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Letters to the Editors

Comment on: Hydromagnetic Waves in a Non-Uniform Plasma

by E. Kupfer

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Recently, Kupfer (1975) and Siebert (1975) have reconsidered the problem of geomagnetic pulsations with periods which vary systematicaly with geomagnetic latitude. This comment proposes a much simpler explanation of this phenomenon than that discussed by Kupfer and Siebert.

Voelker (1968) first observed a type of pulsation which is seen simultaneously with different periods at the observatories along a latitudinal chain. He named them pulsation single effects (pse's). Similar events were subsequently reported by Orr and Matthew (1971), Rostoker and Samson (1972), Zelwer and Morrison (1972) and others. These are relatively rare events, which are found almost always only in the H-component. This would naively suggest a meridional field line oscillation in the magnetosphere. In attempting to explain how a meridional oscillation can exhibit a latitude dependent period, workers have been forced to propose rather bizarre models, e.g. Siebert (1964).

It was first shown by Dungey (1954) that there can exist an axisymmetric mode of magnetospheric oscillation which is azimuthally polarized and in which L shells would be decoupled. This mode allows each L shell to oscillate with its own natural period independently of the others, and could therefore explain a simultaneous observation of latitude dependent period. Numerical evaluations of the resonant period of this oscillation were made by Cummings, O'Sullivan and Coleman (1969) and by Orr and Matthew (1971).

In order to relate Dungey's theory to the ground observations, account must be taken of the 90° rotation of the polarization angle of a pulsation signal as it passes through the ionosphere (Hughes and Southwood, 1974, 1976; Hughes, 1974). This effect occurs because the ionospheric E-layer is both a Hall and Pedersen conductor. The Pedersen currents flowing in this region shield the magnetospheric magnetic perturbations from the ground, while the magnetic fields observed at the Earth are caused by the E region Hall currents and are therefore polarized orthogonally to the magnetospheric perturbation. This explains why Dungey's axisymmetric mode, which is azimuthally (D) polarized, is seen on the ground as an H polarized signal. Thus, by taking account of ionospheric effects, we see that the observations of Voelker and others are simply explained by Dungey's original theory, and that we have no need to invoke the much more complicated theories such as that being discussed by Kupfer (1975) and Siebert (1975). A simple test for this theory is provided by the axisymmetric nature of Dungey's mode. This means that this particular class of pulsations should have very small East-West variations of amplitude and phase.

References

Cummings, W.D., O'Sullivan, R.J., Coleman, P.J.: Standing Alfven waves in the magnetosphere. J. Geophys. Res. **74**, 778–793, 1969

Dungey, J.W.: Electrodynamics of the outer atmosphere. Penn State Univ. Ionosph. Res. Lab. Sci. Rep. No. **69**, 1–52, 1954

Hughes, W.J.: The effect of the atmosphere and ionosphere on long period magnetospheric pulsation. Planetary Space Sci. **22**, 1157–1172, 1974

Hughes, W.J., Southwood, D.J.: Effect of atmosphere and ionosphere on magnetospheric micropulsation signals. Nature **248**, 493–495, 1974

Hughes, W.J., Southwood, D.J.: The screening of micropulsation signals by the atmosphere and ionosphere. J. Geophys. Res. **81**, in press, 1976

Kupfer, E.: Hydromagnetic waves in a non-uniform plasma. J. Geophys. **41**, 123–126, 1975

Orr, D., Matthew, J.A.D.: The variation of geomagnetic micropulsation period with latitude and the plasmapause. Planetary Space Sci. **19**, 897–905, 1971

Rostoker, G., Samson, J.C.: Pc micropulsations with discrete, latitude dependent frequencies. J. Geophys. Res. **77**, 6249–6253, 1972

Siebert, M.: Geomagnetic pulsations with latitude dependent periods and their relation to the structure of the magnetosphere. Planetary Space Sci. **12**, 137–147, 1964

Siebert, M.: Comment on: Hydromagnetic waves in a non-uniform plasma by E. Kupfer. J. Geophys. **41**, 325–327, 1975

Voelker, H.: Observations of geomagnetic pulsations: Pc 3, 4 and Pi 2 at different latitudes. Ann. Geophys. **24**, 245–252, 1968

Zelwer, R., Morrison, H.F.: Spatial characteristics of mid-latitude geomagnetic pulsations. J. Geophys. Res. **77**, 674–694, 1972

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