Foundations Of Time Frequency Analysis Applied And Numerical Harmonic Analysis

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Advances in Gabor Analysis Hans G. Feichtinger 2012-12-06 The Applied and Numerical Harmonic Analysis (ANHA) book series aims to provide the engineering, mathematical, and scientific communities with significant developments in harmonic analysis, ranging from abstract har monic analysis to basic applications. The title of the series reflects the im portance of applications and numerical implementation, but richness and relevance of applications and implementation depend fundamentally on the structure and depth of theoretical underpinnings. Thus, from our point of view, the interleaving of theory and applications and their creative symbi otic evolution is axiomatic. Harmonic analysis is a wellspring of ideas and applicability that has flour ished, developed, and deepened over time within many disciplines and by means of creative cross-fertilization with diverse areas. The intricate and fundamental relationship between harmonic analysis and fields such as sig nal processing, partial differential equations (PDEs), and image processing is reflected in our state of the art ANHA series. Our vision of modern harmonic analysis includes mathematical areas such as wavelet theory, Banach algebras, classical Fourier analysis, time frequency analysis, and fractal geometry, as well as the diverse topics that impinge on them.
 A Basis Theory Primer Christopher Heil 2011 This textbook is a self-contained introduction to the abstract theory of bases and redundant frame expansions and their use in both applied and classical harmonic analysis. The four parts of the text take the reader from classical functional analysis and basis theory to modern time-frequency and wavelet theory. Extensive exercises complement the text and provide opportunities for learning-by-doing, making the text suitable for graduate-level courses. The

self-contained presentation with clear proofs is accessible to graduate students, pure and applied mathematicians, and engineers interested in the mathematical underpinnings of applications.

 Harmonic and Applied Analysis Stephan Dahlke 2015-09-12 This contributed volume explores the connection between the theoretical aspects of harmonic analysis and the construction of advanced multiscale representations that have emerged in signal and image processing. It highlights some of the most promising mathematical developments in harmonic analysis in the last decade brought about by the interplay among different areas of abstract and applied mathematics. This intertwining of ideas is considered starting from the theory of unitary group representations and leading to the construction of very efficient schemes for the analysis of multidimensional data. After an introductory chapter surveying the scientific significance of classical and more advanced multiscale methods, chapters cover such topics as An overview of Lie theory focused on common applications in signal analysis, including the wavelet representation of the affine group, the Schrödinger representation of the Heisenberg group, and the metaplectic representation of the symplectic group An introduction to coorbit theory and how it can be combined with the shearlet transform to establish shearlet coorbit spaces Microlocal properties of the shearlet transform and its ability to provide a precise geometric characterization of edges and interface boundaries in images and other multidimensional data Mathematical techniques to construct optimal data representations for a number of signal types, with a focus on the optimal approximation of functions governed by anisotropic singularities. A unified notation is used across all of the chapters to ensure consistency of the mathematical material presented. Harmonic and Applied Analysis: From Groups to Signals is aimed at graduate students and researchers in the areas of harmonic analysis and applied mathematics, as well as at other applied scientists interested in representations of multidimensional data. It can also be used as a textbook for graduate courses in applied harmonic analysis.?

 Ideal Sequence Design in Time-Frequency Space Myoung An 2008-11-09 This book develops theory and algorithms leading to systematic waveform design in time-frequency space. The key tool employed in the work is the Zak transform, which provides a two-dimensional image for sequences, the Fourier transform, convolution, and correlation, and allows for the design of sequences directly in Zak space. Application areas covered include pulse radars and sonars, multibeam radar and sonar imaging systems, remote dielectric material identification, and code division multiple-access communication systems. This is an excellent reference text for graduate students, researchers, and engineers in radar, sonar, and communication systems.

 Foundations of Time-Frequency Analysis Karlheinz Gröchenig 2013-12-01 Time-frequency analysis is a modern branch of harmonic analysis. It com prises all those parts of mathematics and its applications that use the struc ture of translations and modulations (or time-frequency shifts) for the anal ysis of functions and operators. Time-frequency analysis is a form of local Fourier analysis that treats time and frequency simultaneously and sym metrically. My goal is a systematic exposition of the foundations of time-frequency analysis, whence the title of the book. The topics range from the

elemen tary theory of the short-time Fourier transform and classical results about the Wigner distribution via the recent theory of Gabor frames to quantita tive methods in time-frequency analysis and the theory of pseudodifferential operators. This book is motivated by applications in signal analysis and quantum mechanics, but it is not about these applications. The main ori entation is toward the detailed mathematical investigation of the rich and elegant structures underlying time-frequency analysis. Time-frequency analysis originates in the early development of quantum mechanics by H. Weyl, E. Wigner, and J. von Neumann around 1930, and in the theoretical foundation of information theory and signal analysis by D.

