

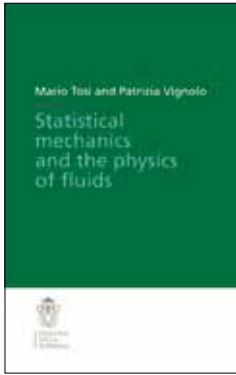


New Publications

Graphics: RovaiWeber design, Firenze
Catalogue production: Bruna Parra
Edited by: Luisa Ferrini
Printed by: Industrie Grafiche Pacini, Pisa

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Appunti



Mario Tosi and Patrizia Vignolo
**Statistical mechanics
and the physics of fluids**

Pisa, Edizioni della Normale 2005
ISBN 88-7642-144-0, pp. XII-194, € 18.00

This volume collects the lecture notes of a course on statistical mechanics, held at Scuola Normale Superiore of Pisa for third-to-fifth year students in physics and chemistry.

Three main themes are covered in the book.

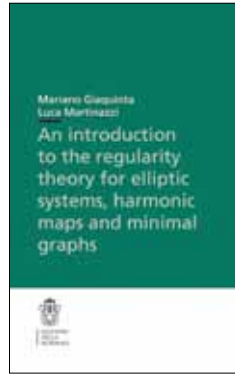
The first part gives a compact presentation of the foundations of statistical mechanics and their connections with thermodynamics.

Applications to ideal gases of material particles and of excitation quanta are followed by a brief introduction to a real classical gas and to a weakly coupled classical plasma, and by a broad overview on the three states of matter.

The second part is devoted to fluctuations around equilibrium and their correlations.

Coverage of liquid structure and critical phenomena is followed by a discussion of irreversible processes as exemplified by diffusive motions and by the dynamics of density and heat fluctuations.

Finally, the third part is an introduction to some advanced themes: supercooling and the glassy state, non-Newtonian fluids including polymers and liquid crystals, and dynamic instabilities and turbulence. These topics, which are largely taken over from the book by N.H. March and M. Tosi on *Introduction to Liquid State Physics*, are meant to stimulate the reader to further study of the literature in these technically important areas.



Mariano Giaquinta and Luca Martinazzi
**An introduction to the regularity theory
for elliptic systems, harmonic maps
and minimal graphs**

Pisa, Edizioni della Normale 2005
ISBN 88-7642-168-8, pp. IX-302, € 24.00

This volume deals with the regularity theory for elliptic systems. We may find the origin of such a theory in two of the problems posed by David Hilbert in his celebrated lecture delivered on the occasion of the International Congress of Mathematicians in 1900 in Paris:

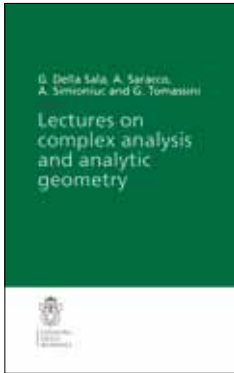
- 19th problem: are the solutions to regular problems in the Calculus of Variations always necessarily analytic?

- 20th problem: does any variational problem have a solution, provided that certain assumptions regarding the given boundary conditions are satisfied, and provided that the notion of a solution is suitably extended?

During the last century these two problems have generated a great deal of work, usually referred to “as is” in regularity theory, which makes this topic quite relevant in many fields and still very active for research. However, the purpose of this volume, addressed mainly to students, is much more limited. We aim to illustrate only some of the basic ideas and techniques introduced in this context, confining ourselves to important but simple situations and refraining from completeness. In fact some relevant topics are omitted.

Topics include: harmonic functions, direct methods, Hilbert space methods and Sobolev spaces, energy estimates, Schauder and L_p -theory both with and without potential theory, including the Calderon-Zygmund theorem, Harnack’s and De Giorgi-Moser-Nash theorems in the scalar case and partial regularity theorems in the vector valued case; finally, harmonic maps and minimal graphs in codimension 1 and greater than 1.

Appunti



**Giuseppe Della Sala, Alberto Saracco
Alexandru Simioniu
and Giuseppe Tomassini**
**Lectures on complex analysis
and analytic geometry**
Pisa, Edizioni della Normale 2006
ISBN 88-7642-199-8, pp. XIX-430, € 25.00

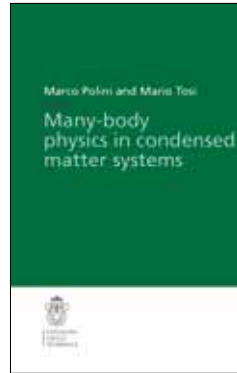
This book is an introduction to the theory of holomorphic functions of several complex variables. It is based on the courses attended by the students of mathematics at Scuola Normale Superiore of Pisa. Its treated subjects range from an advanced undergraduate course to a Ph.D. level.

The book is largely divided into three parts. The first one, perhaps the most curricular, deals with the domains of holomorphy and their characterizations, through different notions of convexity (holomorphic convexity, Levi-convexity and pseudoconvexity) and the Cauchy-Riemann equation.

The extension of this matter to complex spaces, known as the Oka-Cartan theory, is the content of the second part. This theory systematically makes use of local analytic geometry and of the theory of sheaves and cohomology.

The last part deals with the interplay between the theory of topological algebras and the theory of holomorphic functions. Some of the advanced results in the field are overviewed, sometimes without detailed proofs, and (still) open problems are discussed.

All the topics of these lectures are basic and we have no presumption of giving a complete outline either of the main developments or of the interface with other fields of mathematical research. However, we believe that they provide good material to approach the broad subject of several complex variables, and that they could be a good source of interesting problems and themes in the subject.



