

Index

S-parameters, 133, *see* scattering parameters

Abbe's diffraction limit, 246, *see* diffraction limit
 acausal wave solution, 8, 10, 21, 22, 27, 222, 322, 323, 325

adjoint operator, 25, 26, 72, 321–323
 adjoint source, 30, 76–78, 80, 81, 323, 325
 alternating current (AC), 9
 auto-correlation, 218, 220

back-propagation, 36–38, 40, 41, 43–45, 66, 232–235
 filtered back-propagation, 263
 Born approximation, 91, 95–100, 104, 107, 108, 110, 141, 142, 150, 181, 183, 185, 198, 264, 268, 286
 Born iterative method (BIM), 209, 292, 293
 Born series, 91, 94, 97
 convergence of, 100
 boundary conditions, 6, 20, 21, 27, 29, 35–37, 46, 47, 49, 50, 57, 58, 60, 61, 70, 112, 120, 121, 123, 124, 135, 168, 173, 302, 304, 316, 318, 321, 325
 electromagnetic, 124, 125, 177
 radiation boundary conditions, 114, 184
 boundary-element method (BEM), 53

calibration object (CO), 184, 192, 199, 207, 210–212, 216, 255, 284–287, 289
 CO power map, 213
 Cauchy initial-value problem, 44, *see* initial-value problem
 Cauchy's principal value, 53, *see* principal value
 causal wave solution, 8, 14, 22, 27, 28, 322, 323, 325
 causality, 21, 22, 26, 28, 221
 chirp-pulse microwave computed tomography (CP-MCT), 265
 component drift, 282, 287
 constitutive parameters, 2, 4, 12, 60, 67, 87, 119, 121, 128, 130, 140, 162, 165
 constitutive relations, 299
 constitutive tensors, 133

contrast resolution, 266, 288
 contrast sensitivity, 288
 convolution, 10, 74, 76, 78, 79, 202–204, 212, 213, 216, 221, 228, 230, 242, 260, 270
 theorem, 65
 correlation, 219, *see* cross-correlation
 cross-correlation, 203, 218–220, 222, 229, 230
 spatial, 229
 temporal, 229

d'Alembert's operator, 23, 25–27, 322, 323
 deconvolution, 229–231
 Wiener, 231, 247
 delay and sum (DAS), 223, 226, 228, 229, 234, 235
 diffraction limit, 246, 264, 273, 274
 diffraction tomography, 236, 258, 259, 264
 discrete Fourier transform (DFT), 62
 distorted Born iterative method (DBIM), 209, 292, 294
 DORT (décomposition de l'opérateur de retournement temporel), 233, 234
 double-layer sheet, 52, *see* double-layer surface source
 double-layer surface source, 50–53, 58
 duality
 electromagnetic, 306

electric field integral equation (EFIE), 116–119, 125–128
 electromagnetic duality, 306
 equivalence principle, 20, 36, 48, 116, 297, 301
 in electromagnetism, 124
 in EM radiation, 126
 in EM scattering, 128, 129
 in radiation, 48, 49
 in scattering, 55, 58
 Love's equivalence principle, 125, 126, 129
 equivalent sources, 77
 boundary values as, 58
 on surface, 20, 39, 48–51, 53, 55, 58, 66
 extinction theorem, 53, 57, 58, 125

