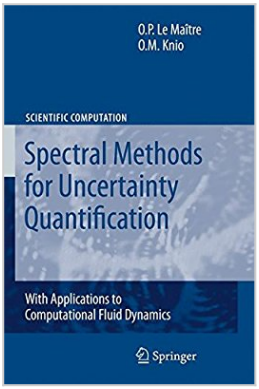

Spectral Methods for Uncertainty Quantification: With Applications to Computational Fluid Dynamics (Scientific Computation)

By Olivier Le Maitre, Omar M Knio

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This book deals with the application of spectral methods to problems of uncertainty propagation and quanti?cation in model-based computations. It speci?cally focuses on computational and algorithmic features of these methods which are most useful in dealing with models based on partial differential equations, with special att- tion to models arising in simulations of ?uid ?ows. Implementations are illustrated through applications to elementary problems, as well as more elaborate examples selected from the authors' interests in incompressible vortex-dominated ?ows and compressible ?ows at low Mach numbers. Spectral stochastic methods are probabilistic in nature, and are consequently rooted in the rich mathematical foundation associated with probability and measure spaces. Despite the authors' fascination with this foundation, the discussion only - ludes to those theoretical aspects needed to set the stage for subsequent applications. The book is authored by practitioners, and is primarily intended for researchers or graduate students in computational mathematics, physics, or ?uid dynamics. The book assumes familiarity with elementary methods for the numerical solution of time-dependent, partial differential equations; prior experience with spectral me- ods is naturally helpful though not essential. Full appreciation of elaborate examples in computational ?uid dynamics (CFD) would require familiarity with key, and in some cases delicate, features of the associated numerical methods. Besides these shortcomings, our aim is to treat algorithmic and computational aspects of spectral stochastic methods with details suf?cient to address and reconstruct all but those highly elaborate examples.

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Editorial Review

From the Back Cover

This book presents applications of spectral methods to problems of uncertainty propagation and quantification in model-based computations, focusing on the computational and algorithmic features of these methods most useful in dealing with models based on partial differential equations, in particular models arising in simulations of fluid flows. Spectral stochastic methods are probabilistic in nature, and are consequently rooted in the rich mathematical foundations associated with probability and measure spaces. A brief discussion is provided of only those theoretical aspects needed to set the stage for subsequent applications. These are demonstrated through detailed treatments of elementary problems, as well as in more elaborate examples involving vortex-dominated flows and compressible flows at low Mach numbers. Some recent developments are also outlined in the book, including iterative techniques (such as stochastic multigrids and Newton schemes), intrusive and non-intrusive formalisms, spectral representations using mixed and discontinuous bases, multi-resolution approximations, and adaptive techniques. Readers are assumed to be familiar with elementary methods for the numerical solution of time-dependent, partial differential equations; prior experience with spectral approximation is helpful but not essential.

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