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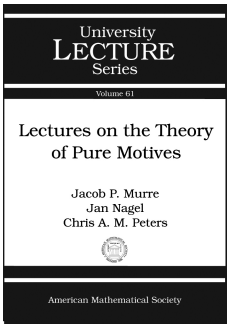
Algebra and Algebraic Geometry



Lectures on the Theory of Pure Motives

Jacob P. Murre, *Universiteit Leiden, The Netherlands*, **Jan Nagel**, *Université de Bourgogne, Dijon Cedex, France*, and **Chris A. M. Peters**, *Université Grenoble I, St. Martin d'Heres, France*

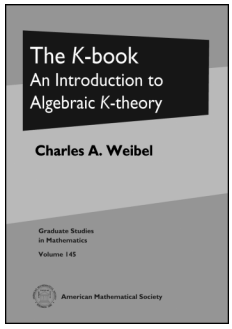
The theory of motives was created by Grothendieck in the 1960s as he searched for a universal cohomology theory for algebraic varieties. The theory of pure motives is well established as far as the construction is concerned. Pure motives are expected to have a number of additional properties predicted by Grothendieck's standard conjectures, but these conjectures remain wide open. The theory for mixed motives is still incomplete.

This book deals primarily with the theory of pure motives. The exposition begins with the fundamentals: Grothendieck's construction of the category of pure motives and examples. Next, the standard conjectures and the famous theorem of Jannsen on the category of the numerical motives are discussed. Following this, the important theory of finite dimensionality is covered. The concept of Chow-Künneth decomposition is introduced, with discussion of the known results and the related conjectures, in particular the conjectures of Bloch-Beilinson type. We finish with a chapter on relative motives and a chapter giving a short introduction to Voevodsky's theory of mixed motives.

Contents: Algebraic cycles and equivalence relations; Survey of some of the main results on Chow groups; Proof of the theorem of Voisin-Voevodsky; Motives: Construction and first properties; On Grothendieck's standard conjectures; Finite dimensionality of motives; Properties of finite dimensional motives; Chow-Künneth decomposition; The Picard and Albanese motive; Chow-Künneth decomposition in a special case; On the conjectural Bloch-Beilinson filtration; Relative Chow-Künneth decomposition; Surfaces fibered over a curve; Beyond pure motives; The category of motivic complexes; Bibliography; Index of notation; Index.

University Lecture Series, Volume 61

April 2013, 149 pages, Softcover, ISBN: 978-0-8218-9434-7, 2010 *Mathematics Subject Classification:* 14-02, 14C15, 14C25, 19E15, **AMS members US$35.20**, List US$44, Order code ULECT/61



The *K*-book

An Introduction to Algebraic *K*-theory

Charles A. Weibel, *Rutgers University, New Brunswick, NJ*

Informally, K-theory is a tool for probing the structure of a mathematical object such as a ring or a topological space in terms of suitably parameterized vector spaces and producing important intrinsic invariants which are useful in the study of algebraic and geometric questions. Algebraic K-theory, which is the main character of this book, deals mainly with studying the structure of rings. However, it turns out that even working in a purely algebraic context, one requires techniques from homotopy theory to construct the higher K-groups and to perform computations. The resulting interplay of algebra, geometry, and topology in K-theory provides a fascinating glimpse of the unity of mathematics.

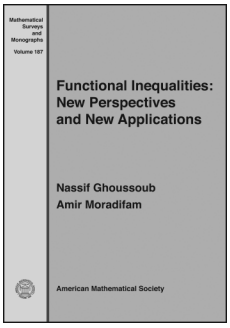
This book is a comprehensive introduction to the subject of algebraic K-theory. It blends classical algebraic techniques for K_0 and K_1 with newer topological techniques for higher K-theory such as homotopy theory, spectra, and cohomological descent. The book takes the reader from the basics of the subject to the state of the art, including the calculation of the higher K-theory of number fields and the relation to the Riemann zeta function.

Contents: Projective modules and vector bundles; The Grothendieck group K_0; K_1 and K_2 of a ring; Definitions of higher K-theory; The fundamental theorems of higher K-theory; The higher K-theory of fields; Nomenclature; Bibliography; Index.