Marco Polini and Mario Tosi
**Many-body physics in condensed
matter systems**
Pisa, Edizioni della Normale 2006
ISBN 88-7642-192-0, pp. IX-320, € 24.00

This volume collects the lecture notes of an introductory course on the theory of many-body systems, held at the Scuola Normale Superiore of Pisa. It is mainly addressed to fourth and fifth-year undergraduates and to first-year graduates in physics and chemistry. The book is also suitable for researchers in the field wanting to gain a general introductory overview of its modern focal points. Starting from a set of notes first prepared in 1994, which were mainly focused on conduction electrons in metals and semiconductors, these lecture notes are now being reprinted with some major changes and additions in order to provide the reader with an overview of recent developments in the understanding of low-dimensional electron fluids and of confined quantum gases made from bosonic and fermionic atoms and molecules. The book is divided into seven chapters and includes 18 appendices on specialized topics. The introductory chapter illustrates some of the long-standing problems in many-body physics. Chapters 2, 3 and 4 are mainly devoted to topics concerning electron fluids. A formal presentation of the theory of Green's functions and linear response functions for fermions in chapter 2 is followed by a chapter on electron liquids in the normal state and by a further chapter on the magnetism of conduction electrons and strongly correlated electron fluids. Chapter 5 turns to the formal theory of Green's functions and linear response functions for bosons. And finally, Chapters 6 and 7 are on trapped boson gases and on confined fermion gases and gaseous boson-fermion mixtures.

Appunti



Paolo Azzurri
Problemi di meccanica
Pisa, Edizioni della Normale 2008 (second edition)
ISBN 978-88-7642-317-8, pp. VIII-156, € 18.00

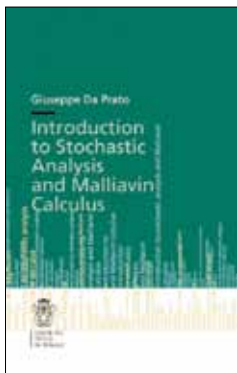


Riccardo Barbieri
Lectures on the ElectroWeak Interactions
Pisa, Edizioni della Normale 2007
ISBN 978-88-7642-311-6, pp. 81, € 18.00

Il presente volume contiene una selezione di esercizi proposti agli studenti del primo anno della Classe di Scienze della Scuola Normale per il corso di meccanica del prof. Lorenzo Foà, negli anni 2003 - 2007. Il libro di riferimento per il corso è *Classical Mechanics* di D. Rutherford (1957). I problemi trattati riguardano la cinematica e la dinamica del punto materiale, la cinematica e la dinamica dei sistemi, moti in campi centrali, la dinamica del corpo rigido, le oscillazioni e la meccanica analitica con formalismo lagrangiano. In questa seconda edizione, a pochi mesi di distanza dalla prima, sono stati aggiunti sette problemi risolti e, in particolare, sono stati rivisti e modificati i testi delle soluzioni dei problemi 1 e 5.

Elementary particle physics is the quadrant of nature whose laws can be written in a few lines with absolute precision and the greatest empirical adequacy. If this is the case, as I believe it is, it must be possible and is probably useful to introduce the students and the interested readers to the entire subject in a compact way. This is the main aim of these Lectures.

Appunti



Giuseppe Da Prato
Introduction to Stochastic Analysis and Malliavin Calculus
Pisa, Edizioni della Normale 2008 (second edition)
ISBN 978-88-7642-337-6, pp. XVI-211, € 25,00

This volume presents an introductory course on differential stochastic equations and Malliavin calculus.

The material of the book has grown from a series of courses delivered at the Scuola Normale Superiore of Pisa (and also at the Universities of Trento and Funchal) and has been refined over several years of teaching experience in the subject.

The lectures are addressed to a reader who is familiar with basic notions of measure theory and functional analysis.

The first part is devoted to the Gaussian measure in a separable Hilbert space, the Malliavin derivative, the construction of the Brownian motion and Itô's formula.

The second part deals with differential stochastic equations and their connection with parabolic problems.

The third part contains an introduction to Malliavin calculus.

Several applications are given, notably the Feynman-Kac, Girsanov and Clark-Ocone formulae, the Krylov-Bogoliubov and Von Neumann theorems.



Andrea C.G. Menzacci, Sanjoy K. Mitter
Probabilità e informazione
Pisa, Edizioni della Normale 2008 (second edition)
ISBN 978-88-7642-324-6, pp. XVI-440, € 20,00

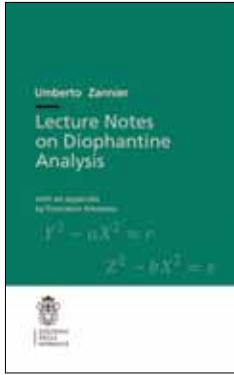
Questo volume raccoglie i risultati di dieci anni di esperienza didattica in corsi di probabilità, tenuti sia alla Scuola Normale Superiore che all'Università di Pisa.

Questi corsi, rivolti a studenti di Matematica, Fisica e Informatica (e anche occasionalmente di Chimica e Biologia) hanno presentato la probabilità in maniera elementare, con particolare attenzione alla probabilità discreta, ma sempre rivolgendo lo sguardo anche alla teoria più generale.

Il testo presenta tutti i risultati oramai classici, quali le leggi dei grandi numeri (per processi scorrelati e per catene di Markov) e del limite centrale (con dimostrazione per il caso bernoulliano) e propone anche sviluppi più avanzati, quali la speranza e varianza condizionale, il processo di Poisson, la teoria di grandi deviazioni e la teoria ergodica (in forma semplificata).