Bioelectrical Signal Processing in Cardiac and Neurological Applications Leif Sörnmo 2005-07-21 The analysis of bioelectrical signals continues to receive wide attention in research as well as commercially because novel signal processing techniques have helped to uncover valuable information for improved diagnosis and therapy. This book takes a unique problem-driven approach to biomedical signal processing by considering a wide range of problems in cardiac and neurological applications-the two "heavyweight" areas of biomedical signal processing. The interdisciplinary nature of the topic is reflected in how the text interweaves physiological issues with related methodological considerations. Bioelectrical Signal Processing is suitable for a final year undergraduate or graduate course as well as for use as an authoritative reference for practicing engineers, physicians, and researchers. A problem-driven, interdisciplinary presentation of biomedical signal processing Focus on methods for processing of bioelectrical signals (ECG, EEG, evoked potentials, EMG) Covers both classical and recent signal processing techniques Emphasis on model-based statistical signal processing Comprehensive exercises and illustrations Extensive bibliography

Quaternion and Clifford Fourier Transforms and Wavelets Eckhard Hitzer 2013-06-24 Quaternion and Clifford Fourier and wavelet transformations generalize the classical theory to higher dimensions and are becoming increasingly important in diverse areas of mathematics, physics, computer science and engineering. This edited volume presents the state of the art in these hypercomplex transformations. The Clifford algebras unify Hamilton's quaternions with Grassmann algebra. A Clifford algebra is a complete algebra of a vector space and all its subspaces including the measurement of volumes and dihedral angles between any pair of subspaces. Quaternion and Clifford algebras permit the systematic generalization of many known concepts. This book provides comprehensive insights into current developments and applications including their performance and evaluation. Mathematically, it indicates where further investigation is required. For instance, attention is drawn to the matrix isomorphisms for hypercomplex algebras, which will help readers to see that software implementations are within our grasp. It also contributes to a growing unification of ideas and notation across the expanding field of hypercomplex transforms and wavelets. The first chapter provides a historical background and an overview of the relevant literature, and shows how the contributions that follow relate to each other and to prior work. The book will be a valuable resource for graduate students as well as for scientists and engineers.

Handbook of Mathematical Methods in Imaging Otmar Scherzer 2010-11-23 The

Handbook of Mathematical Methods in Imaging provides a comprehensive treatment of the mathematical techniques used in imaging science. The material is grouped into two central themes, namely, Inverse Problems (Algorithmic Reconstruction) and Signal and Image Processing. Each section within the themes covers applications (modeling), mathematics, numerical methods (using a case example) and open questions. Written by experts in the area, the presentation is mathematically rigorous. The entries are cross-referenced for easy navigation through connected topics. Available in both print and electronic forms, the handbook is enhanced by more than 150 illustrations and an extended bibliography. It will benefit students, scientists and researchers in applied mathematics. Engineers and computer scientists working in imaging will also find this handbook useful.

*Time Frequency Analysis Boualem Boashash 2003-10-16 Time Frequency Signal Analysis and Processing covers fundamental concepts, principles and techniques, treatment of specialised and advanced topics, methods and applications, including results of recent research. This book deals with the modern methodologies, key techniques and concepts that form the core of new technologies used in IT, multimedia, telecommunications as well as most fields of engineering, science and technology. It focuses on advanced techniques and methods that allow a refined extraction and processing of information, allowing efficient and effective decision making that would not be possible with classical techniques. The Author, fellow of IEEE for Pioneering contributions to time-frequency analysis and signal processing education, is an expert in the field, having written over 300 papers on the subject over a period pf 25 years. This is a REAL book, not a mere collection of specialised papers, making it essential reading for researchers and practitioners in the field of signal processing. *The most comprehensive text and reference book published on the subject, all the most up to date research on this subject in one place *Key computer procedures and code are provided to assist the reader with practical implementations and applications *This book brings together the main knowledge of time-frequency signal analysis and processing, (TFSAP), from theory and applications, in a user-friendly reference suitable for both experts and beginners*

Frames and Bases Ole Christensen 2008-06-05 Based on a streamlined presentation of the author's successful work, An Introduction to Frames and Riesz Bases, this book develops frame theory as part of a dialogue between mathematicians and engineers. Newly added sections on applications will help mathematically oriented readers to see where frames are used in practice and engineers to discover the mathematical background for applications in their field. The book presents basic results in an accessible way and includes extensive exercises.