Graduate Studies in Mathematics, Volume 145

May 2013, approximately 642 pages, Hardcover, ISBN: 978-0-8218-9132-2, LC 2012039660, 2010 *Mathematics Subject Classification:* 19-00, 19-01, **AMS members US$71.20**, List US$89, Order code GSM/145

Differential Equations



Functional Inequalities: New Perspectives and New Applications

Nassif Ghoussoub, *University of British Columbia, Vancouver, BC, Canada*, and **Amir Moradifam**, *Columbia University, New York, NY*

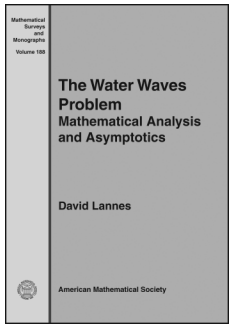
The book describes how functional inequalities are often manifestations of natural mathematical structures and physical phenomena, and how a few general principles validate large classes of analytic/geometric inequalities, old and new. This point of view leads to "systematic" approaches for proving the most basic inequalities, but also for improving them, and for devising new ones—sometimes at will—and often on demand. These general principles also offer novel ways for estimating best constants and for deciding whether these are attained in appropriate function spaces.

As such, improvements of Hardy and Hardy-Rellich type inequalities involving radially symmetric weights are variational manifestations of Sturm's theory on the oscillatory behavior of certain ordinary differential equations. On the other hand, most geometric inequalities, including those of Sobolev and Log-Sobolev type, are simply expressions of the convexity of certain free energy functionals along the geodesics on the Wasserstein manifold of probability measures equipped with the optimal mass transport metric. Caffarelli-Kohn-Nirenberg and Hardy-Rellich-Sobolev type inequalities are then obtained by interpolating the above two classes of inequalities via the classical ones of Hölder. The subtle Moser-Onofri-Aubin inequalities on the two-dimensional sphere are connected to Liouville type theorems for planar mean field equations.

Contents: *Hardy type inequalities:* Bessel pairs and Sturm's oscillation theory; The classical Hardy inequality and its improvements; Improved Hardy inequality with boundary singularity; Weighted Hardy inequalities; The Hardy inequality and second order nonlinear eigenvalue problems; *Hardy-Rellich type inequalities:* Improved Hardy-Rellich inequalities on $H_0^2(\Omega)$; Weighted Hardy-Rellich inequalities on $H^2(\Omega) \cap H_0^1(\Omega)$; Critical dimensions for 4th order nonlinear eigenvalue problems; *Hardy inequalities for general elliptic operators:* General Hardy inequalities; Improved Hardy inequalities for general elliptic operators; Regularity and stability of solutions in non-self-adjoint problems; *Mass transport and optimal geometric inequalities:* A general comparison principle for interacting gases; Optimal Euclidean Sobolev inequalities; Geometric inequalities; *Hardy-Rellich-Sobolev inequalities:* The Hardy-Sobolev inequalities; Domain curvature and best constants in the Hardy-Sobolev inequalities; *Aubin-Moser-Onofri inequalities:* Log-Sobolev inequalities on the real line; Trudinger-Moser-Onofri inequality on $\mathbb{S}^2$; Optimal Aubin-Moser-Onofri inequality on $\mathbb{S}^2$; Bibliography.

Mathematical Surveys and Monographs, Volume 187

March 2013, approximately 310 pages, Hardcover, ISBN: 978-0-8218-9152-0, 2010 *Mathematics Subject Classification:* 42B25, 35A23, 26D10, 35A15, 46E35, **AMS members US$78.40**, List US$98, Order code SURV/187



The Water Waves Problem

Mathematical Analysis and Asymptotics

David Lannes, *Ecole Normale Supérieure et CNRS, Paris, France*

This monograph provides a comprehensive and self-contained study on the theory of water waves equations, a research area that has been very active in recent years. The vast literature devoted to the study of water waves offers numerous asymptotic models. Which model provides the best description of waves such as tsunamis or tidal waves? How can water waves equations be transformed into simpler asymptotic models for applications in, for example, coastal oceanography? This book proposes a simple and robust framework for studying these questions.

The book should be of interest to graduate students and researchers looking for an introduction to water waves equations or for simple asymptotic models to describe the propagation of waves. Researchers working on the mathematical analysis of nonlinear dispersive equations may also find inspiration in the many (and sometimes new) models derived here, as well as precise information on their physical relevance.

