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Short Communication

Correction of Graphs Concerning the Chapman-Ferraro Image Method

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The basic investigations concerning the interaction between the solar wind particles and the geomagnetic field were done by Chapman and Ferraro (1931). Unfortunately they published some wrong graphs on the current system and on the resulting magnetic field line structure, which are reproduced subsequently by several authors in the literature.

The concept of the Chapman-Ferraro image method initially was invented by Maxwell (1881, 1954), who analysed the physical processes arising in the case of a relative motion between a magnetic pole and a conductive sheet. The sudden introduction of a magnetic system (e.g., the earth's dipole field) and the relative motion between it and a conductive sheet (e.g., the foremost front of the approaching solar wind particles) will generate currents within the sheet. As Chapman and Ferraro (l.c.) pointed out, *the electric field lines are the lines of intersection of the sheet with the equipotential surfaces of the magnetic field.* In spite of their correct equations the graph of the Chapman-Ferraro-currents within the sheet is wrong (Fig. 1 a), which is reproduced by Chapman and Bartels (1940), Chamberlain (1958), Chapman (1964) and certainly in other papers, too.

The exact definition on the electric field lines (as mentioned above) leads to our calculated Fig. 1 b and differs from the wrong current line picture known in the literature in the way that the big semiaxis of the oval field lines is parallel to the y – axis and not parallel to the x – axis. The electric field has a positive maximum value at the point (0, 0, 0), two points with $\vec{E}=0$ and two further points beyond those with $\vec{E}=0$ with the coordinates ($\pm z/\sqrt{3}/2$, 0, 0) with a negative maximum value (z means the dipole's distance to the sheet).

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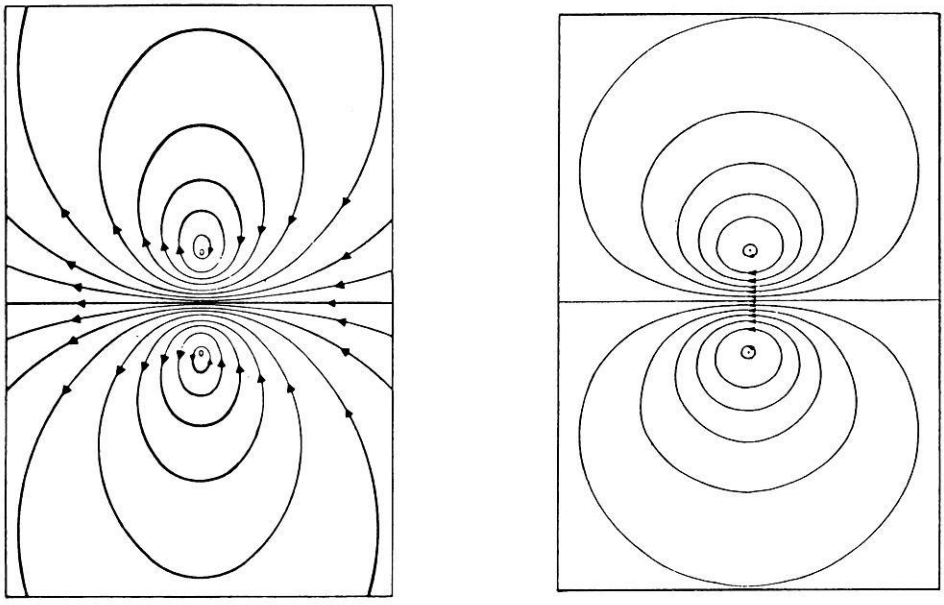

Fig. 1. The wrong and corrected graphs of the electric field line pattern

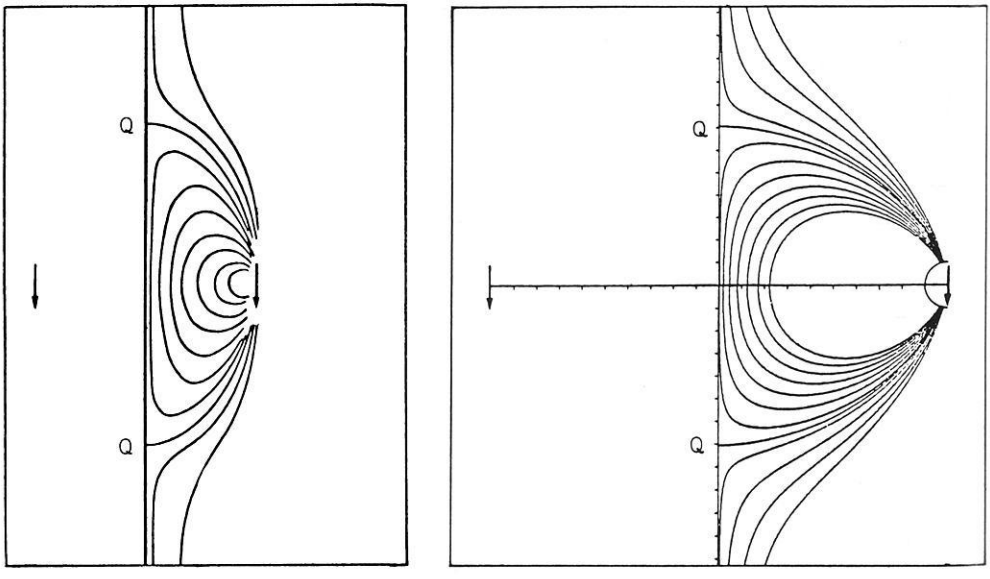

Fig. 2. The wrong and corrected graphs of the magnetic field line pattern

The current system excited in the sheet produces a magnetic effect, which can be represented by two image dipoles in both the half-spaces before and behind the sheet. The superposition of the earth's dipole field and the sheet's magnetic field led to the first impression of the internal magnetospheric $\vec{B}$-field structure. But again the magnetic field line structure in the paper of Chapman and Ferraro (l.c.) (Fig. 2a) is not correct. The field lines of the total magnetic field penetrate perpendicularly the current sheet at the points $\vec{E}=0$ with the coordinates $(\pm z/\sqrt{2}, 0, 0)$. In Fig. 2b one can see the correct relation between the dipole's distance z (standardized to unity) and the position of the point Q. In the case of total magnetic shielding one special magnetic field line ends perpendicularly at the sheet at the point Q, which is a point of zero-$\vec{E}$ and zero-$\vec{B}$.

Of course the magnetospheric boundary physics is explained in many new investigations, but some of them are applied to the Chapman-Ferraro-image method and this fact required a correction of the corresponding graphs.

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