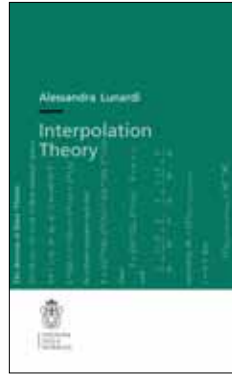
Come Breiman ebbe a commentare, «La teoria della probabilità ha una mano sinistra e una destra - la destra è la rigorosa fondazione basata sulla teoria della misura - e la sinistra è la "intuizione probabilistica" basata su situazioni reali», la sinergia fra i due aspetti si rispecchia nei numerosi esercizi (la maggior parte con soluzione), negli esempi e nelle applicazioni che arricchiscono questo testo. In questa stessa esigenza si colloca, in particolare, il capitolo dove si presenta la teoria dell'informazione e dei codici.

Appunti



Umberto Zannier
Lecture Notes on Diophantine Analysis
Pisa, Edizioni della Normale 2009
ISBN 978-88-7642-341-3, pp. XVI-233, € 25,00

These lecture notes originate from a course delivered at the Scuola Normale in Pisa in 2006. The book mainly deals with Diophantine problems on affine curves, in practice describing the integer solutions of equations in two variables. This case historically suggested some major ideas for more general problems. Starting with linear and quadratic equations, the important connections with Diophantine Approximation are presented and Thue's celebrated results are proved in full detail. In later chapters more modern issues on heights of algebraic points are dealt with, and applied to a sharp quantitative treatment of the unit equation. The volume also contains several Supplements, hinted exercises and an Appendix on recent work on heights.



Alessandra Lunardi
Interpolation Theory
Pisa, Edizioni della Normale 2009 (second edition)
ISBN 978-88-7642-342-0, pp. XI-191, € 25,00

This book is the second edition of 1999 lecture notes of the courses on interpolation theory that the author delivered at the Scuola Normale in 1998 and 1999. In the mathematical literature there are many good books on the subject, but none of them is very elementary, and in many cases the basic principles are hidden below great generality. In this second edition, the principles of interpolation theory are illustrated aiming at simplification rather than at generality. The abstract theory is reduced as far as possible, and many examples and applications are given, especially to operator theory and to regularity in partial differential equations. Moreover the treatment is self-contained, the only prerequisite being the knowledge of basic functional analysis.

Appunti



Gianni Fochi
Chimica da capire
Compendio di chimica generale con brevi cenni di chimica inorganica descrittiva
Pisa, Edizioni della Normale 2009
ISBN 978-88-7642-346-8, pp. XVIII-251, € 25,00

Questo libro vuole fornire agli studenti del primo anno di un corso universitario gli elementi essenziali per una introduzione alla chimica generale. Esso si segnala all'attenzione del lettore per la sua impostazione: l'esperienza didattica ha infatti convinto l'autore che l'introduzione dei concetti fondamentali debba precedere il confronto con la vastità del sapere chimico, cioè con la congerie di fatti sperimentali inquadrabili in un gran numero di settori diversificati. A questo scopo la termodinamica, che nei manuali generalmente in uso trova di solito spazio solo verso la fine e come argomento accessorio, diventa la chiave di volta per la comprensione dell'equilibrio chimico, che è il fondamento della chimica stessa.

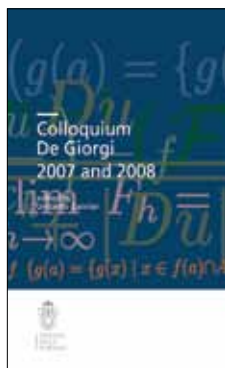
Altra caratteristica dell'opera è la mole contenuta con la dichiarata selezione degli argomenti essenziali ad una preparazione di base, suscettibili, se necessario, di successivi approfondimenti; alcuni capitoli, per il loro valore propedeutico, possono costituire inoltre un ottimo punto di riferimento anche per studenti dell'ultimo anno delle scuole medie superiori.

Colloquia



Colloquium De Giorgi 2006
edited by Umberto Zannier

Pisa, Edizioni della Normale 2007
ISBN 978-88-7642-212-6, pp. x-57, € 16.00



Colloquium De Giorgi 2007 and 2008
edited by Umberto Zannier

Pisa, Edizioni della Normale 2009
ISBN 978-88-7642-344-4, pp. XII-98, € 20.00

Since 2001 the Scuola Normale Superiore of Pisa has organized the “Colloquio De Giorgi”, a series of colloquium talks named after Ennio De Giorgi. The Colloquio is addressed to a general mathematical audience, and especially meant to attract graduate students and advanced undergraduate students. The lectures are intended to be not too technical, in fields of wide interest. They must provide an overview of the general topic, possibly in a historical perspective, together with a description of more recent progress. The idea of collecting the materials from these lectures and publishing them in annual volumes came out recently, as a recognition of their intrinsic mathematical interest, and also with the aim of preserving memory of these events.

CRM Series



Matematica, cultura e società 2004

Pisa, Edizioni della Normale 2005
ISBN 88-7642-158-0, pp. 155, € 12.00

Matematica, cultura e società 2006

Pisa, Edizioni della Normale 2009
ISBN 978-88-7642-315-4, pp. VIII-90, € 14.00

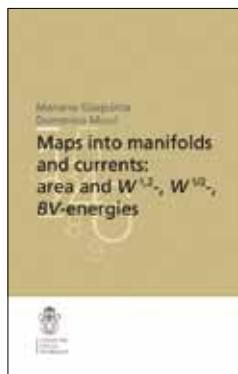
Matematica, cultura e società 2005

Pisa, Edizioni della Normale 2006
ISBN 88-7642-188-2, pp. 123, € 14.00

«Matematica, Cultura e Società» è il titolo di una rassegna di conferenze pubbliche che dal 2003 il Centro De Giorgi dedica alla divulgazione della matematica e, più in generale, del sapere scientifico. L'idea che sta alla base della rassegna è quella di creare un canale di comunicazione tra società e mondo della ricerca scientifica.

