

FLUID MECHANICS AND ITS APPLICATIONS

P. Chassaing, R.A. Antonia, E. Anselmetti,
L. Joly and S. Sarkar

Variable Density Fluid Turbulence



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Variable Density Fluid Turbulence:

Variable Density Fluid Turbulence P. Chassaing, R.A. Antonia, Fabien Anselmet, L. Joly, S. Sarkar, 2013-06-29 The first part aims at providing the physical and theoretical framework of the analysis of density variations in fully turbulent flows Its scope is deliberately educational In the second part basic data on dynamical and scalar properties of variable density turbulent flows are presented and discussed based on experimental data and or results from direct numerical simulations This part is rather concerned with a research audience The last part is more directly devoted to an engineering audience and deals with prediction methods for turbulent flows of variable density fluid Both first and second order single point modeling are discussed with special emphasis on the capability to include specific variable density compressibility effects **The**

Dynamics of Variable-density Turbulence, 1995 The dynamics of variable density turbulent fluids are studied by direct numerical simulation The flow is incompressible so that acoustic waves are decoupled from the problem and implying that density is not a thermodynamic variable Changes in density occur due to molecular mixing The velocity field is in general divergent A pseudo spectral numerical technique is used to solve the equations of motion Three dimensional simulations are performed using a grid size of 1283 grid points Two types of problems are studied 1 the decay of isotropic variable density turbulence and 2 buoyancy generated turbulence in a fluid with large density fluctuations In the case of isotropic variable density turbulence the overall statistical decay behavior for the cases studied is relatively unaffected by the presence of density variations when the initial density and velocity fields are statistically independent The results for this case are in quantitative agreement with previous numerical and laboratory results In this case the initial density field has a bimodal probability density function pdf which evolves in time towards a Gaussian distribution The pdf of the density field is symmetric about its mean value throughout its evolution If the initial velocity and density fields are statistically dependent however the decay process is significantly affected by the density fluctuations For the case of buoyancy generated turbulence variable density departures from the Boussinesq approximation are studied The results of the buoyancy generated turbulence are compared with variable density model predictions Both a one point engineering model and a two point spectral model are tested against the numerical data Some deficiencies in these variable density models are discussed and modifications are suggested *IUTAM Symposium on Variable Density Low-Speed Turbulent Flows* Louis Fulachier, John L. Lumley, Fabien

Anselmet, 2012-12-06 The General Assembly of the International Union of Theoretical and Applied Mechanics in its meeting on August 28 1994 selected for 1996 only four Mechanics Symposia of which ours is the only one related to Fluid Mechanics Variable Density Low Speed Turbulent Flows This IUTAM Symposium organized by the Institut de Recherche sur les Phenomenes Hors Equilibre Marseille is the logical continuation of the meetings previously organized or co organized on the French or European level such as Euromech 237 Marseille 1988 by the same research group of Marseille This meeting focused specifically on the structure of turbulent flows in which density varies strongly the effect of this variation on the

velocity and scalar fields is in no sense negligible We were mainly concerned with low speed flows subjected to strong local changes of density as a consequence of heat or mass transfer or of chemical reactions Compressible turbulent flows such as supersonic ones were also considered in order to underline their similarities to and their differences from low speed variable density flows

Modeling and Simulation of Turbulent Mixing and Reaction Daniel Livescu, Arash G. Nouri, Francine Battaglia, Peyman Givi, 2020-02-19 This book highlights recent research advances in the area of turbulent flows from both industry and academia for applications in the area of Aerospace and Mechanical engineering Contributions include modeling simulations and experiments meant for researchers professionals and students in the area

Probability Density Function Method for Variable-density Pressure-gradient-driven Turbulence and Mixing, 2010 Probability density function PDF methods are extended to variable density pressure gradient driven turbulence We apply the new method to compute the joint PDF of density and velocity in a non premixed binary mixture of different density molecularly mixing fluids under gravity The full time evolution of the joint PDF is captured in the highly non equilibrium flow starting from a quiescent state transitioning to fully developed turbulence and finally dissipated by molecular diffusion High Atwood number effects as distinguished from the Boussinesq case are accounted for both hydrodynamic turbulence and material mixing are treated at arbitrary density ratios with the specific volume mass flux and all their correlations in closed form An extension of the generalized Langevin model originally developed for the Lagrangian fluid particle velocity in constant density shear driven turbulence is constructed for variable density pressure gradient driven flows The persistent small scale anisotropy a fundamentally non Kolmogorovian feature of flows under external acceleration forces is captured by a tensorial diffusion term based on the external body force The material mixing model for the fluid density an active scalar is developed based on the beta distribution The beta PDF is shown to be capable of capturing the mixing asymmetry and that it can accurately represent the density through transition in fully developed turbulence and in the decay process The joint model for hydrodynamics and active material mixing yields a time accurate evolution of the turbulent kinetic energy and Reynolds stress anisotropy without resorting to gradient diffusion hypotheses and represents the mixing state by the density PDF itself eliminating the need for dubious mixing measures Direct numerical simulations of the homogeneous Rayleigh Taylor instability are used for model validation

