

## CONTENT

Preface	ix
1. Real full wave solution of Maxwell's equations	1
1.1 Theoretical background (Cs. Ferencz)	1
1.2 Laplace-transformation with multi variables (Cs. Ferencz)	7
1.3 Application of the method in a homogeneous magnetoionic medium for longitudinal propagation (Cs. Ferencz)	10
1.3.1 Formulation of the problem	13
1.3.2 The propagation problem in half space "2"	14
1.3.3 Longitudinal plane wave solution in half-space "2" ..	20
1.3.4 Derivation of the existing modes in the half space "1"	24
1.3.5 Mode-coupling at the boundary surface $A_1$	27
1.3.6 Character of excitations	31
1.3.7 Some results of model-calculations	33
1.3.8 Conclusions	37
2. Application of the method for different propagation situations	39
2.1 Propagation in inhomogeneous, lossless, electronplasma – longitudinal propagation (Cs. Ferencz)	39
2.1.1 The propagation problem in half space "2"	39
2.1.2 Longitudinal quasi-homogeneous plane wave solution in half space "2"	41
2.1.3 The quasi-homogeneous solution after mode-coupling at the boundary surface $A_1$	45
2.1.4 Coupled W.K.B. solution in half space "2"	45
2.1.5 Solution for strong inhomogeneities (in half space "2") using only one space-variable	47
2.1.6 Some results of model-calculations	52
2.1.7 Conclusions	63

2.2	Whistler-mode solution in lossy electronplasma (O.E. Ferencz).....	64	3.3	Goals of future ELF~VLF investigations (Cs. Ferencz)...	167
2.2.1	Solution if the medium "2" is a homogeneous plasma.....	64	3.3.1	Experimental investigation of the theoretical questions of electromagnetic wave propagation .....	168
2.2.2	The excitation and the coupling .....	78	3.3.2	Investigation of possible relationships between seismic activity (precursors and earthquakes) and ELF~VLF phenomena .....	170
2.2.3	Solution in a weakly inhomogeneous plasma .....	80	3.3.3	The investigation of whistlers and the general ELF~VLF electromagnetic activity around the Earth.....	171
2.2.4	Numerical results.....	88	3.3.4	Investigation of ELF~VLF activity of other planets .....	173
2.2.5	Conclusions .....	93	3.3.5	Investigation of interplanetary space .....	174
2.3	Whistler-mode solution in a plasma containing two components (phenomenon of proton-whistlers) (O.E. Ferencz).....	96	4.	Methods of signal analysis.....	176
2.3.1	Introduction .....	96	4.1	General character of the signals (D. Hamar).....	176
2.3.2	Solution for a homogeneous plasma .....	99	4.1.1	The matched filter .....	178
2.3.3	Solution for a weakly inhomogeneous plasma.....	110	4.1.1.1	Matched filter approximation for a linear frequency modulated pulse with rectangular envelope .....	179
2.3.4	Numerical results.....	111	4.1.2	Application of matched filtering to whistlers .....	181
2.3.5	Conclusions .....	116	4.1.2.1	The FIT method .....	182
2.4	Whistler-mode solution in a plasma containing ions with arbitrary distribution (phenomenon of ion-cyclotron whistlers) (O.E. Ferencz) .....	118	4.1.2.2	Construction of the matched filter .....	185
2.4.1	Solution for a homogeneous plasma .....	118	4.2	The fine structure of signals (D. Hamar) .....	187
2.4.2	Solution for a weakly inhomogeneous plasma.....	123	4.2.1	Matched filtering of the data .....	187
2.4.3	Numerical results.....	124	4.3	Derivation of propagation direction (J. Lichtenberger) ...	194
2.4.4	Conclusions .....	132	4.3.1	Methods for space (satellite) measurements .....	194
2.5	Whistler-mode solution in case of non-longitudinal propagation (O.E. Ferencz) .....	133	4.3.1.1	Cross-product (CP) method .....	194
2.5.1	Introduction .....	133	4.3.1.2	Means method .....	195
2.5.2	The applied model .....	135	4.3.1.3	The Wave Distribution Function (WDF) method .....	197
2.5.3	Solution for a homogeneous plasma .....	138	4.3.1.4	The Matched Filtering and Parameter Estimation (MFPE) method.....	198
2.5.4	Numerical results.....	149	4.3.2	Methods for ground based measurements.....	203
2.5.5	Conclusions .....	155	4.3.2.1	The goniometer method .....	203
3.	Measuring of general shape electromagnetic signals of natural environment .....	157	4.3.2.2	Methods for elliptically polarised waves.....	204
3.1	Ground based measurements (J. Lichtenberger) .....	157			
3.2	Satellite measurements (J. Lichtenberger).....	162			

4.3.2.3	The MFPE method modified for ground based measurements.....	208
4.4	Benefits of using the real full-wave solutions (O.E. Ferencz and Cs. Ferencz).....	215
4.4.1	Separation of different effects in the received signals .....	215
4.4.2	Investigation of travel-time residuals .....	225
Outlook	.....	231
Acknowledgements	.....	232
Appendix A.	Determination of integration constants $C_y$ and $C_z$ in equations (1.27).....	234
Appendix B	Derivation of the monochromatic case from the general equations.....	237
Appendix C	Fulfilment of the conservation of wave crests .....	240
Appendix D.	Inverse Laplace transform of the excited signals in half space "1" .....	242
Appendix E.	Summary of the Wentzel-Kramer-Brillouin (W.K.B.) Method.....	244
References	.....	250
Subject Index	.....	257