Muovendo da diverse prospettive, queste lezioni - che si differenziano, oltre che per argomenti (dalla storia, alla filosofia, al cinema), per forme e modalità di trattazione - si propongono di illustrare alcuni aspetti del ruolo culturale della matematica nella società del passato e del presente; di comunicare quanto la matematica sia diffusamente presente nella cultura, nella scienza e nella tecnologia, oggi ancor più di quanto non sia stato nel passato; di contribuire, infine, a fare in modo che diminuisca il numero di coloro che considerano un valore la divisione fra le due culture.

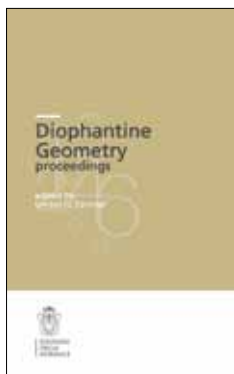
CRM Series



Mariano Giaquinta and Domenico Mucci
Maps into manifolds and currents: area and $W^{1,2}$, $W^{1/2}$, BV-energies

Pisa, Edizioni della Normale 2006

ISBN 88-7642-200-5, pp. XXII-391, € 24.00



Diophantine Geometry. Proceedings
edited by Umberto Zannier

Pisa, Edizioni della Normale 2007

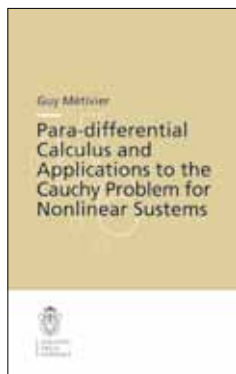
ISBN 978-88-7642-206-5, pp. XVII-390, € 26.00

This volume deals with the problem of characterizing the limit points of sequences of smooth maps from the unit ball of \mathbb{R}^n with values into a smooth boundaryless Riemannian manifold and with equibounded 'integral energies'. After surveying some known results about Cartesian currents and graphs with finite area and finite boundary area, we do characterize, as in the title, weak limits of sequences of smooth maps with equibounded $W^{1,2}$, $W^{1/2}$, or BV-energies.

The book contains research papers on Diophantine Geometry, written by participants to a related workshop held at the Centro De Giorgi of the Scuola Normale of Pisa during the period April-July 2005.

The authors are eminent experts in the field; actually, several interacting subfields of the main topic are represented here, which is particularly useful to get a broad overview of recent research developments.

CRM Series



Guy Métivier
Para-differential Calculus and Applications to the Cauchy Problem for Nonlinear Systems
Pisa, Edizioni della Normale 2008
ISBN 978-88-7642-329-1, pp. XI-138, € 24.00

The main aim is to present at the level of beginners several modern tools of micro-local analysis which are useful for the mathematical study of nonlinear partial differential equations. The core of these notes is devoted to a presentation of the para-differential techniques, which combine a linearization procedure for nonlinear equations, and a symbolic calculus which mimics or extends the classical calculus of Fourier multipliers. These methods apply to many problems in nonlinear PDE's such as elliptic equations, propagation of singularities, boundary value problems, shocks or boundary layers. However, in these introductory notes, we have chosen to illustrate the theory on two selected and relatively simple examples, which allow becoming familiar with the techniques. They concern the well-posedness of the Cauchy problem for systems of nonlinear PDE's, firstly hyperbolic systems and secondly coupled systems of Schrödinger equations which arise in various models of wave propagation.



Francesco Guerra and Nadia Robotti
Ettore Majorana
Aspects of his Scientific and Academic Activity
Pisa, Edizioni della Normale 2008
ISBN 978-88-7642-331-4, pp. XII-243, € 24.00

Little more than one hundred years have gone by since the birth of Ettore Majorana, a highly renowned theoretical physicist. His career was brief and irregular but very intense, and he disappeared in March 1938 in circumstances that still are not completely clear. This volume is a contribution to a better understanding of the scientific, academic and human personality of Ettore Majorana, beyond the layers of legendary aspects which have accumulated over the years. Based on primary sources alone—scientific literature of the period and numerous archival documents—the figure of Ettore Majorana emerges in a completely new light. The young scientist is intensely involved in scientific research, completely independent, always striving to offer innovative contributions of the highest level according to the most advanced international standards, and very determined to make his results known by following a shrewd publication strategy. He is profoundly interested in his academic career, very scrupulous with institutional relationships, and attentive to his students. Moreover, his documented scholarly activity is much wider than previously reported. This historical analysis shows also that Majorana had a very important role in orienting research in Rome, especially in the sector of the statistical model of the atom and in Nuclear Physics. It is also clear that there are aspects of Ettore Majorana's life which transmit a solid historical legacy from the cultural and human points of view, besides the scientific legacy which is universally recognized to him. A rich reproduction of original documents completes the volume.



Mathematical Methods in Biomedical Imaging and Intensity-Modulated Radiation Therapy (IMRT)

edited by **Y. Censor, M. Jiang and A.K. Louis**

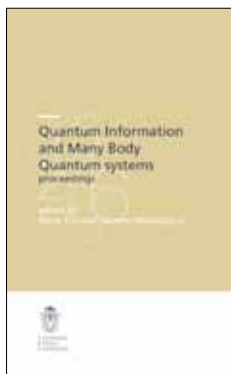
Pisa, Edizioni della Normale 2008

ISBN 978-88-7642-314-7, pp. XX-523, € 30.00

This book contains papers presented by leading experts at the “Interdisciplinary Workshop on Mathematical Methods in Biomedical Imaging and Intensity-Modulated Radiation Therapy (IMRT)” held at the Centro di Ricerca Matematica (CRM) Ennio De Giorgi at Pisa, Italy, from October 15 to 19, 2007.