The Evolution of Applied Harmonic Analysis Elena Prestini 2003-12-16 A sweeping exploration of essential concepts and applications in modern mathematics and science through the unifying framework of Fourier analysis! This unique, extensively illustrated book, accessible to specialists and non-specialists, describes the evolution of harmonic analysis, integrating theory and applications in a way that requires only some general mathematical sophistication and knowledge of calculus in certain sections. Historical sections interwoven with key scientific developments show how,

when, where, and why harmonic analysis evolved "The Evolution of Applied Harmonic Analysis" will engage graduate and advanced undergraduate students, researchers, and practitioners in the physical and life sciences, engineering, and mathematics.

Wavelet Transforms and Time-Frequency Signal Analysis Lokenath Debnath 2012-12-06 The last fifteen years have produced major advances in the mathematical theory of wavelet transforms and their applications to science and engineering. In an effort to inform researchers in mathematics, physics, statistics, computer science, and engineering and to stimulate furtherresearch, an NSF-CBMS Research Conference on Wavelet Analysis was organized at the University of Central Florida in May 1998. Many distinguished mathematicians and scientists from allover the world participated in the conference and provided a digest of recent developments, open questions, and unsolved problems in this rapidly growing and important field. As a follow-up project, this monograph was developed from manuscripts sub mitted by renowned mathematicians and scientists who have made important contributions to the subject of wavelets, wavelet transforms, and time-frequency signal analysis. This publication brings together current developments in the theory and applications of wavelet transforms and in the field of time-frequency signal analysis that are likely to determine fruitful directions for future advanced study and research.

Four Short Courses on Harmonic Analysis Brigitte Forster 2009-11-03 Written by internationally renowned mathematicians, this state-of-the-art textbook examines four research directions in harmonic analysis and features some of the latest applications in the field. The work is the first one that combines spline theory, wavelets, frames, and time-frequency methods leading up to a construction of wavelets on manifolds other than Rn. Four Short Courses on Harmonic Analysis is intended as a graduate-level textbook for courses or seminars on harmonic analysis and its applications. The work is also an excellent reference or self-study guide for researchers and practitioners with diverse mathematical backgrounds working in different fields such as pure and applied mathematics, image and signal processing engineering, mathematical physics, and communication theory.

Landscapes of Time-Frequency Analysis Paolo Boggiatto 2020-11-21 This contributed volume features chapters based on talks given at the second international conference titled Aspects of Time-Frequency Analysis (ATFA 19), held at Politecnico di Torino from June 25th to June 27th, 2019. Written by experts in harmonic analysis and its applications, these chapters provide a valuable overview of the state-of-the-art of this active area of research. New results are collected as well, making this a valuable resource for readers seeking to be brought up-to-date. Topics covered include: Signal analysis Quantum theory Modulation space theory Applications to the medical industry Wavelet transform theory Anti-Wick operators Landscapes of Time-Frequency Analysis: ATFA 2019 will be of particular interest to researchers and advanced students working in time-frequency analysis and other related areas of harmonic analysis.

Time-Frequency Signal Analysis and Processing Boualem Boashash 2015-12-11 Time-Frequency Signal Analysis and Processing (TFSAP) is a collection of theory, techniques and algorithms used for the analysis and processing of non-stationary signals, as found in a wide range of applications including

telecommunications, radar, and biomedical engineering. This book gives the university researcher and R&D engineer insights into how to use TFSAP methods to develop and implement the engineering application systems they require. New to this edition: New sections on Efficient and Fast Algorithms; a "Getting Started" chapter enabling readers to start using the algorithms on simulated and real examples with the TFSAP toolbox, compare the results with the ones presented in the book and then insert the algorithms in their own applications and adapt them as needed. Two new chapters and twenty three new sections, including updated references. New topics including: efficient algorithms for optimal TFDs (with source code), the enhanced spectrogram, time-frequency modelling, more mathematical foundations, the relationships between QTFDs and Wavelet Transforms, new advanced applications such as cognitive radio, watermarking, noise reduction in the time-frequency domain, algorithms for Time-Frequency Image Processing, and Time-Frequency applications in neuroscience (new chapter). A comprehensive tutorial introduction to Time-Frequency Signal Analysis and Processing (TFSAP), accessible to anyone who has taken a first course in signals Key advances in theory, methodology and algorithms, are concisely presented by some of the leading authorities on the respective topics Applications written by leading researchers showing how to use TFSAP methods