- fast Fourier transform (FFT), 204, 214, 231, 247–249, 252, 253
- feature-free region (FFR), 284–288
- filtered back-propagation, 263
- finite-difference time-domain (FDTD), 44, 45, 152, 227, 234
- finite-element method (FEM), 53
- finite-element time-domain (FETD), 44, 45, 152
- Fourier transform (FT), 61–65, 82, 186, 187, 203, 213, 217, 219, 220, 222, 230, 242–244, 247, 271
- Fréchet derivative, 163, 164, 170, 171, 189–191
 - of S -parameters, 163, 181, 195
- fundamental solution, 71, 72, 74, 76, 145–147
 - causal, 72
 - to the 1D lossy wave equation, 88
 - to the 1D wave equation, 84–86
 - to the 2D Helmholtz equation, 146, 260, 264
 - to the 2D lossy-wave equation, 89
 - to the 2D wave equation, 86, 227
 - to the 3D lossy-wave equation, 88
 - to the 3D wave equation, 85, 86
 - to the adjoint operator, 72
 - to the Helmholtz equation, 72, 89–91, 113, 126
 - to the lossy wave equation, 87
 - to the vector Helmholtz equation, 113
 - to the wave equation, 84, 85
- Green's dyadic, 112–117, 119, 126–128, 130, 132–135, 141, 145, 146
 - as an incident field, 133, 134, 145
 - for layered media, 146
 - of the Helmholtz equation, 132
 - reciprocity of, 115, 133
 - singularity of, 117
- Green's function, 10, 15–17, 19–21, 24, 25, 27, 46, 52, 55, 56, 59, 66, 69–72, 76, 78, 80, 94, 95, 97, 99, 103, 107, 112, 145, 150, 178, 184, 233, 234, 260, 264, 294
 - acausal, 21, 22, 26, 27, 29, 33, 62, 65, 320–322
 - adjoint, 25–27, 320–322
 - approximation of, 150, 275
 - as an incident field, 71, 73, 76, 78, 83, 132
 - causal, 22, 26, 27, 29, 33, 35, 36, 44, 62, 65, 320–322
 - gradient of, 52
 - of the Helmholtz equation, 22, 53, 54, 58, 90, 118
 - of the wave equation, 22, 24, 26–29, 40, 84, 86
 - reciprocity of, 20, 22, 25, 40, 69, 322
 - self-adjoint, 25
 - singularity of, 53, 118
 - uniqueness of, 20
- Green's theorem, 17, 18, 21, 23–25
- Green's vector function, 115, 133–137, 145, 149, 150, 178, 179, 268
- Green's vector identity, 114
- ground penetrating radar (GPR), 215, 222, 223, 256
- Helmholtz equation, 23, 24, 36, 46, 48–50, 52, 54, 58, 61, 62, 64–66, 68, 69, 71, 72, 89, 91
 - operator of, 25, 46, 71, 72, 77, 90
 - vector Helmholtz equation, 112–114, 131, 307, 309–311
- holographic inversion, 240
- holography, 147–151, 236, 237, 250, 253, 255
 - far-field, 256
 - indirect, 257
 - optical, 237
- image point-spread function (IPSF), 267, 268
- initial conditions, 6, 16, 18, 27–29, 35, 36, 84, 302
- initial-value problem, 44, 45
- inverse Fourier transform (inverse FT), 78, 83, 152, 160, 214, 231, 236, 244, 251, 263, 276, 287
- Kirchhoff–Helmholtz integral equation, 36, 46, 47, 65
- Lippmann–Schwinger equation of scattering, 69
- Lorentz force, 302
- magnetic field integral equation (MFIE), 116–119, 125, 126, 132, 152
- Maxwell's equations, 1–3, 111, 114, 118, 121, 143, 152, 297, 307, 310, 314, 316, 318
 - in the frequency domain, 111, 303
 - in the time domain, 2, 152, 297
 - integral form, 305
- method of moments (MoM), 53, 130
- migration, 218, 221, 223, 226–228
 - steering filter, 222
- MUSIC (multiple signal classification), 233, 234
- noise floor, 44, 184, 280, 281, 283, 284, 288
 - thermal, 281
- nonradiating sources, 43, 70, 318
- nonuniqueness, 70, 159, 210
- perfect electric conductor (PEC), 118, 119, 124, 132, 176–179
- perfect magnetic conductor (PMC), 124
- point spread function (PSF), 185–188, 200, 201, 203–207, 209, 210, 212, 216, 217, 219, 220, 222, 228–230, 234, 242–244, 249–253, 255, 260, 269, 271, 272, 274
- power map, 205, 207–210, 212, 213
 - CO power map, 213
 - OUT power map, 207, 208, 212

