Preface

A comprehensive study of the properties of eigen waves propagating across the axis of symmetry in various cylindrical waveguide-structures filled with magneto-active plasma is performed in the present book, using the example of flute waves. The aim of the authors is to collect in a single book the materials devoted to various characteristics of these transverse waves first of all, their dispersion properties and their impact on various design features of waveguides, like possible application of a dielectric coating on the inner wall of the cylindrical waveguide. Their damping due to various mechanisms, like collisions between plasma particles, resonant damping, transformation into the coupled bulk mode, radiation through a narrow slot in the waveguide wall are also considered here. Since a real experimental device confines a non-uniform plasma, the impacts of an inhomogeneity of the plasma density and of a constant external magnetic field on the frequency spectrum and the spatial field distribution of these waves are studied here as well. Changing of the surface flute wave properties due to the influence of the shape of the waveguide cross-section including non-circularity of both constructive elements, namely the plasma column and the metal waveguide, and the coupling between different flute modes propagating in a current-carrying plasma waveguide are also in the scope of our book. We have even demonstrated how one can investigate the properties of surface waves, which in addition to their azimuthal mode number have also a small axial wave number, using the theory of surface flute waves. It should be mentioned that all problems considered in this book are solved by the method of successive approximations. It is surprising that the theory of surface waves propagating strictly across the axis of symmetry in relative simple models of cylindrical waveguides allows one to solve the problems of transverse wave propagation in squared waveguides, and to develop the theory of azimuthally non-symmetric surface waves, which have a small axial wave number. Therefore, the material presented in this book will be useful for graduate students specializing in the field of plasma physics and for professionals who are interested in problems of specifically confined plasma structures.

Interest in plasma physics, observed over the last 50 years, is maintained primarily due to the prospects of energy generation by controlled thermonuclear fusion and owing to astrophysical studies. However, research for solutions in these complex fields also leads to the active development of various applied investigations in related areas of science such as plasma electronics, physics of gas discharges,

collective effects of charge carriers in plasmas of solids, plasmonics, and nano-science. The plasmas, which are investigated in these fields of science in order to find some new prospective applications, have different values of characteristic parameters, and hence their properties are different. But common for any plasma is that all internal processes are accompanied by the propagation of electromagnetic waves.

Another unifying feature of plasma phenomena observed on the Earth is the limited space, which is occupied by a plasma. These two factors are common for all problems, which are discussed in this book, and which are belonging to electrodynamics of restricted magneto-active plasmas. This circumstance distinguishes our book from well-known fundamental monographs on plasma electrodynamics. Another fact, which testifies the importance of our book, is connected with the wide field of the presented existing applications of surface wave propagation and prospective ones, namely fabrication and processing of a large-sized semiconductor plates using gas discharges sustained by azimuthally non-symmetric surface waves, production of nano-crystals with outstanding mechanical and electrical properties, elaboration of new bio-sensors, which allow one to perform diagnostics of animal and plant pathogens, to carry out in situ gene analysis or rapid testing of a malarial strain, water purity analysis, etc.

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Kharkiv, Ukraine
Karlsruhe, Germany

Volodymyr Girka
Igor Girka
Manfred Thumm

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