 Theory of Besov Spaces Yoshihiro Sawano 2018-11-04 This is a self-contained textbook of the theory of Besov spaces and Triebel-Lizorkin spaces oriented toward applications to partial differential equations and problems of harmonic analysis. These include a priori estimates of elliptic differential equations, the T1 theorem, pseudo-differential operators, the generator of semi-group and spaces on domains, and the Kato problem. Various function spaces are introduced to overcome the shortcomings of Besov spaces and Triebel-Lizorkin spaces as well. The only prior knowledge required of readers is familiarity with integration theory and some elementary functional analysis.Illustrations are included to show the complicated way in which spaces are defined. Owing to that complexity, many definitions are required. The necessary terminology is provided at the outset, and the theory of distributions, L^p spaces, the Hardy-Littlewood maximal operator, and the singular integral operators are called upon. One of the highlights is that the proof of the Sobolev embedding theorem is extremely simple. There are two types for each function space: a homogeneous one and an inhomogeneous one. The theory of function spaces, which readers usually learn in a standard course, can be readily applied to the inhomogeneous one. However, that theory is not sufficient for a homogeneous space; it needs to be reinforced with some knowledge of the theory of distributions. This topic, however subtle, is also covered within this volume. Additionally, related function spaces—Hardy spaces, bounded mean oscillation spaces, and Hölder continuous spaces—are defined and discussed, and it is shown that they are special cases of Besov spaces and Triebel-Lizorkin spaces.

 The XFT Quadrature in Discrete Fourier Analysis Rafael G. Campos 2019-05-24 This book has two main objectives, the first of which is to extend the power of numerical Fourier analysis and to show by means of theoretical examples and numerous concrete applications that when computing discrete Fourier transforms of periodic and non periodic functions, the usual kernel matrix of the Fourier transform, the discrete Fourier transform (DFT), should be

replaced by another kernel matrix, the eXtended Fourier transform (XFT), since the XFT matrix appears as a convergent quadrature of a more general transform, the fractional Fourier transform. In turn, the book's second goal is to present the XFT matrix as a finite-dimensional transformation that links certain discrete operators in the same way that the corresponding continuous operators are related by the Fourier transform, and to show that the XFT matrix accordingly generates sequences of matrix operators that represent continuum operators, and which allow these operators to be studied from another perspective.

 Functional Analysis, Harmonic Analysis, and Image Processing: A Collection of Papers in Honor of Björn Jawerth Michael Cwikel 2017-07-26 This volume is dedicated to the memory of Björn Jawerth. It contains original research contributions and surveys in several of the areas of mathematics to which Björn made important contributions. Those areas include harmonic analysis, image processing, and functional analysis, which are of course interrelated in many significant and productive ways. Among the contributors are some of the world's leading experts in these areas. With its combination of research papers and surveys, this book may become an important reference and research tool. This book should be of interest to advanced graduate students and professional researchers in the areas of functional analysis, harmonic analysis, image processing, and approximation theory. It combines articles presenting new research with insightful surveys written by foremost experts.

 Numerical Fourier Analysis Gerlind Plonka 2019-02-05 This book offers a unified presentation of Fourier theory and corresponding algorithms emerging from new developments in function approximation using Fourier methods. It starts with a detailed discussion of classical Fourier theory to enable readers to grasp the construction and analysis of advanced fast Fourier algorithms introduced in the second part, such as nonequispaced and sparse FFTs in higher dimensions. Lastly, it contains a selection of numerical applications, including recent research results on nonlinear function approximation by exponential sums. The code of most of the presented algorithms is available in the authors' public domain software packages. Students and researchers alike benefit from this unified presentation of Fourier theory and corresponding algorithms.

 Harmonic and Applied Analysis Filippo De Mari 2021-12-13 Deep connections exist between harmonic and applied analysis and the diverse yet connected topics of machine learning, data analysis, and imaging science. This volume explores these rapidly growing areas and features contributions presented at the second and third editions of the Summer Schools on Applied Harmonic Analysis, held at the University of Genova in 2017 and 2019. Each chapter offers an introduction to essential material and then demonstrates connections to more advanced research, with the aim of providing an accessible entrance for students and researchers. Topics covered include ill-posed problems; concentration inequalities; regularization and large-scale machine learning; unitarization of the radon transform on symmetric spaces; and proximal gradient methods for machine learning and imaging.