- power waves, 155, 157, 158, 180
 - root-power waves, 157
- principal value, 117, 118
- radiation boundary condition, 65, 114
- receiver sensitivity, 280–282
- reciprocity, 20–22, 25–27, 46, 69, 72, 115, 133, 134, 141, 322, 326
- reference object (RO), 211, 212, 284–288
- region of interest (ROI), 284–287
- resolution
 - contrast, 266
 - spatial, 163, *see* spatial resolution
- resolvent kernel, 94, 183, 186, 216, 242, 269
- response Jacobian, 162, *see* response sensitivity
- response sensitivity, 162, *see* sensitivity
- Rytov approximation, 91, 100, 104, 107, 108, 141, 142
- Rytov expansion, 105, 107, 108
- scalarization
 - of the EM field, 312, 317
 - of the EM sources, 317
- scattered-power map, 205, 207, 210, 212, 253, *see* power map
- scattering matrix, 158, *see also* scattering parameters
- scattering parameters, 133, 137, 154, 156–158
 - data equation of, 178, 179
 - general sensitivity formula, 164
 - sensitivities of, 162
 - sensitivity formula for constitutive parameters, 165
 - sensitivity formula for shape parameters of dielectric objects, 171
 - sensitivity formula for shape parameters of metallic objects, 176
- self-adjoint operator, 25, 26, 72, 77
- sensitivity
 - analysis, 33, 162, 164
 - analytical sensitivity formula, 164
 - of *S*-parameters, 162, 164
 - sensitivity formula, 164
 - to constitutive parameters, 165
 - to shape parameters of dielectric objects, 171
 - to shape parameters of metallic objects, 176
- sensitivity map, 188, 191–199, 201, 203, 204, 206–208, 210, 212, 253
- signal-to-noise ratio (SNR), 212, 231, 247, 266, 281, 282, 284
 - of an ideal observer, 266
- single-layer sheet, 51, *see* single-layer surface source
- single-layer surface source, 50–53, 58
- singular-value decomposition (SVD), 209
 - truncated (TSVD), 209, 247
- Sommerfeld’s boundary condition, 65
- spatial resolution, 163, 188, 189, 196, 197, 200–202, 208, 209, 232, 235, 239, 244, 246, 247, 266, 267
 - bi-static formula for, 274
 - cross-range, 197–199, 201, 245, 253
 - lateral, 197, 198
 - range, 199, 202, 210, 245, 253
- steering filter, 219, 220, 222, 223, 225, 228, 229
 - migration, 222, 225
- surface sources, 49, *see* equivalent source
- synthetic aperture radar (SAR), 215, 236, 240, 273, 277
- synthetic focusing, 215
- TE/TM decomposition, 317, 319
- terminal conditions, 18, 27–29, 326
- time reversal (TR), 27, 41, 73, 231–235
- time-reversal cavity (TRC), 232
- time-reversal mirror (TRM), 232–234
- tomography, 143, 144, 147, 163
 - computed, 98, 258, 265
 - diffraction, 236, *see* diffraction tomography
- transmission-line matrix method (TLM), 43–45, 152, 234
- transverse electric (TE), 264
- transverse electromagnetic (TEM), 7, 9, 157, 211
- transverse magnetic (TM), 143, 145, 226, 264
- ultra-wideband (UWB), 152, 215, 216, 219, 220, 224, 231
- uncertainty, 184, 268, 284
- uniqueness
 - of Green’s function, 20
 - of the inverse source problem, 318
 - theorem for the Helmholtz equation, 53, 54
 - theorem for the wave equation, 38–40
 - theorem of electromagnetism, 119–121, 125
- vector network analyzer (VNA), 154, 160, 161, 239, 257, 281–283
- vector potentials, 3, 312, 315, 316, 318, 319
- wave equation, 3–6, 9, 16, 18, 23, 31, 313, 319
 - adjoint, 30, 31
 - adjoint solution of, 320
 - damped-wave equation, 23–26, 87
 - fundamental solutions of, 84
 - integral solutions of, 19, 27
 - loss-free, 18, 21, 23, 24, 26–28
 - operator of, 18
 - vector wave equation, 307–311, 319
- wave functions, 2, 3, 9, 13, 312, 314, 315, 318
 - spherical, 318
- wave potentials, 312
- Wiener inverse filter, 231