latitudes, and other hydromagnetic waves propagating obliquely or perpendicular to the geomagnetic line of force cause the sudden increase of the geomagnetic field at low latitudes.

The above model can explain the observed fact that sudden commencements have been registered earlier at high latitudes than low latitudes and the preliminary reverse impulse has preceded by 1–2 min the main impulse of *sc**, which has taken place almost simultaneously with the ordinary *sc* in low latitude zones.

Table 2

Position of the source on the equatorial plane	Transit time of charged particles	T_a (sec)	T_m (sec)
$4r_0$	Within several seconds	28·9	19·1
$6r_0$	Within several seconds	116·6	67·1

But this model requires that the ordinary *sc* at low latitudes should occur earlier than the main impulse of *sc** at high latitudes by about several tens of seconds. In this argument we do not consider the distortion of the geomagnetic field by the impact of solar plasma on it. It seems likely from the above results that the transit times of modified Alfvén waves from the geomagnetic equatorial plane to high latitudes on the earth's surface will give more hopeful values to explain *sc** phenomena.

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Rate of ion–atom interchange

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Bates and Nicolet (1960) have deduced that ion–atom interchange processes like

$$O^+ + O_2 \rightarrow O_2^+ + O \quad (1)$$

$$O^+ + N_2 \rightarrow NO^+ + N \quad (2)$$

and

$$O_2^+ + N \rightarrow NO^+ + O \quad (3)$$

must be very much slower than some aeronomers have supposed since otherwise almost all the O^+ ions in the upper atmosphere would be replaced by NO^+ ions within a few seconds of sunset. HERTZBERG (1961) has recently questioned the deduction. Though DICKINSON and SAYERS (1960) have reported laboratory measurements which indicate that the rate coefficient for process (1) is about $2{\cdot}5 \times 10^{-11}$ cm^3/sec HERTZBERG believes that neither steric hindrance nor activation energy is likely to enter and therefore that the rate coefficients for exothermic ion–atom interchange processes are of the order of 10^{-9} cm^3/sec. He argues that this is not inconsistent with the O^+ ions persisting long after sunset since they may be reformed through

$$O_2^+ + N \rightarrow NO + O^+ \qquad (4)$$

(which is only slightly endothermic). There is however a difficulty. HERTZBERG lists all the ion–atom interchange processes which might conceivably be important in the upper atmosphere. The only one which leads to the conversion of NO^+ ions into another species of positive ion is

$$NO^+ + N(^2D) \rightarrow N_2 + O^+. \qquad (5)$$

This can safely be ignored: thus it requires an electronic transition so that its rate coefficient would be expected to be very much less than that for a simple ion–atom interchange process (cf. BATES, 1955); and furthermore metastable atoms of nitrogen are rare compared with other atoms and molecules. The conversion of other positive ions into NO^+ is effectively irreversible under upper atmospheric conditions. Hence NO^+ would be the dominant species of positive ion in ion–atom interchange equilibrium. If the rate coefficients for ion–atom interchange were indeed of order 10^{-9}cm^3/sec this equilibrium would be reached shortly after sunset in contradiction to the observations of rocket scientists (JOHNSON *et al.*, 1958; POLOSKOV, 1960).

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Thickness of an active auroral curtain

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ONE of the most remarkable characteristics of the polar aurora is its thin curtain structure. In a homogeneous arc, the thickness may be of the order of a few kilometers. In the active