 Finite Frames Peter G. Casazza 2012-09-13 Hilbert space frames have long served as a valuable tool for signal and image processing due to their resilience to additive noise, quantization, and erasures, as well as their ability to capture valuable signal characteristics. More recently, finite

*frame theory has grown into an important research topic in its own right, with a myriad of applications to pure and applied mathematics, engineering, computer science, and other areas. The number of research publications, conferences, and workshops on this topic has increased dramatically over the past few years, but no survey paper or monograph has yet appeared on the subject. Edited by two of the leading experts in the field, Finite Frames aims to fill this void in the literature by providing a comprehensive, systematic study of finite frame theory and applications. With carefully selected contributions written by highly experienced researchers, it covers topics including: * Finite Frame Constructions; * Optimal Erasure Resilient Frames; * Quantization of Finite Frames; * Finite Frames and Compressed Sensing; * Group and Gabor Frames; * Fusion Frames. Despite the variety of its chapters' source and content, the book's notation and terminology are unified throughout and provide a definitive picture of the current state of frame theory. With a broad range of applications and a clear, full presentation, this book is a highly valuable resource for graduate students and researchers across disciplines such as applied harmonic analysis, electrical engineering, quantum computing, medicine, and more. It is designed to be used as a supplemental textbook, self-study guide, or reference book.*

Analysis and Probability Palle E. T. Jorgensen 2007-10-17 Combines analysis and tools from probability, harmonic analysis, operator theory, and engineering (signal/image processing) Interdisciplinary focus with hands-on approach, generous motivation and new pedagogical techniques Numerous exercises reinforce fundamental concepts and hone computational skills Separate sections explain engineering terms to mathematicians and operator theory to engineers Fills a gap in the literature

New Trends in Applied Harmonic Analysis, Volume 2 Akram Aldroubi 2019-11-26 This contributed volume collects papers based on courses and talks given at the 2017 CIMPA school Harmonic Analysis, Geometric Measure Theory and Applications, which took place at the University of Buenos Aires in August 2017. These articles highlight recent breakthroughs in both harmonic analysis and geometric measure theory, particularly focusing on their impact on image and signal processing. The wide range of expertise present in these articles will help readers contextualize how these breakthroughs have been instrumental in resolving deep theoretical problems. Some topics covered include: Gabor frames Falconer distance problem Hausdorff dimension Sparse inequalities Fractional Brownian motion Fourier analysis in geometric measure theory This volume is ideal for applied and pure mathematicians interested in the areas of image and signal processing. Electrical engineers and statisticians studying these fields will also find this to be a valuable resource.

New Trends in Applied Harmonic Analysis Akram Aldroubi 2016-04-21 This volume is a selection of written notes corresponding to courses taught at the CIMPA School: "New Trends in Applied Harmonic Analysis: Sparse Representations, Compressed Sensing and Multifractal Analysis". New interactions between harmonic analysis and signal and image processing have seen striking development in the last 10 years, and several technological deadlocks have been solved through the resolution of deep theoretical problems in harmonic analysis. New Trends in Applied Harmonic Analysis

focuses on two particularly active areas that are representative of such advances: multifractal analysis, and sparse representation and compressed sensing. The contributions are written by leaders in these areas, and cover both theoretical aspects and applications. This work should prove useful not only to PhD students and postdocs in mathematics and signal and image processing, but also to researchers working in related topics.

 Applications in Time-Frequency Signal Processing Antonia Papandreou-Suppappola 2018-10-03 Because most real-world signals, including speech, sonar, communication, and biological signals, are non-stationary, traditional signal analysis tools such as Fourier transforms are of limited use because they do not provide easily accessible information about the localization of a given frequency component. A more suitable approach for those studying non-stationary signals is the use of time frequency representations that are functions of both time and frequency. Applications in Time-Frequency Signal Processing investigates the use of various time-frequency representations, such as the Wigner distribution and the spectrogram, in diverse application areas. Other books tend to focus on theoretical development. This book differs by highlighting particular applications of time-frequency representations and demonstrating how to use them. It also provides pseudo-code of the computational algorithms for these representations so that you can apply them to your own specific problems. Written by leaders in the field, this book offers the opportunity to learn from experts. Time-Frequency Representation (TFR) algorithms are simplified, enabling you to understand the complex theories behind TFRs and easily implement them. The numerous examples and figures, review of concepts, and extensive references allow for easy learning and application of the various time-frequency representations.

