The book is divided into three parts.

The first part is concerned with the theory of linear waves. After introducing the basic concepts, the authors explore systematically the properties of waves on a stretched string, sound waves, linear water waves, waves in elastic solids and electromagnetic waves. Each section starts with a clear derivation of the basic equations. When necessary basic concepts of fluid mechanics, electromagnetism, chemistry, thermodynamics, etc. are derived from physical principles.

The second part of the book deals with nonlinear waves. The authors first introduce the concepts of shocks by considering traffic waves. They then use the ideas developed for traffic flows to investigate more complicated problems arising in gas dynamics. There is a very nice chapter on nonlinear waves in which shallow water theory, the Stokes' expansion for gravity waves, the Korteweg–de Vries equation and nonlinear capillary waves are investigated. This second part of the book concludes with a chapter on electrochemical waves the transmission of nerve impulses (Fitzhugh–Nagumo model).

The third part covers some advanced topics. Here the interested reader will learn about diffraction, scattering, solitons, the inverse scattering transform, Burgers' equation and the nonlinear Schrödinger equation. These problems are more difficult but the first two parts of the book provide the necessary background to grasp the material.

One attractive feature of the book is the abundance of worked examples and exercises (with solutions available to teachers). The mathematics is clearly presented and physical interpretations of the results are given when appropriate. While learning about waves, the reader will also be introduced to important methods in applied mathematics such as WKB expansions, Fourier methods, asymptotic analysis, the Wiener–Hopf technique and perturbation theory.

In conclusion, this is a wonderful book whose reading I would recommend to any scientist interested in learning the mathematical theory of wave motion.

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Large Eddy Simulation for Incompressible Flows – An Introduction by Pierre Sagaut (Springer-Verlag, Germany, 2001, 319 pp.) DM 119.00, US$ 59.95 hardcover. ISBN 3 540 67890 5

Large-Eddy Simulation (LES) is a tool to compute turbulent flows by resolving the large scales and modeling the small ones (the so-called Sub-Grid Scales: SGS). This is an intermediate approach between solving for the mean flow quantities governed, e.g., by the Reynolds Averaged Navier–Stokes equations (RANS) and solving for the full unsteady flow (Direct Numerical Simulation: DNS). The first approach (RANS) is computationally cheap with rather limited information. The second approach (DNS), yielding the desired results and a complete physical description of the flow, is in general prohibitively expensive.

This book is a review of effective and precise modeling techniques for LES of high Reynolds number industrial flows. This alternative method to DNS provides detailed unsteady flow characteristics without having to solve for all wave numbers of the flow. The effects of the non-resolved small scales are then taken into account in the so-called filtered Navier–Stokes equations through an extra turbulent transport term involving a SGS stress tensor. The reduction in number of discretization points (presented in the book as reduction of degrees of freedom) has to be compensated by modeling this SGS stress tensor. The author defines two modeling strategies which led to the SGS models developed up to now for turbulent incompressible flows. The first, called functional modeling, aims at properly representing the interaction between resolved and unresolved scales rather than the structure of the SGS stress tensor. The second, the structural modeling, searches for the best mathematical representation of the SGS tensor and disregards the nature of scale interactions.

The introduction already gives the orientation of the book towards the notion of scales in the computation of turbulent flows. The concept of resolved and modeled scales is then introduced through a wave number decomposition in spectral space, yielding the classical definition of a filtering procedure associated with the LES method.

Chapter 2 recalls the main mathematical characteristics of a filter defined both in physical and spectral space. A few classical filters used in the literature are described. The author also discusses properties of general non-homogeneous and non-isotropic filters related to the commutation error due to differenciation. Such properties are more and more considered as destructive for LES when not accounted for.

Once the mathematical basis of a filter has been set, chapter 3 then focuses on the filtered Navier–Stokes equations obtained by convolution of a filter with the classical evolution equations. A complete analysis of the constitutive equations of LES is presented both in physical and spectral space. Transport equations for resolved and non-resolved kinetic energy (representing the trace of the SGS tensor) are derived, leading to the classical splitting introduced by Leonard and to the 'Germano Identity' considered here in various non-classical ways. Some important properties such as invariance and realizability which have to be verified by a SGS model are then extensively described.

