# Basic principles of sound radiation and scattering

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**Abstract, Contents and Preface**
(translated from the Russian)

## Abstract

The book gives a brief account of the theory of radiation and scattering of sound in liquids and gases. General principles of radiation and scattering of acoustic waves are considered, including Huygens' principle, the reciprocity theorem, the problem of the existence and uniqueness of solutions. Acoustic fields generated by some complicated radiators are analysed in detail. Basic definitions and facts relating to the scattering of sound by an infinite cylinder, sphere, gas bubbles in liquids, etc. are considered as well. Much of attention is paid to the general theory of scattering with respect to the scattering of acoustic waves. These include the method of boundary integral equations and the methods based on the approximate solutions of the equations of Lippmann - Schwinger type. Considered are also energy conservation issues at wave scattering and the problems linked to causality and Kramers - Kronig relations. The book is intended for students and researchers working in the field of acoustics.

## Contents

# Preface

This textbook reflects the contents of the course of lectures that have been delivered by the author over the years to students of the Acoustics Department of the Faculty of Physics at Moscow M.V. Lomonosov State University. A shortened version of this course has been delivered also to members of staff of the Acoustics Laboratory at the Moscow Research Institute of Standard and Experimental Design. The main purpose of this book is to assist the reader, who just began to study the theory of radiation and scattering of sound, to get a logically complete account of this important part of acoustics, with a minimum amount of necessary facts and arguments. In this regard, the proposed book differs significantly from the existing manuals dealing with similar

problems (see the reading list at the end of the book), in which the abundance of factual material and its not always successful composition complicate an introduction to the subject.

Coverage in the book begins with the general principles of radiation and scattering (Chapter 1), of which much attention is paid to Huygens' principle in the formulation of Helmholtz. The developed methods and ideas are then used for calculations of sound fields radiated by a number of complex vibrating structures (Chapter 2), and for the analysis of the acoustic scattering (Chapters 3 and 4). To understand the text of the book the reader does not require any prior knowledge of acoustics, although, of course, the presence of an elementary acquaintance with the subject will not be redundant. Much of the material in the book refers to the well-known classical problems of acoustics. Therefore, the only achievement of the author in presenting these problems, if the word ‘achievement’ is at all appropriate in this case, was the following. From the numerous derivations reported in the literature the author choose one or more that best met the objective of logical unity of the description or had the greatest simplicity and elegance. This is especially true of the material of the first three chapters, which, however, also contains some original approaches and interpretations. The content of the final, fourth chapter is based on the material rather poorly reflected in the academic literature on acoustics. Here, one should mention the method of boundary integral equations, which since recently has been widely used for the numerical solution of radiation and diffraction problems for bodies of arbitrary shape.

One can predict natural reservations from readers regarding the fact that the book does not address many exactly solvable problems of radiation and scattering of sound. For example, the problem of radiation by pulsating cylinders or their segments, the problem of scattering of sound by a wedge, by an elliptical cylinder, by an ellipsoid, etc. The main reason behind these omissions was the intention to limit the presentation with the simple examples that adequately illustrate the main ideas, techniques and solutions, and at the same time help to avoid turning this textbook into a guide to the practical use of special functions. Due to the limited volume of the book, we have not included such important topics as sound radiation by moving sources, sound radiation by vortices, and laser generation of sound. Beyond the limits of this book are also numerous problems of radiation and scattering of sound in solids. They would require special consideration. Many of these problems though can be found, if needed, in the recommended literature.

I am grateful to all my colleagues who participated in the discussion of the book in the process of its preparation for press. Special thanks are to V.A. Krasil’nikov, O.V. Rudenko, Y.P. Lysanov, P.N. Kravchun and R.Y. Vinokur, who made a number of useful comments, and to Mrs. L.S. Perge, who typed the manuscript and helped to eliminate some bugs and literary shortcomings.

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