 Modulation Spaces Árpád Bényi 2020-02-22 This monograph serves as a much-needed, self-contained reference on the topic of modulation spaces. By gathering together state-of-the-art developments and previously unexplored applications, readers will be motivated to make effective use of this topic in future research. Because modulation spaces have historically only received a cursory treatment, this book will fill a gap in time-frequency analysis literature, and offer readers a convenient and timely resource. Foundational concepts and definitions in functional, harmonic, and real analysis are reviewed in the first chapter, which is then followed by introducing modulation spaces. The focus then expands to the many valuable applications of modulation spaces, such as linear and multilinear pseudodifferential operators, and dispersive partial differential equations. Because it is almost entirely self-contained, these insights will be accessible to a wide audience of interested readers. Modulation Spaces will be an ideal reference for researchers in time-frequency analysis and nonlinear partial differential equations. It will also appeal to graduate students and seasoned researchers who seek an introduction to the time-frequency analysis of nonlinear dispersive partial differential equations.

 Foundations of Discrete Harmonic Analysis Vasily N. Malozemov 2020-06-24 This book provides an introduction to discrete harmonic analysis (DHA) with a view towards applications to digital signal processing. In a nutshell, DHA is used to determine the time-frequency structure of a digitized signal, providing a representation of the signal as a sum of spectral components

that can then be analyzed. The main methods of DHA are discrete Fourier transform and other discrete orthogonal transforms such as the Walsh and Haar transforms. Fast algorithms are used to process signals in real time, while additional options are provided by spline harmonic analysis. These topics are carefully covered in the book. With only modest prerequisites, some of which are recalled at the beginning, a profound mathematical theory is built almost from scratch. The 150 exercises included form an integral part of the text. Based decades of teaching experience, this book provides a basis for lecture courses starting at the upper undergraduate level, and will also prove a valuable resource for mathematicians and engineers interested in digital signal processing.

Excursions in Harmonic Analysis, Volume 2 Travis D Andrews 2013-01-04 The Norbert Wiener Center for Harmonic Analysis and Applications provides a state-of-the-art research venue for the broad emerging area of mathematical engineering in the context of harmonic analysis. This two-volume set consists of contributions from speakers at the February Fourier Talks (FFT) from 2006-2011. The FFT are organized by the Norbert Wiener Center in the Department of Mathematics at the University of Maryland, College Park. These volumes span a large spectrum of harmonic analysis and its applications. They are divided into the following parts: Volume I · Sampling Theory · Remote Sensing · Mathematics of Data Processing · Applications of Data Processing Volume II · Measure Theory · Filtering · Operator Theory · Biomathematics Each part provides state-of-the-art results, with contributions from an impressive array of mathematicians, engineers, and scientists in academia, industry, and government. Excursions in Harmonic Analysis: The February Fourier Talks at the Norbert Wiener Center is an excellent reference for graduate students, researchers, and professionals in pure and applied mathematics, engineering, and physics.

Operator-Related Function Theory and Time-Frequency Analysis Karlheinz Gröchenig 2014-11-25 This book collects the proceedings of the 2012 Abel Symposium, held at the Norwegian Academy of Science and Letters, Oslo. The Symposium, and this book, are focused on two important fields of modern mathematical analysis: operator-related function theory and time-frequency analysis; and the profound interplay between them. Among the original contributions and overview lectures gathered here are a paper presenting multifractal analysis as a bridge between geometric measure theory and signal processing; local and global geometry of Prony systems and Fourier reconstruction of piecewise-smooth functions; Bernstein's problem on weighted polynomial approximation; singular distributions and symmetry of the spectrum; and many others. Offering a selection of the latest and most exciting results obtained by world-leading researchers, the book will benefit scientists working in Harmonic and Complex Analysis, Mathematical Physics and Signal Processing.

An Introduction to Frames and Riesz Bases Ole Christensen 2016-05-24 This revised and expanded monograph presents the general theory for frames and Riesz bases in Hilbert spaces as well as its concrete realizations within Gabor analysis, wavelet analysis, and generalized shift-invariant systems. Compared with the first edition, more emphasis is put on explicit constructions with attractive properties. Based on the exiting development of frame theory over the last decade, this second edition now includes new