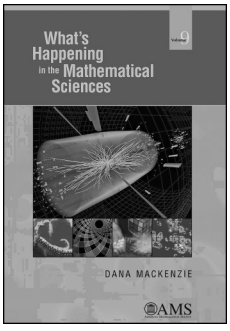
This item will also be of interest to those working in mathematical physics.

Contents: The water waves equations and its asymptotic regimes; The Laplace equation; The Dirichlet-Neumann operator; Well-posedness of the water waves equations; Shallow water asymptotics: Systems. Part 1: Derivation; Shallow water asymptotics: Systems. Part 2: Justification; Shallow water asymptotics: Scalar equations; Deep water models and modulation equations; Water waves with surface tension; Appendix A. More on the Dirichlet-Neumann operator; Appendix B. Product and commutator estimates; Appendix C. Asymptotic models: A reader's digest; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 188

May 2013, approximately 328 pages, Hardcover, ISBN: 978-0-8218-9470-5, 2010 *Mathematics Subject Classification:* 76B15, 35Q53, 35Q55, 35J05, 35J25, **AMS members US$78.40**, List US$98, Order code SURV/188

General Interest



What's Happening in the Mathematical Sciences, Volume 9

Dana Mackenzie

What's Happening in the Mathematical Sciences looks at some highlights of the most recent developments in mathematics. These include the mathematics behind stories that made headlines, as well as fascinating mathematical stories that never made it into the newspapers.

In 2009, a flu pandemic, the world's first in more than 40 years, tested a new generation of mathematical models that take some of the guesswork out of public health decisions. As health officials rushed to quell the outbreak of H1N1 flu, mathematicians were working just as hurriedly to answer questions like these: Was the epidemic serious enough to justify school closings or quarantines? Who should be vaccinated first, the elderly or the young? Their findings substantially affected the response of local governments, national governments, and the World Health Organization.

Mathematics can also help society prepare for other kinds of natural and manmade disasters. A major tsunami in 2011 in Japan, like the one seven years earlier in the Indian Ocean, highlighted flaws in our understanding of these catastrophic events and inadequacies in our early warning systems. Geoscientists are working together with mathematicians to improve our short-term forecasting ability and quantify the long-term risks of tsunamis. Meanwhile, in California, another group of mathematicians succeeded in adapting earthquake prediction algorithms to forecast criminal activity. Their "predictive policing" software was tested in Los Angeles and is being adopted by other cities across the United States.

Fortunately, not all mathematics has to do with emergencies. Pure mathematicians have been busy cleaning out their closets of long-standing open problems. In 2012, two conjectures about different kinds of minimizing surfaces were solved: the Willmore Conjecture (minimizing energy) and the Lawson Conjecture (minimizing area). Also in 2012, following up on the extraordinary proofs of the Poincaré Conjecture and Thurston's Geometrization Conjecture, topologists proved a collection of conjectures that ensure that three-dimensional spaces can all be constructed in a uniform way. Meanwhile, for the last ten years, a new way of understanding algebraic curves and surfaces has developed, leading to a subject now known as tropical geometry. With the new ideas, certain hard problems in algebraic geometry suddenly become easy and certain "mathematical mysteries" of string theory begin to make sense.

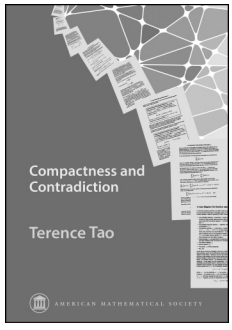
In physics, the nine-billion-dollar search for the elusive Higgs boson finally bagged its quarry in 2012. This discovery, one of the most widely publicized science stories of the year, provides experimental evidence for the "Higgs mechanism," a nearly 50-year-old mathematical argument that explains how certain subatomic particles acquire mass.

Rounding out this volume are chapters on a new statistical technique called topic modeling, which is breaking down the academic barriers between math and the humanities, and new discoveries about mathematicians' (and a lot of other people's) favorite toy: the Rubik's Cube.

