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Buchbesprechung: Stochastic partial differential equations : a modeling, white noise functional analysis approach [H. Holden; B.Oksendal; J. Uboe]

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Stochastic Partial Differential Equations

A Modeling, White Noise Functional Analysis Approach

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Stochastic methods have become increasingly important in the analysis of a broad range of phenomena in natural sciences and economics. Many processes are described by differential equations where some of the parameters and/or the initial data are not known with complete certainty, due to lack of information, uncertainty in the measurements, or incomplete knowledge of the mechanisms themselves. To compensate for this lack of information one introduces stochastic noise in the equations, either in the parameters or in the initial data. This results in stochastic differential equations.

First some of the mathematical background is discussed to provide the necessary tools to study several different stochastic partial differential equations. The techniques are mainly from functional analysis. The Wiener-Itô chaos expansion as well as the Itô/Skorohod integrals are developed in this setting, and properties of the Wick product and the Hermite transform are proved. The first applications are given to stochastic ordinary differential equations, e.g., the Volterra equation.

The main emphasis of the book is on stochastic partial differential equations. First the stochastic Poisson equation and the stochastic transport equation are discussed. Next, the authors consider the stochastic Schrödinger equation as well as the stochastic heat equation. The nonlinear Burgers' equation with a stochastic source is discussed, and finally the stochastic pressure equation, as well as other important equations are treated. The white noise approach often allows for solutions given by explicit formulas in terms of expectations of certain auxiliary processes.

The noise in the above examples are all of Gaussian white noise type. But in the end the authors also show how to adapt the analysis to SPDEs involving noise of Poissonian type.