

David Colton Rainer Kress

Inverse Acoustic and Electromagnetic Scattering Theory

Second Edition



Springer

Table of Contents

1	Introduction	1
1.1	The Direct Scattering Problem	2
1.2	The Inverse Scattering Problem	7
2	The Helmholtz Equation	13
2.1	Acoustic Waves	13
2.2	Green's Theorem and Formula	16
2.3	Spherical Harmonics	21
2.4	Spherical Bessel Functions	28
2.5	The Far Field Mapping	32
3	Direct Acoustic Obstacle Scattering	38
3.1	Single- and Double-Layer Potentials	39
3.2	Scattering from a Sound-Soft Obstacle	46
3.3	The Reciprocity Relation	54
3.4	The Two-Dimensional Case	64
3.5	On the Numerical Solution in \mathbb{R}^2	67
3.6	On the Numerical Solution in \mathbb{R}^3	78
4	Ill-Posed Problems	85
4.1	The Concept of Ill-Posedness	86
4.2	Regularization Methods	87
4.3	Singular Value Decomposition	89
4.4	Tikhonov Regularization	97
4.5	Nonlinear Operators	102
5	Inverse Acoustic Obstacle Scattering	105
5.1	Uniqueness	106
5.2	Physical Optics Approximation	113
5.3	Continuity and Differentiability of the Far Field Mapping	114
5.4	Approximation of the Scattered Field	134
5.5	Superposition of the Incident Fields	145

6	The Maxwell Equations	153
6.1	Electromagnetic Waves	154
6.2	Green's Theorem and Formula	155
6.3	Vector Potentials	165
6.4	Scattering from a Perfect Conductor	172
6.5	Vector Wave Functions	177
6.6	The Reciprocity Relation	185
7	Inverse Electromagnetic Obstacle Scattering	195
7.1	Uniqueness	195
7.2	Continuous Dependence on the Boundary	199
7.3	Approximation of the Scattered Field	203
7.4	Superposition of the Incident Fields	206
8	Acoustic Waves in an Inhomogeneous Medium	211
8.1	Physical Background	212
8.2	The Lippmann–Schwinger Equation	214
8.3	The Unique Continuation Principle	218
8.4	Far Field Patterns	222
8.5	The Analytic Fredholm Theory	233
8.6	Transmission Eigenvalues	238
8.7	Numerical Methods	246
9	Electromagnetic Waves in an Inhomogeneous Medium	250
9.1	Physical Background	251
9.2	Existence and Uniqueness	252
9.3	Far Field Patterns	256
9.4	The Spherically Stratified Dielectric Medium	259
9.5	The Exterior Impedance Boundary Value Problem	264
10	The Inverse Medium Problem	271
10.1	The Inverse Medium Problem for Acoustic Waves	272
10.2	A Uniqueness Theorem	274
10.3	A Dual Space Method	280
10.4	A Modified Dual Space Method	285
10.5	The Inverse Medium Problem for Electromagnetic Waves	289
10.6	Numerical Examples	300
10.7	The Two-Dimensional Case	307
	References	318
	Index	332