Contents: A massive breakthrough (about the mathematics of the Higgs particle); Tubing through hyperspace (about the proofs of the Willmore conjecture, Lawson's conjecture, and the Pinkall-Sterling conjecture); Tsunamis: Learning from math, learning from the past (title is self explanatory); Today's forecast: Ten percent chance of burglary (about protective policing); Topologists cross four off "bucket list" (about the proof of the Virtual Haken Conjecture and three related conjectures); Speedcubing, anyone? (about the mathematics of the Rubik's cube); The right epidemic at the right time (about the 2009 flu epidemic and mathematical models of epidemics); Thinking topically: Latent Dirichlet allocation (about topic models); Thinking tropically (about tropical geometry).

What's Happening in the Mathematical Sciences, Volume 9

May 2013, approximately 136 pages, Softcover, ISBN: 978-0-8218-8739-4, 2010 *Mathematics Subject Classification:* 00A06, **AMS members US$20**, List US$25, Order code HAPPENING/9



Compactness and Contradiction

Terence Tao, *University of California, Los Angeles, CA*

There are many bits and pieces of folklore in mathematics that are passed down from advisor to student, or from collaborator to collaborator, but which are too fuzzy and nonrigorous to be discussed in the formal literature. Traditionally, it was a matter of luck and location as to who learned such "folklore mathematics". But today, such bits and pieces can be communicated effectively and efficiently via the semiformal medium of research blogging. This book grew from such a blog.

The articles, essays, and notes in this book are derived from the author's mathematical blog in 2010. It contains a broad selection of mathematical expositions, commentary, and self-contained technical notes in many areas of mathematics, such as logic, group theory, analysis, and partial differential equations. The topics range from the foundations of mathematics to discussions of recent mathematical breakthroughs.

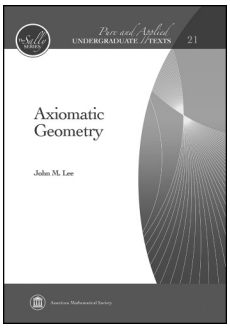
Lecture notes from the author's courses that appeared on the blog have been published separately in the *Graduate Studies in Mathematics* series.

This item will also be of interest to those working in analysis, algebra and algebraic geometry, and logic and foundations.

Contents: Logic and foundations; Group theory; Analysis; Nonstandard analysis; Partial differential equations; Miscellaneous; Bibliography; Index.

April 2013, approximately 262 pages, Softcover, ISBN: 978-0-8218-9492-7, 2010 *Mathematics Subject Classification:* 00B15, **AMS members US$35.20**, List US$44, Order code MBK/81

Geometry and Topology



Axiomatic Geometry

John M. Lee, *University of Washington, Seattle, WA*

The story of geometry is the story of mathematics itself: Euclidean geometry was the first branch of mathematics to be systematically studied and placed on a firm logical foundation, and it is the prototype for the axiomatic method that lies at the foundation of modern mathematics. It has been taught to students for more than two millennia as a model of logical thought.

This book tells the story of how the axiomatic method has progressed from Euclid's time to ours, as a way of understanding what mathematics is, how we read and evaluate mathematical arguments, and why mathematics has achieved the level of certainty it has. It is designed primarily for advanced undergraduates who plan to teach secondary school geometry, but it should also provide something of interest to anyone who wishes to understand geometry and the axiomatic method better. It introduces a modern, rigorous, axiomatic treatment of Euclidean and (to a lesser extent) non-Euclidean geometries, offering students ample opportunities to practice reading and writing proofs while at the same time developing most of the concrete geometric relationships that secondary teachers will need to know in the classroom.

This item will also be of interest to those working in general interest.

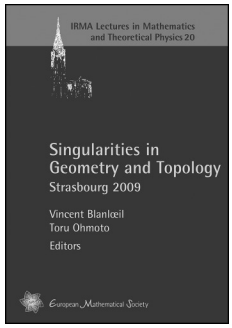
Contents: Euclid; Incidence geometry; Axioms for plane geometry; Angles; Triangles; Models of neutral geometry; Perpendicular and parallel lines; Polygons; Quadrilaterals; The Euclidean parallel postulate; Area; Similarity; Right triangles; Circles; Circumference and circular area; Compass and straightedge constructions; The parallel postulate revisited; Introduction to hyperbolic geometry; Parallel lines in hyperbolic geometry; Epilogue: Where do we go from here?; Hilbert's axioms; Birkhoff's postulates; The SMSG postulates; The postulates used in this book; The language of mathematics; Proofs; Sets and functions; Properties of the real numbers; Rigid motions: Another approach; References; Index.