A Two-Equation Turbulence Model for a Dispersed Two-Phased Flow with Variable Density Fluid and Constant Density Particles Gordon C. K. Yeh, Said E. Elghobashi, RAND ASSOCIATES MARINA DEL REY CA., 1985 A two equation turbulence model has been developed for predicting a dispersed two phase flow with variable density fluid and constant density particles The two equations describe the conservation of turbulence kinetic energy and its dissipation rate for the fluid They have been derived rigorously from the momentum equations of the carrier fluid in the two phase flow Closure of the time mean equations is achieved by modeling the turbulent correlations up to third order The new model eliminates the need to simulate in an ad hoc manner the effects of the dispersed phase on turbulent structure in situations

where the compressibility of the fluid must be taken into account **Turbulent Shear Layers in Supersonic Flow**

Alexander J. Smits, Jean-Paul Dussauge, 2006-05-11 A good understanding of turbulent compressible flows is essential to the design and operation of high speed vehicles Such flows occur for example in the external flow over the surfaces of supersonic aircraft and in the internal flow through the engines Our ability to predict the aerodynamic lift drag propulsion and maneuverability of high speed vehicles is crucially dependent on our knowledge of turbulent shear layers and our understanding of their behavior in the presence of shock waves and regions of changing pressure *Turbulent Shear Layers in Supersonic Flow* provides a comprehensive introduction to the field and helps provide a basis for future work in this area Wherever possible we use the available experimental work and the results from numerical simulations to illustrate and develop a physical understanding of turbulent compressible flows Transport Processes in Space Physics and Astrophysics

Gary P. Zank, 2013-10-19 *Transport Processes in Space Physics and Astrophysics* is aimed at graduate level students to provide the necessary mathematical and physics background to understand the transport of gases charged particle gases energetic charged particles turbulence and radiation in an astrophysical and space physics context Subjects emphasized in the work include collisional and collisionless processes in gases neutral or plasma analogous processes in turbulence fields and radiation fields and allows for a simplified treatment of the statistical description of the system A systematic study that addresses the common tools at a graduate level allows students to progress to a point where they can begin their research in a variety of fields within space physics and astrophysics This book is for graduate students who expect to complete their research in an area of plasma space physics or plasma astrophysics By providing a broad synthesis in several areas of transport theory and modeling the work also benefits researchers in related fields by providing an overview that currently does not exist For numerous interesting and challenging space physics and astrophysics problems there is a need to describe the long term behavior of systems governed by macroscopic laws and microscopic randomness A random event has an outcome that is uncertain and unpredictable yet the collective behavior of a system can be governed by well defined mathematical and physical principles Examples of physical problems include the behavior of gases in the presence of microscopic inter particle collisions the evolution of a gas of charged protons and electrons a plasma the collective propagation of solar energetic particles or cosmic rays in a magnetically turbulent medium the collective behavior of dust in an accretion disk subject to coagulation and destruction the evolution of low frequency magnetic field turbulence in the inhomogeneous solar wind or the transport of photons in a partially ionized interstellar medium This book provides graduate students with a unified introduction to the physics of collective phenomena or transport processes for gases charged and uncharged fields and photons in a space physics or astrophysics context Particle Dynamics with Aggregation and Fragmentation Culbert B. Laney, 2025 The main goal of this book is to provide a complete overview of particle aggregation and fragmentation It uses broad physical principles such as conservation of mass momentum and energy draws on rigorous

mathematical theory and modern high performance computing and provides extensive references High Performance Computing on Vector Systems 2010 Michael M. Resch, Katharina Benkert, Xin Wang, Martin Galle, Wolfgang Bez, Hiroaki Kobayashi, Sabine Roller, 2010-09-10 This book covers the results of the 11th and 12th Tera op Workshop and continued a series initiated by NEC and the HLRS in 2004 As part of the Tera op Workbench it has become a meeting platform for scientists application developers international experts and hardware designers to discuss the current state and future directions of supercomputing with the aim of achieving the highest sustained application performance The Tera op Workbench Project is a collaboration between the High Performance Computing Center Stuttgart HLRS and NEC Deutschland GmbH NEC HPCE to support users to achieve their research goals using High Performance Computing The first stage of the Tera op Workbench project 2004 2008 concentrated on user's applications and their optimization for the 72 node NEC SX 8 installation at HLRS During this stage numerous individual codes developed and maintained by researchers or commercial organizations have been analyzed and optimized Several of the codes have shown the ability to outreach the TFlop/s threshold of sustained performance This created the possibility for new science and a deeper understanding of the underlying physics **Progress in Natural Science** ,1996 **The Dynamics of Variable-density Turbulence** Donald Leon Sandoval,1995 **Scientific and Technical Aerospace Reports** ,1987 International Aerospace Abstracts ,1998 **Proceedings of the ASME Heat Transfer Division** ,2005 **Symposium on Turbulent Shear Flows** ,1981 **Introduction to Aeronautical Dynamics** Manfred Rauscher,1953 *Rapports et procès-verbaux des réunions* International Council for the Exploration of the Sea,1930 Journal of Non-equilibrium Thermodynamics ,1990 *Physical Variability in the North Atlantic* A. J. Lee,H. Charnock,1972

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