by a magnetic field. Specifically, a mechanism is proposed for ejection into the atmosphere of geomagnetically trapped protons and electrons. It is assumed that the energetic particles are distributed in longitude irregularly. The tendency for positive and negative particles to drift in opposite directions will then lead to momentary electrostatic fields, arising from excess charges of one sign aligned along a magnetic line of force. As particles drift into this potential, they lose transverse kinetic energy and a portion of the particles immediately spiral out the ends of the flux tube into the atmosphere. As the potential grows, the drift of particles into this "discharge tube" is inhibited, but more of those entering the potential with high velocity are ejected, regaining their lost transverse kinetic energy in accelerated motion along the magnetic field. The potential may rise sufficiently to discharge particles with energies of several kev within an interval of less than a second, which is rapid enough to render neutralization by ionospheric ions and electrons unimportant.

If the density fluctuations of auroral plasma exceed a certain critical value, the electrostatic field will cause them to grow rapidly. This instability is identified with auroral ray structure. A density fluctuation may maintain its identity, even though individual particles are constantly moving through it. This characteristic may be associated with the fading and reappearance of rayed structures.

The basic mechanism of electrostatic fields arising from the particle drifts will also produce local accelerations of particles, by tending to establish an equipartition of energy between protons and electrons. This is presumably the mechanism for the local acceleration of auroral electrons, although it will also modify, but less severely, the energy spectrum of trapped protons.

Various other consequences of these macroscopic but short-lived electric fields are examined, with a view toward understanding auroral morphology. It is proposed that an $\boldsymbol{E}\times\boldsymbol{B}$ drift accounts for the statistical preference for auroral patterns to move toward the sunlit hemisphere and for the departures of auroral forms from alignment along circles of geomagnetic latitude, even in the polar cap. The $\boldsymbol{E}$ field, when transferred to the atmosphere by bombardment and by ordinary

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conduction, will produce a Hall current parallel to auroral motions; this current is identified with the auroral electrojet and associated magnetic disturbances. It is suggested that these considerations also have a bearing on the north-south thickness of auroral forms, on auroral break-up, and on daily variations.

Discussion

Hines, C. O.: Your description led to the appropriate sense of motion for sub-auroral latitudes. Is it capable also of providing the reversed sense of motion observed for superauroral latitudes (as reported by T. N. Davis, for example)?

Chamberlain, J. W.: Yes, if the plasma density gradient is such as to provide the proper electric polarization. However, I am doubtful that the high-latitude motions have been systematically established yet. When they are established they would indicate (according to my interpretation) the plasma density gradient in the outer magnetosphere.

Vestine, E. H.: 1) It seems to me that the accelerating mechanism described closely resembles that described by Kern yesterday, and that the mechanism for driving the polar electrojets are similar, or is there a difference?

2) Will the mechanism, in your opinion, be able to supply meridional electric field to drive the Hall current of the electrojets, for several hours, so that its time constant is long, provided a supply mechanism is continuously maintained?

Chamberlain: 1) There are similarities in the morphology discussed by Kern (as well as by others at this conference) with my own suggestions. However, I believe that the accelaration and bombardment mechanism I have proposed is new. Kern, as well as others beginning with Martyn, has talked of a discharge of particles arising from charge accumulation. But they have not previously considered the essential feature of my mechanism: the loss of transverse kinetic energy and the change in pitch angle owing to longitudial drifts against a polarization electric field. In his abstract for this conference, Dr. Kern has, however, referred to this effect and referenced my forthcoming paper. I believe he has adopted the mechanism but perhaps modified it somewhat in his current work reported yesterday.

2) I think that the Hall current would flow only so long as the "generator"—charge seperation in the magnetosphere—is at work. When the plasma density gradient becomes so small that charge seperation becomes negligible, the currents will stop flowing. However, the mechanism has the feature of maintaining the density gradients, rather than smoothing them, so that it may last for long period.