Pure and Applied Undergraduate Texts, Volume 21

May 2013, approximately 472 pages, Hardcover, ISBN: 978-0-8218-8478-2, LC 2012043438, 2010 *Mathematics Subject Classification:* 51-01; 51M05, 51M10, **AMS members US$60**, List US$75, Order code AMSTEXT/21

New AMS-Distributed Publications

Algebra and Algebraic Geometry



Singularities in Geometry and Topology—Strasbourg 2009

Vincent Blanlœil, *Université de Strasbourg, France*, and **Toru Ohmoto**, *Hokkaido University, Sapporo, Japan*, Editors

This volume arises from the Fifth Franco-Japanese Symposium on Singularities, held in Strasbourg in August 2009. The conference brought together an international group of researchers, mainly from France and Japan, working on singularities in algebraic geometry, analytic geometry and topology. The conference also featured the JSPS Forum on Singularities and Applications, which aimed to introduce some recent applications of singularity theory to physics and statistics.

This book contains research papers and short lecture notes on advanced topics on singularities. Some surveys on applications that were presented at the JSPS Forum are also included. Among the topics covered are splice surface singularities, b-functions, equisingularity, degenerating families of Riemann surfaces, hyperplane arrangements, mixed singularities, jet schemes, noncommutative blow-ups, characteristic classes of singular spaces, and applications to geometric optics, cosmology, and learning theory.

Graduate students who wish to learn about various approaches to singularities, as well as experts in the field and researchers in other areas of mathematics and science, will find the contributions to this volume a rich source for further study and research.

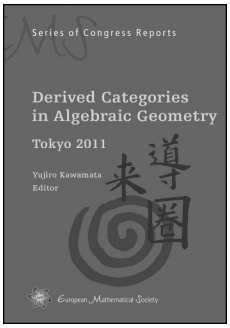
A publication of the European Mathematical Society. Distributed within the Americas by the American Mathematical Society.

Contents: A. Joets, Optical caustics and their modelling as singularities (JSPS Forum); **H. A. Hamm**, On local equisingularity; **S. Ishii**, **A. Sannai**, and **K.-i. Watanabe**, Jet schemes of homogeneous hypersurfaces; **T. Koike**, Singularities in relativity (JSPS Forum); **Y. Matsumoto**, On the universal degenerating family of Riemann surfaces; **Y. Nakamura** and **S. Tajima**, Algebraic local cohomologies and local b-functions attached to semiquasihomogeneous singularities with $L(f) = 2$; **T. Ohmoto**, A note on the Chern-Schwartz-MacPherson class; **M. Oka**, On mixed projective curves; **T. Okuma**, Invariants of splice quotient singularities; **O. Riemenschneider**, A note on the toric duality between $A_{n,q}$ and $A_{n,n-q}$; **J. Schürmann**, Nearby cycles and characteristic classes of singular spaces; **T. Suwa**, Residues of singular holomorphic distributions (lecture); **S. Watanabe**, Two birational invariants in statistical learning theory (JSPS Forum); **T. Yasuda**, Frobenius morphisms of noncommutative blowups; **S. Yokura**, Bivariant

motivic Hirzebruch class and a zeta function of motivic Hirzebruch class (lecture); **M. Yoshinaga**, Minimality of hyperplane arrangements and basis of local system cohomology.

IRMA Lectures in Mathematics and Theoretical Physics, Volume 20

December 2012, 370 pages, Softcover, ISBN: 978-3-03719-118-7, 2010 *Mathematics Subject Classification:* 13A35, 14A22, 14B05, 14B07, 14B15, **AMS members US$49.60**, List US$62, Order code EMSILMTP/20



Derived Categories in Algebraic Geometry—Tokyo 2011

Yujiro Kawamata, *University of Tokyo, Japan*, Editor

The study of derived categories is a subject that attracts increasingly many mathematicians from various fields of mathematics, including abstract algebra, algebraic geometry, representation theory, and mathematical physics.