The book consists of research and review papers by leading experts and practitioners in biomedical imaging and intensity-modulated radiation therapy (IMRT). The topics include mathematical aspects and practical problems in current major and emerging technologies for the diagnostic and therapeutic medicine and biology research. The contributed work signifies the interdisciplinary cooperation between mathematicians and scientists from medical physics, engineering, clinical medicine and biology, that leads to mathematically-based better solutions of practical problems in biomedical imaging and IMRT.

This book is also a survey of important research directions and opportunities in mathematics induced by problems in biomedical imaging and radiation planning applications.



Quantum Information and Many Body Quantum Systems. Proceedings

edited by **Marie Ericsson and Simone Montangero**

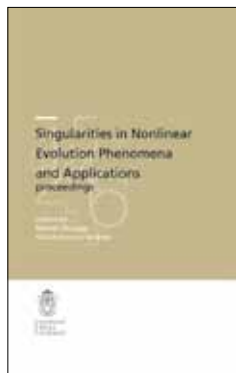
Pisa, Edizioni della Normale 2008

ISBN 978-88-7642-307-9, pp. XIII-171, € 29.00

In the most recent years growing attention has been dedicated to many body quantum systems from the point of view of quantum information. Indeed, after the initial investigation of simple systems as single or two qubits, the need for understanding the characteristics of a realistic quantum information device necessarily leads to the study of many body quantum systems. These studies are also driven by the very fast development of experiments which in recent years have reached the goal of coherent control of a few qubits with a roadmap for further scaling and improvement of coherent control and manipulation techniques.

This book gives a selection of the current research topics in the field of quantum information for many body quantum systems together with open problems.

CRM Series

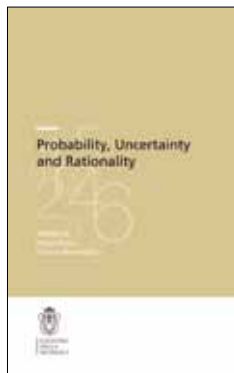


Singularities in Nonlinear Evolution Phenomena and Applications. Proceedings
edited by Matteo Novaga and Giandomenico Orlandi

Pisa, Edizioni della Normale 2009

ISBN 978-88-7642-343-7, pp. XIII-234, € 29.00

This volume collects some contributed papers by the participants to the workshop “Singularities in nonlinear evolution phenomena and applications”, which has been held at the Centro di Ricerca Matematica E. De Giorgi, from May 26th to May 30th 2008. The topic of the workshop was the formation and the evolution of singular structures, like systems of points, curves and surfaces. Such questions naturally arise in many models from Physics, Biology, Image Processing and Applied Mathematics in general, and have attracted a lot of attention in recent years. Their analysis requires sophisticated tools and an interdisciplinary approach, and poses new challenging mathematical problems.



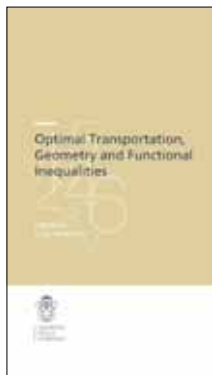
Probability, Uncertainty and Rationality
edited by Hykel Hosni and Franco Montagna

Pisa, Edizioni della Normale 2010

ISBN 978-88-7642-347-5, pp. xv-291, € 29.00

This volume explores, from a mathematical and a philosophical perspective, the virtuous circle connecting logic and rationality. While logic lends its methods, techniques and ideas to the investigation of rationality, the practical problems which arise in modelling rational behaviour, especially in the social sciences, motivate logicians to develop more refined logical formalisms. This is why non classical logics - a unifying theme of this volume - play a fundamental role in the construction of formal models of rationality.

CRM Series



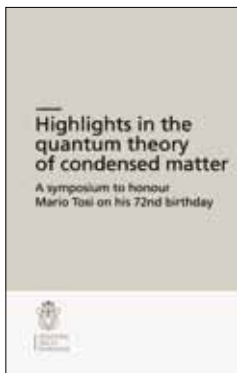
Optimal Transportation, Geometry and Functional Inequalities

edited by Luigi Ambrosio

Pisa, Edizioni della Normale 2010

ISBN 978-88-7642-373-4, pp. VI-120, € 26,00

In 2008, a school on the theory of Optimal Transportation and its applications took place in Pisa, with lectures by F. Barthe, W. Gangbo, F. Maggi and R. McCann. This book collects the notes of the first three lecturers. These notes provide a deep insight into the topics of concentration inequalities, evolution PDE's of Hamiltonian type, geometric and functional inequalities.