Chapters 4, 5 and 6 are devoted to the two modeling strategies mentioned above. Chapter 4 presents a large spectrum of SGS models aiming at representing the transfer of energy between resolved and non-resolved scales. This, being called 'functional modeling' comprises all the models based on the eddy-viscosity assumption. This concept which allows to account for forward energy cascade processes only (Kolmogorov cascade towards the small unresolved scales) in the inertial range of the spectrum has been improved during the last 40 years since the Smagorinsky model appeared (e.g., the varions formulations of the dynamic model). One will also find here spectral eddy-viscosity models, built out of spectral triad interactions (including the EDQNM theory described in detail in the Appendix). The backward energy transfer process is a main characteristic of intermittent flows like transitional and wall bounded flows. Dealing with such a behaviour is the topic of stochastic models which belong to a sub-set generated by the 'functional modeling'.

Chapter 5 concerns anisotropic meshes and anisotropic flows. It forms the bridge to the next chapter. The models described here mainly account for geometrical considerations which yield a better description of the flow anisotropy and generally break with the classical eddy-viscosity assumption.

Chapter 6 describes the progress made in the last 20 years in getting a better description of the form of the model rather than its interaction properties. The present family of SGS models is referred to as 'structural models'. They are born out of mathematical approximations of the filtering procedure. Applying Taylor expansions to the filtered velocity field with respect to the non-filtered field yields a non-linear description of the SGS stress tensor related to the rotation and strain rate tensors. A similar approximation yields the scale similarity models for which the SGS tensor is replaced by various forms of the generalized Leonard stress tensor. The so-called mixed models blending both scale similarity and eddy-viscosity concepts appear as a compromise between functional and structural modeling. Finally various deconvolution methods are presented which mainly aim at determining the large scale part of the velocity field from a defiltering procedure based on approximated inverse filtering. The most advanced models then try to reconstruct part of the information lost at the cut-off wave number based on non-linear interactions. Such models appear therefore to be still at the limit between structural and functional modeling.

Chapters 7 to 10 highlight typical problems arising during applications of the LES method. The most important topics which should determine the research activities during the following decennium are related to the interaction between SGS model and numerical schemes on one hand, and the determination of exact and efficient boundary conditions (wall boundary and inflow conditions) on the other hand. Chapter 11 gives a few examples of realisations of three main flow families: homogeneous turbulence, wall bounded flows, free shear flows.

In summary, the book provides a broad and nearly complete picture of LES techniques for incompressible flows. Beginners in the field will enjoy its introductory character, while experts may discover ideas they thought of persuing themselves. The book can be strongly recommended to postgraduate students, researchers and engineers in all fields where statistical turbulence modeling fails.

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Turbulence Structure and Vortex Dynamics edited by J.C.R. Hunt and J.C. Vassilicos (Cambridge University Press, UK, 2001, 306 pp.) £55.00, US$ 80.00 hardcover. ISBN 0 521 78131 0

In turbulence, as in other subjects in physics, things can either be seen in terms of particles or in terms of waves, which in this particular case means that it is possible to describe the flow in terms of global modes, or in terms of structures. Also, as in other areas of physics, both points of views have their adherents who, on occasions, tend to see one of them as contradictory to the other. The synthesis of the statistical theories of the former with the structural descriptions of the latter has still not been done, and it is not absolutely clear that it will eventually succeed in a useful sense.

The title of this book, which is the proceedings of a workshop held at the Isaac Newton Institute in Cambridge, in the Spring of 1999, suggests that the participants subscribe to the structural approach, but a look at the index shows that the aim of the meeting was more an attempt to reconcile both points of view.

As it often happens with proceedings, the articles in the book are varied. About one third of them deal with vortex dynamics, with little or no reference to turbulence, and at least two papers are dedicated to statistical theories of turbulence with no apparent relation with vortices. The rest, however, make an attempt to link both points of view, and it is there perhaps that the interest of this book mostly lies.

As is unavoidable in these kinds of books, some of the articles have been superseded by newer, and in a few cases by older, published work by the same authors, but a substantial fraction of them seems to have been specially written for this meeting. Those include some welcome surveys of areas which may be unfamiliar to the readers of the book. There is for example an introduction by Barenghi to the description of superfluid turbulence in terms of vortex tangles which I read with pleasure, and a survey of vortices in rotating flows by Cambon which I could not find elsewhere in such a compact form.