sections on the rapidly growing fields of LCA groups, generalized shift-invariant systems, duality theory for as well Gabor frames as wavelet frames, and open problems in the field. Key features include: *Elementary introduction to frame theory in finite-dimensional spaces * Basic results presented in an accessible way for both pure and applied mathematicians * Extensive exercises make the work suitable as a textbook for use in graduate courses * Full proofs includ ed in introductory chapters; only basic knowledge of functional analysis required * Explicit constructions of frames and dual pairs of frames, with applications and connections to time-frequency analysis, wavelets, and generalized shift-invariant systems * Discussion of frames on LCA groups and the concrete realizations in terms of Gabor systems on the elementary groups; connections to sampling theory * Selected research topics presented with recommendations for more advanced topics and further readin g * Open problems to stimulate further research An Introduction to Frames and Riesz Bases will be of interest to graduate students and researchers working in pure and applied mathematics, mathematical physics, and engineering. Professionals working in digital signal processing who wish to understand the theory behind many modern signal processing tools may also find this book a useful self-study reference. Review of the first edition: "Ole Christensen's An Introduction to Frames and Riesz Bases is a first-rate introduction to the field ... . The book provides an excellent exposition of these topics. The material is broad enough to pique the interest of many readers, the included exercises supply some interesting challenges, and the coverage provides enough background for those new to the subject to begin conducting original research." — Eric S. Weber, American Mathematical Monthly, Vol. 112, February, 2005

 Advances in Microlocal and Time-Frequency Analysis Paolo Boggiatto 2020-03-03 The present volume gathers contributions to the conference Microlocal and Time-Frequency Analysis 2018 (MLTFA18), which was held at Torino University from the 2nd to the 6th of July 2018. The event was organized in honor of Professor Luigi Rodino on the occasion of his 70th birthday. The conference's focus and the contents of the papers reflect Luigi's various research interests in the course of his long and extremely prolific career at Torino University.

 Noncommutative Analysis, Operator Theory and Applications Daniel Alpay 2016-06-30 This book illustrates several aspects of the current research activity in operator theory, operator algebras and applications in various areas of mathematics and mathematical physics. It is addressed to specialists but also to graduate students in several fields including global analysis, Schur analysis, complex analysis, C*-algebras, noncommutative geometry, operator algebras, operator theory and their applications. Contributors: F. Arici, S. Bernstein, V. Bolotnikov, J. Bourgain, P. Cerejeiras, F. Cipriani, F. Colombo, F. D'Andrea, G. Dell'Antonio, M. Elin, U. Franz, D. Guido, T. Isola, A. Kula, L.E. Labuschagne, G. Landi, W.A. Majewski, I. Sabadini, J.-L. Sauvageot, D. Shoikhet, A. Skalski, H. de Snoo, D. C. Struppa, N. Vieira, D.V. Voiculescu, and H. Woracek.

 Sampling Theory, a Renaissance Götz E. Pfander 2015-12-08 Reconstructing or approximating objects from seemingly incomplete information is a frequent challenge in mathematics, science, and engineering. A multitude of tools

designed to recover hidden information are based on Shannon's classical sampling theorem, a central pillar of Sampling Theory. The growing need to efficiently obtain precise and tailored digital representations of complex objects and phenomena requires the maturation of available tools in Sampling Theory as well as the development of complementary, novel mathematical theories. Today, research themes such as Compressed Sensing and Frame Theory re-energize the broad area of Sampling Theory. This volume illustrates the renaissance that the area of Sampling Theory is currently experiencing. It touches upon trendsetting areas such as Compressed Sensing, Finite Frames, Parametric Partial Differential Equations, Quantization, Finite Rate of Innovation, System Theory, as well as sampling in Geometry and Algebraic Topology.

 Excursions in Harmonic Analysis, Volume 4 Radu Balan 2015-10-20 This volume consists of contributions spanning a wide spectrum of harmonic analysis and its applications written by speakers at the February Fourier Talks from 2002 – 2013. Containing cutting-edge results by an impressive array of mathematicians, engineers and scientists in academia, industry and government, it will be an excellent reference for graduate students, researchers and professionals in pure and applied mathematics, physics and engineering. Topics covered include: Special Topics in Harmonic Analysis Applications and Algorithms in the Physical Sciences Gabor Theory RADAR and Communications: Design, Theory, and Applications The February Fourier Talks are held annually at the Norbert Wiener Center for Harmonic Analysis and Applications. Located at the University of Maryland, College Park, the Norbert Wiener Center provides a state-of- the-art research venue for the broad emerging area of mathematical engineering.

 The abc-Problem for Gabor Systems Xin-Rong Dai 2016-10-05 A longstanding problem in Gabor theory is to identify time-frequency shifting lattices aZ×bZ and ideal window functions ?I on intervals I of length c such that {e?2?inbt?I(t?ma): (m,n)?Z×Z} are Gabor frames for the space of all square-integrable functions on the real line. In this paper, the authors create a time-domain approach for Gabor frames, introduce novel techniques involving invariant sets of non-contractive and non-measure-preserving transformations on the line, and provide a complete answer to the above abc-problem for Gabor systems.

