Quantification in Signal Processing for Magnetic Resonance Spectroscopy (Series in Atomic Molecular Physics)

Dzevad Belkic, Karen Belkic

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This interdisciplinary book simultaneously deals with three selected fields. Specifically, it presents a joint framework with the unified quantum-mechanical theories of resonant scattering, spectroscopy, and signal processing. Both the standard and non-standard analyses are expounded by encompassing the key ingredient of the S- and R-matrices, variational principles, complex coordinate scaling, wave packet propagation, Fredholm determinants, finite-rank separable expansions, filter diagonalization, the Lanczos algorithm, and the Padé methodology.

The highly developed mathematical theory of rational functions with the traditional Padé approximant as the leading proponent is advantageously exploited. Remarkably, this single strategy can be efficiently employed for vastly different tasks, ranging from optimal solutions of the major quantum-mechanical enquiry—the eigenvalue problems for determining the state and structure of the investigated generic systems via acceleration of slowly converging series—to powerful transformations of divergent into convergent perturbation expansions in a variety of applications. Moreover, accuracy, stability, and robustness put the Padé method at the forefront of the multitude of the existing solvers of the so-called inverse mathematically ill-conditioned problems.

The analyzed theoretical formalism is mathematically and physically rigorous with the added value for wide, practical applications. It can be used with equal or comparable success in optimally quantifying resonances in physics, chemistry, biology, and medical diagnostics as well as in the applied area of signal processing. The overall scope and structure of this book is systematically and methodologically presented in a way to be maximally suitable for graduate students and researchers in the above-mentioned basic and applied sciences.

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