The concept of the derived category of sheaves was invented by Grothendieck and Verdier in the 1960s as a tool to express important results in algebraic geometry such as the duality theorem. In the 1970s, Beilinson, Gelfand, and Gelfand discovered that a derived category of an algebraic variety may be equivalent to that of a finite-dimensional non-commutative algebra, and Mukai found that there are non-isomorphic algebraic varieties that have equivalent derived categories. In this way, the derived category provides a new concept that has many incarnations. In the 1990s, Bondal and Orlov uncovered an unexpected parallelism between the derived categories and the birational geometry. Kontsevich's homological mirror symmetry provided further motivation for the study of derived categories.

This book contains the proceedings of a conference held at the University of Tokyo in January 2011 on the current status of the research on derived categories related to algebraic geometry. Most articles are survey papers on this rapidly developing field.

The book is suitable for mathematicians who want to enter this exciting field. Some basic knowledge of algebraic geometry is assumed.

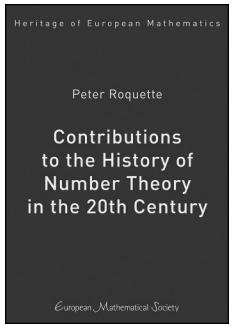
A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: **M. Bernardara** and **M. Bolognesi**, Categorical representability and intermediate Jacobians of Fano threefolds; **A. Canonaco** and **P. Stellari**, Fourier-Mukai functors: A survey; **S. Cautis**, Flops and about: A guide; **A. Ishii** and **K. Ueda**, A note on derived categories of Fermat varieties; **D. Kaledin**, Homology of infinite loop spaces; **B. Keller**, Cluster algebras and derived categories; **I. Mori**, Some derived equivalences between noncommutative schemes and algebras; **A. Polishchuk**, Lagrangian-invariant sheaves and functors for abelian varieties; **M. Popa**, Generic vanishing filtrations and perverse objects in derived categories of coherent sheaves; **C. Schnell**, The fundamental group is not a derived invariant; **Y. Toda**, Introduction and open problems of Donaldson–Thomas theory; **M. Van den Bergh**, Notes on formal deformations of abelian categories; List of contributors.

EMS Series of Congress Reports, Volume 8

December 2012, 354 pages, Hardcover, ISBN: 978-3-03719-115-6, 2010 *Mathematics Subject Classification:* 13D09, 14-02, 14-06, 14F05, 16E35, 18E30, **AMS members US$78.40**, List US$98, Order code EMSSCR/8

General Interest



Contributions to the History of Number Theory in the 20th Century

Peter Roquette, *University of Heidelberg, Germany*

The 20th century was a time of great upheaval and great progress in mathematics. In order to get the overall picture of trends, developments, and results, it is illuminating to examine their manifestations locally, in the personal lives and work of mathematicians who were active during this time. The university archives of Göttingen harbor a wealth of papers, letters, and manuscripts from several generations of mathematicians—documents which tell the story of the historic developments from a local point of view.

This book offers a number of essays based on documents from Göttingen and elsewhere—essays which have not yet been included in the author's collected works. These essays, independent from each other, are meant as contributions to the imposing mosaic of the history of number theory. They are written for mathematicians, but there are no special background requirements.

The essays discuss the works of Abraham Adrian Albert, Cahit Arf, Emil Artin, Richard Brauer, Otto Grün, Helmut Hasse, Klaus Hoechsmann, Robert Langlands, Heinrich-Wolfgang Leopoldt, Emmy Noether, Abraham Robinson, Ernst Steinitz, Hermann Weyl, and others.

This item will also be of interest to those working in number theory.

A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: The Brauer-Hasse-Noether theorem; The remarkable career of Otto Grün; At Emmy Noether's funeral; Emmy Noether and Hermann Weyl; Emmy Noether: The testimonials; Abraham Robinson and his infinitesimals; Cahit Arf and his invariant; Hasse–Arf–Langlands; Ernst Steinitz and abstract field theory; Heinrich-Wolfgang Leopoldt; On Hoechsmann's theorem; Acknowledgements; Bibliography; Name index; Subject index.

Heritage of European Mathematics, Volume 7

December 2012, 289 pages, Hardcover, ISBN: 978-3-03719-113-2, 2010 *Mathematics Subject Classification:* 01-02, 03-03, 11-03, 12-03, 16-03, 20-03, **AMS members US$78.40**, List US$98, Order code EMSHEM/7