 Time?Frequency and Time?Scale Methods Jeffrey A. Hogan 2007-12-21 Developed in this book are several deep connections between time-frequency (Fourier/Gabor) analysis and time-scale (wavelet) analysis, emphasizing the powerful adaptive methods that emerge when separate techniques from each area are properly assembled in a larger context. While researchers at the forefront of these areas are well aware of the benefits of such a unified approach, there remains a knowledge gap in the larger community of practitioners about the precise strengths and limitations of Fourier/Gabor analysis versus wavelets. This book fills that gap by presenting the interface of time-frequency and time-scale methods as a rich area of work. "Foundations of Time-Frequency and Time-Scale Methods" will be suitable for applied mathematicians and engineers in signal/image processing and communication theory, as well as researchers and students in mathematical analysis, signal analysis, and mathematical physics.

 Excursions in Harmonic Analysis, Volume 3 Radu Balan 2015-06-02 This volume

consists of contributions spanning a wide spectrum of harmonic analysis and its applications written by speakers at the February Fourier Talks from 2002 – 2013. Containing cutting-edge results by an impressive array of mathematicians, engineers, and scientists in academia, industry, and government, it will be an excellent reference for graduate students, researchers, and professionals in pure and applied mathematics, physics, and engineering. Topics covered include · spectral analysis and correlation; · radar and communications: design, theory, and applications; · sparsity · special topics in harmonic analysis. The February Fourier Talks are held annually at the Norbert Wiener Center for Harmonic Analysis and Applications. Located at the University of Maryland, College Park, the Norbert Wiener Center provides a state-of- the-art research venue for the broad emerging area of mathematical engineering.

Sound, Music, and Motion Mitsuko Aramaki 2014-12-04 This book constitutes the thoroughly refereed post-conference proceedings of the 10th International Symposium on Computer Music Modeling and Retrieval, CMMR 2013, held in Marseille, France, in October 2013. The 38 conference papers presented were carefully reviewed and selected from 94 submissions. The chapters reflect the interdisciplinary nature of this conference with following topics: augmented musical instruments and gesture recognition, music and emotions: representation, recognition, and audience/performers studies, the art of sonification, when auditory cues shape human sensorimotor performance, music and sound data mining, interactive sound synthesis, non-stationarity, dynamics and mathematical modeling, image-sound interaction, auditory perception and cognitive inspiration, and modeling of sound and music computational musicology.

Time-Frequency Analysis of Operators Elena Cordero 2020-09-21 This authoritative text studies pseudodifferential and Fourier integral operators in the framework of time-frequency analysis, providing an elementary approach, along with applications to almost diagonalization of such operators and to the sparsity of their Gabor representations. Moreover, Gabor frames and modulation spaces are employed to study dispersive equations such as the Schrödinger, wave, and heat equations and related Strichartz problems. The first part of the book is addressed to non-experts, presenting the basics of time-frequency analysis: short time Fourier transform, Wigner distribution and other representations, function spaces and frames theory, and it can be read independently as a short text-book on this topic from graduate and under-graduate students, or scholars in other disciplines.

Frames and Other Bases in Abstract and Function Spaces Isaac Pesenson 2017-06-11 The first of a two volume set on novel methods in harmonic analysis, this book draws on a number of original research and survey papers from well-known specialists detailing the latest innovations and recently discovered links between various fields. Along with many deep theoretical results, these volumes contain numerous applications to problems in signal processing, medical imaging, geodesy, statistics, and data science. The chapters within cover an impressive range of ideas from both traditional and modern harmonic analysis, such as: the Fourier transform, Shannon sampling, frames, wavelets, functions on Euclidean spaces, analysis on function spaces of Riemannian and sub-Riemannian manifolds, Fourier analysis on manifolds

and Lie groups, analysis on combinatorial graphs, sheaves, co-sheaves, and persistent homologies on topological spaces. Volume I is organized around the theme of frames and other bases in abstract and function spaces, covering topics such as: The advanced development of frames, including Sigma-Delta quantization for fusion frames, localization of frames, and frame conditioning, as well as applications to distributed sensor networks, Galerkin-like representation of operators, scaling on graphs, and dynamical sampling. A systematic approach to shearlets with applications to wavefront sets and function spaces. Prolate and generalized prolate functions, spherical Gauss-Laguerre basis functions, and radial basis functions. Kernel methods, wavelets, and frames on compact and non-compact manifolds.