Highlights in the quantum theory of condensed matter. A symposium to honour Mario Tosi on his 72nd birthday
edited by Fabio Beltram

Pisa, Edizioni della Normale 2005

ISBN 88-7642-170-X, pp. XIX-282, € 23,00

The birth of condensed matter physics in Italy is linked to a small number of very distinguished scientists. Mario Tosi, Professor of Physics of Matter at the Scuola Normale Superiore, is unquestionably among the leading figures, a true founder of the theoretical activity in the country and a true catalyst of novel research directions internationally. This volume collects the proceedings of a symposium held at Scuola Normale Superiore of Pisa, designed to show Mario Tosi's broad, deep influence in very diverse areas of the quantum theory of condensed matter. The topics covered in the volume represent the breadth of his interests and the highlights in the quantum theory of condensed matter:

- Liquids
- Electronic states in complex structures
- Quantum degenerate gases
- Many-body physics



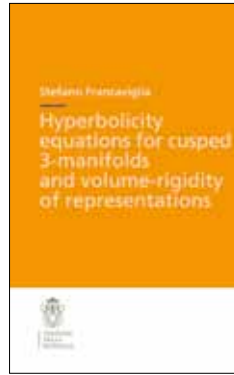
Francesco Costantino
**Shadows and branched shadows
of 3 and 4-manifolds**

Pisa, Edizioni della Normale 2005
ISBN 88-7642-154-8, pp. xx-183, € 10.00

The theory of shadows of 3 and 4-manifolds represents a bridge between combinatorics of polyhedra and low-dimensional topology. On one side, it allows a purely combinatorial approach to the study of smooth 4-manifolds and, on the other side, it indicates relations between old-standing problems in group theory and recent topological results on 4-dimensional manifolds.

The present Ph.D. thesis is devoted to further develop these connections and to find new applications to low-dimensional topology. The results proved, for the most part, seem to strengthen the idea that topology of 3-manifolds can be used as a guide to study the 4-dimensional case and that polyhedra can be used as a 'bridge': in many cases the 4-dimensional results based on shadows restrict through the theory of spines to results about 3-dimensional topology and geometry.

On the 3-dimensional side, a new notion of 'shadow-complexity' of 3-manifolds is defined. The study of this complexity clarifies how hyperbolic geometry of 3-manifolds is intimately connected with the combinatorial structure of the polyhedra used to describe the manifolds. On the 4-dimensional side, the notion of branched shadow is introduced in order to study, through a purely combinatorial approach, differentiable objects as Spinc and almost complex structures on smooth 4-manifolds. Combinatorial sufficient conditions based on these objects are proved assuring that 'refined' structures on 4-manifolds exist such as integrable complex structures and Stein domain structures.



Stefano Francaviglia
**Hyperbolicity equations for cusped
3-manifolds and volume-rigidity of
representations**

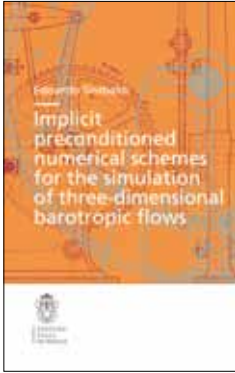
Pisa, Edizioni della Normale 2005
ISBN 88-7642-167-x, pp. 136, € 10.00

One of the most useful tools for studying hyperbolic 3-manifolds is the technique of ideal triangulations, introduced by Thurston to understand the hyperbolic structure of the complement of the figure-eight knot.

If a 3-manifold is equipped with an ideal triangulation, one tries to construct a hyperbolic structure on the manifold by defining the structure on each tetrahedron and then by requiring global compatibility. Straight hyperbolic ideal tetrahedra are parameterized by complex numbers with positive imaginary part, and compatibility translates into algebraic equations in the parameters.

In most of this work we consider generalized solutions of the compatibility equations, without restrictions on the imaginary part, and we investigate which such solutions define a global structure. We begin by facing, and essentially solving in full generality, the analogous two-dimensional Euclidean problem. We then study explicit examples of cusped 3-manifold, exhibiting a variety of different phenomena. Finally, we introduce a certain notion of geometric solution, we prove existence and uniqueness results for such solutions, and we characterize them in terms of the volume of their (suitably defined) holonomy.

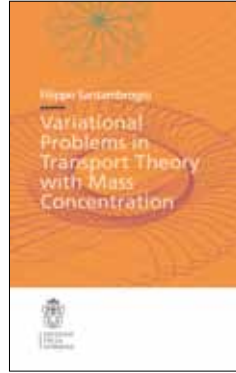
The last part of the thesis is devoted to the study of the volume function on the character variety of a hyperbolic 3-manifold. Our main result here is the proof of a rigidity theorem for representations of maximal volume.



Edoardo Sinibaldi
**Implicit preconditioned numerical schemes
for the simulation of three-dimensional
barotropic flows**

Pisa, Edizioni della Normale 2007
ISBN 978-88-7642-310-9, pp. IX-206, € 18.00

By starting from a specific industrial problem related to the propellant flow within a liquid propellant rocket engine, a numerical method for simulating three-dimensional, generic barotropic flows in rotating frames is developed. A novel finite volume compressible approach for unstructured grids is proposed, suitably preconditioned for accurately dealing with nearly-incompressible flows; the time-advancing is performed by a novel, generic, linearized implicit scheme. A constructive procedure for solving the one-dimensional Riemann problem associated with a generic convex barotropic state law is presented as well. All the proposed numerical ingredients are validated against one-dimensional exact solutions or three-dimensional experimental data related to complex, industrial flows also involving cavitation phenomena.



Filippo Santambrogio
**Variational Problems in Transport Theory
with Mass Concentration**

Pisa, Edizioni della Normale 2007
ISBN 978-88-7642-312-3, pp. VII-196, € 18.50

The thesis mainly deals with variational problems involving optimal transportation of probability measures, in competition with concentration effects. First, some problems where measures have to be selected minimizing transport costs between them but satisfying some concentration criteria are presented in the first chapters, with possible applications mainly to urban planning (where the concentrated measures stand for services in the city and the diffuse ones for population). A second part of the thesis is devoted to optimization problems where the concentration or diffusion phenomena occur directly at the level of the transportation structure: for instance in most communication networks, as well as in river basins and blood vessels joint transportation is favoured, while some models for traffic congestion or compressible fluid mechanics give rise to problems where spread configurations are preferred.



