

Wei Cai

Deterministic, Stochastic, and Deep Learning Methods for Computational Electromagnetics

Second Edition

This book provides a well-balanced and comprehensive treatment of computational electromagnetics based on clear physics, solid mathematical formulation, and state-of-the-art useful numerical methods in deterministic, stochastic, and deep neural network machine learning approaches for computer simulations of electromagnetic and transport processes in biology, microwave and optical wave devices, and nano-electronics. Computational research has become strongly influenced by interactions from many different areas including biology, physics, chemistry, and engineering. A multifaceted approach that addresses the interconnections among mathematical algorithms, physical foundations, and applications is much needed.

The second edition includes five new chapters and covers the following numerical methods: • Multi-scale DeepRitz and PINN, SDE-based, and spectral bias-free deep neural networks for solving PDEs. • Random walk-on-spheres methods for electrostatics. • Stochastic spectral methods for uncertainty quantifications in microchip designs. • Plane wave, finite element, and density matrix minimization DFT methods for electronic structure. • Fast multipole methods for Helmholtz equations in 3D layered media, particle-mesh Ewald, and image-based reaction field method for long-range interactions. • Discontinuous Galerkin, Bloch plane waves, hierarchical Nedelec edge elements, and high-order surface/volume integral equation methods for Maxwell's equations, periodic structures, and quantum dots. • Vlasov-Fokker-Planck and PIC methods for plasma MHD. • Quantum non-equilibrium Green's function and Wigner equation, and hydrodynamic WENO methods for electron transport. • Absorbing and PML boundary conditions for EM scattering, etc.

“This is an impressive . . . excellent book for those who want to study and understand the relationship between mathematical methods and the many different physical problems they can model and solve.”

on the first edition, **Weng Cho Chew**, Distinguished Professor of Electrical and Computer Engineering, Purdue University.

“The second edition of this book is an even great and unique contribution to modern computational methods in modeling electromagnetic problems across classical and quantum fields. Both the organization of the material and the exposition of physical and algorithmic concepts are superb and make the book accessible to researchers and students in every discipline. Highly recommended!”

George Em Karniadakis, The Charles Pitts Robinson and John Palmer Barstow Professor of Applied Mathematics and Engineering, Brown University.

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