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Still one possibility to determine the wave vector onboard one spacecraft

Valery Korepanov and Fedir Dudkin
Lviv Centre of Institute for Space Research, Lviv, Ukraine (vakor@isr.lviv.ua/+380 32 2639163)

Lviv Centre of Institute for Space Research, Lviv, Ukraine (vakor@isr.lviv.ua/+380 32 2639163)

The determination of dispersion relations $\mathrm{k} = \mathrm{k}(\omega)$ for the wave, propagating in space plasmas is an important task of electromagnetic measurements onboard satellites. By this the major problem is to separate the spatial and temporal variations of electromagnetic fields. The wave vector calculation in general case requires measurement of three components of magnetic field **B** vector and three components of electric field **E** vector. The measurement of the electric field **E** with enough good precision requires long booms what is a great problem to realize, especially onboard of microsatellites. We study the possibility to avoid **E** measurements without of loss of wave vector $\overline{k}$ calculations generality and precision. Basing on Maxwell's equation

$$\nabla \times \mathrm{B} = \mu \mathrm{J}$$

where **B**, **J** are vectors of magnetic field and current density respectively and decomposing EM wave in plasma into spectrum of plane waves

$$\dot{\mathrm{B}} = \dot{\mathrm{B}}_0 \exp\left(-j\mathrm{kr}\right), \quad \dot{\mathrm{J}} = \dot{\mathrm{J}}_0 \exp\left(-j\mathrm{kr}\right),$$

where j = (-1)$^{0.5}$, **k** is wave vector, **r** is radius-vector, we also assume that the space derivatives of magnetic field and current density amplitudes are very small. Then the system of 3 equations which allows calculating the wave vector components by using data from 3-component magnetometer and 2-component current density meter for each spectral component of EM wave, or, in other words, dispersion relations **k** = **k**(ω), may be composed.

Such data can be provided by a set of combined sensors (so-called Wave Probe, reference below) each of which consists of a magnetic field sensor and a current density sensor mounted in one case. Obviously, we can neglect EM wave non-uniformity for such a small device.

We have to mention also that these considerations can be applied to known and steady space configurations. (It is supposed that crossing time over a current structure by measuring device is less than characteristic time of structure change). For example, auroral structures can be considered as invariable for satellite transition time across these ones. In addition to that, the magnetic field aligned currents are considered as plane current sheets. The same approach can be applied to currents in magnetopause or bow shock region.

The details of the proposed method and corresponding instrumentation description are presented. Also the space experiment preliminary results are discussed which confirm the fundamental correctness of the calculations.

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Reference:

Dudkin, F., Korepanov, V., Lizunov, G.., Experiment VARIANT - first results from Wave Probe instrument, *Advances in Space Research*, **43**, pp. 1904-1909, 2009.