Mohammad Reza Bakhtiari
Quantum Gases in Quasi-One-Dimensional Arrays

Pisa, Edizioni della Normale 2007
ISBN 978-88-7642-319-2, pp. IX-168, € 18,50

The experimental achievement of Bose-Einstein condensation (1995) and of Fermi degeneracy (1999) in ultra-cold, dilute gases has opened a new field in atomic physics and condensed matter physics.

In this thesis, first an overview of theoretical and experimental facts on ultra-cold atomic gases is presented. Then a Green's function scheme to study coherent transport by fermions through a one-dimensional array of potential wells is described. Within this scheme different geometries for the array like single-period, double-period and Fibonacci-ordered quasi-periodic array are considered. In conclusion, a novel spin-density-functional approach is introduced to study the ground-state of a one-dimensional trapped Fermi gases inside one-dimensional optical lattices. This approach enables the author to investigate both repulsive and attractive Fermi gases within a local-spin-density approximation. Different phases caused by a spin-dependent trap for repulsive gas and also by a spin-imbalanced population for attractive gas are analyzed.



Tamara Servi
On the First-Order Theory of Real Exponentiation

Pisa, Edizioni della Normale 2008
ISBN 978-88-7642-325-3, pp. XII-110, € 18,50

The first-order theory of real exponentiation has been studied by many mathematicians in the last fifty years, in particular by model theorists, real geometers and number theorists. The aim of this work is to present the results obtained so far in this area and to improve and refine them. In the early 1990s A. Macintyre and A.J. Wilkie proved that the theory of real exponentiation is decidable, provided that Schanuel's conjecture holds. In the proof of their result, they proposed a candidate for a complete and recursive axiomatization of the theory. While simplifying their axiomatization, the author of this book analyses (in the first three chapters) the model theory and geometry of a broad class of functions over real closed fields. Even though the methods used are elementary, the results hold in great generality. The last chapter is devoted solely to the decidability problem for the real exponential field.



Davide Vittone
Submanifolds in Carnot Groups
Pisa, Edizioni della Normale 2008
ISBN 978-88-7642-327-7, pp. xx-178, € 18.50

The book is devoted to the study of submanifolds in the setting of Carnot groups equipped with a sub-Riemannian structure; particular emphasis is given to the case of Heisenberg groups. A Geometric Measure Theory viewpoint is adopted, and features such as intrinsic perimeters, Hausdorff measures, area formulae, calibrations and minimal surfaces are considered. Area formulae for the measure of submanifolds of arbitrary codimension are obtained in Carnot groups. Intrinsically regular hypersurfaces in the Heisenberg group are extensively studied: suitable notions of graphs are introduced, together with area formulae leading to the analysis of Plateau and Bernstein type problems.



Alessio Figalli
Optimal Transportation and Action-Minimizing Measures
Pisa, Edizioni della Normale 2008
ISBN 978-88-7642-330-7, pp. xix-251, € 18.50

In this book recent developments in the theory of optimal transportation and some of its applications to fluid dynamics are described. New variants of the original problem are explored and some common (and sometimes unexpected) features in this emerging variety of problems are figured out. In Chapter 1 the optimal transportation problem on manifolds with geometric costs coming from Tonelli Lagrangians is studied, while in Chapter 2 a generalization of the classical transportation problem called the optimal irrigation problem is considered. Then, Chapter 3 is about the Brenier variational theory of incompressible flows, which concerns a weak formulation of the Euler equations viewed as a geodesic equation in the space of measure-preserving diffeomorphism. Chapter 4 is devoted to the study of regularity and uniqueness of solutions of Hamilton-Jacobi equations applying the Aubry-Mather theory. Finally, the last chapter deals with a DiPerna-Lions theory for martingale solutions of stochastic differential equations.



Alberto Saracco
Extension Problems in Complex and CR-geometry

Pisa, Edizioni della Normale 2008

ISBN 978-88-7642-338-3, pp. XIV-153, € 18.50

This book is both a survey of some aspects of extension problems in Complex Analysis and Geometry and a collection of results by the author. After recalling the preliminary and necessary notions of complex analysis, the survey focuses on extension of holomorphic functions (filling both compact and non-compact holes), on the reflection principle, on extension results via cohomology vanishing, and on the boundary problem. The last two subjects include detailed results by the author on non-compact extension: the cohomology of semi-q-coronae and the unbounded boundary problem.



Luigi Manca
Kolmogorov Operators in Spaces of Continuous Functions and Equations for Measures

Pisa, Edizioni della Normale 2008

ISBN 978-88-7642-336-9, pp. XIV-127, € 18.50

The book is devoted to study the relationships between Stochastic Partial Differential Equations and the associated Kolmogorov operator in spaces of continuous functions.

In the first part, the theory of a weak convergence of functions is developed in order to give general results about Markov semigroups and their generator.

In the second part, concrete models of Markov semigroup deriving from Stochastic PDEs are studied. In particular, Ornstein-Uhlenbeck, reaction-diffusion and Burgers equations have been considered. For each case the transition semigroup and its infinitesimal generator have been investigated in a suitable space of continuous functions.

The main results consist in showing that the set of exponential functions provides a core for the Kolmogorov operator.



Moreno Lelli
**Solution Structure
and Solution Dynamics
in Chiral Ytterbium(III)
Complexes**

Pisa, Edizioni della Normale 2009
ISBN 978-88-7642-349-9, pp. xvii-169, € 18,50

The determination of the molecular structure in solution is an important target of the modern chemistry. In many fields, the knowledge of the structural and the dynamics information in solution are a fundamental tool for a complete understanding of chemical processes, from catalytic mechanisms to biological activities of proteins. However there is not a general strategy to approach the problem of solution structural study for any type of molecule. This book proposes a methodology to investigate the structure and the dynamics in solution of chiral ytterbium(III) complexes, based on a combined use of spectroscopic techniques such as Nuclear Magnetic Resonance and Circular Dichroism. This method has been applied here to the study of several ytterbium(III) complexes, recently proposed in scientific literature as catalysts for stereoselective organic reactions. The results evidenced that the structure in solution is sometime different from that one obtained in the solid state from X-ray crystallographic diffraction, furnishing a more suitable basis for the investigation of the catalytic mechanism in solution phase. Furthermore, one chapter has been dedicated to the use of Yb(III) ions as probe for the determination of the absolute configuration of an important class of molecules such as chiral 1,2-diols. This is also an example to how this methodology can be extended to other fields of chemistry.



Gianluca Crippa
**The Flow Associated
to Weakly Differentiable
Vector Fields**

Pisa, Edizioni della Normale 2009
ISBN 978-88-7642-340-6, pp. xv-163, € 18,50

The aim of this book is to provide a self-contained introduction and an up-to-date survey on many aspects of the theory of transport equations and ordinary differential equations with non-smooth velocity fields. The interest in this topic is motivated by important issues in nonlinear PDEs, in particular conservation laws and fluid mechanics. A fascinating feature of this research area, which is currently of concern in mathematics, is the interplay between PDE techniques and geometric measure theory techniques. Several masterpieces appear in the related literature, balancing completely rigorous proofs with more heuristic arguments. A consistent part of the book is based on results obtained by the author in collaboration with other mathematicians. After a short introduction to the classical smooth theory, the book is divided into two parts. The first part focuses on the PDE aspect of the problem, presenting some general tools of this analysis, many well-posedness results, an abstract characterization of the well-posedness, and some examples showing the sharpness of the assumptions made. The second part, instead, deals with the ODE aspect of the problem, respectively by an abstract connection with the PDE, and by some direct and simple (but powerful) a priori estimates.



Filippo Callegaro
**Cohomology of Finite
and Affine Type
Artin Groups over Abelian
Representations**

Pisa, Edizioni della Normale 2009
ISBN 978-88-7642-345-1, pp. XIX-137, € 18,50

The classical theory of braids is deeply connected with the theory of reflection groups and there are many relations between Artin groups and Coxeter groups. It turns out that the classifying spaces of Artin groups of finite type are affine varieties, the complement of the singularities associated to Coxeter groups.

In order to study the topology of the Milnor fiber of these non-isolated singularities together with the monodromy action it is useful to compute the cohomology of the Artin groups with coefficients in an abelian representation.

In this book a description of this cohomology for Artin groups of type A and B and for affine Artin groups of the same type is given



Giuseppe Della Sala
**Geometric Properties
of Non-compact CR
Manifolds**

Pisa, Edizioni della Normale 2010
ISBN 978-88-7642-348-2, pp. XV-103, € 18,50

The book deals with some questions related to the boundary problem in complex and in CR geometry. After a brief introduction summarizing the main results on the extension of CR functions, it is shown in chapters 2 and 3 that, employing the classical Harvey-Lawson theorem and under suitable conditions, the boundary problem for non-compact maximally complex real submanifolds of C^n , $n \geq 3$ is solvable.

In chapter 4, the regularity of Levi flat hypersurfaces C^n ($n \geq 3$) with assigned boundaries is studied in the graph case, in relation to the existence theorem proved by Dolbeault, Tomassini and Zaitsev. Finally, in the last two chapters the structure properties of non-compact Levi-flat submanifolds of C^n are discussed; in particular, using the theory of the analytic multifunctions, a Liouville theorem for Levi flat submanifolds of C^n is proved.

Fuori collana



Stefan Hildebrandt, Anthony Tromba

Principi di minimo

Forme ottimali in natura

Pisa, Edizioni della Normale 2007 (ristampa)

ISBN 88-7642-178-5, pp. 295, ill. a colori, € 35.00

Perché le uova sono a forma di uova, e i pesci a forma di pesce? Perché i pianeti e le stelle sono a forma di sfera piuttosto che di quadrato o piramide? Perché la natura produce alcune forme e le preferisce ad altre forme concepibili? Che cosa può spiegare le somiglianze tra forme e la loro varietà in natura?

Sono queste alcune delle domande alle quali Stefan Hildebrandt e Anthony Tromba tentano di dare una risposta in *Principi di minimo*.

Trattando del calcolo delle variazioni - una branca della matematica che si occupa di forme ottimali in geometria ed in natura, con problemi di massimo e di minimo -, gli autori cercano di rintracciare le leggi fondamentali che governano gli schemi di design della natura e integrano la trattazione scientifica con un ricco apparato di illustrazioni a colori e di esempi: dai nuclei atomici alle bolle di sapone, dalle spirali ai frattali.

Senza utilizzare un linguaggio tecnico, Hildebrandt e Tromba intraprendono un'interessante strada di indagine scientifica, un percorso mai iniziato prima, mostrando il ruolo fondamentale della geometria nell'esplorare e spiegare il nostro mondo.

Questo libro è la traduzione di *The Parsimonious Universe* (New York, Springer 1996), che a sua volta è una versione riveduta e ampliata dell'originale pubblicato da W.H. Freeman nel 1984 con il titolo *Mathematics and Optimal Form*. In seguito sono apparse traduzioni in tedesco, francese, olandese, spagnolo e giapponese.



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