



Nonlinear Evolution of Spatio-Temporal Structures in Dissipative Continuous Systems

Edited by
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L. Kramer**

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F.H. Busse, L. Kramer



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Kramer, 2012-12-12 This volume contains papers contributed to the NATO Advanced Research Workshop Nonlinear Evolution of Spatio Temporal Structures in Dissipative Continuous Systems held in Streithberg Fed Rep Germany Sept 24 through 30 1989 The purpose of the rather long title has been to focus attention on a particularly fruitful direction of research within the broad field covered by terms like Nonlinear Dynamics or Non Equilibrium Systems After physicists have been occupied for several decades mainly with the microscopic structure of matter recent years have witnessed a resurgence of interest in macroscopic patterns and dynamics Research on these latter phenomena has not been dormant of course since fluid dynamicists interested in the origin of turbulence meteorologists studying weather patterns and numerous other scientists have continued to advance the understanding of the structures relevant to their disciplines The recent progress in the dynamics of nonlinear systems with few degrees of freedom and the discovery of universal laws such as the Feigenbaum scaling of period doubling cascades has given rise to new hopes for the understanding of common principles underlying the spontaneous formation of structures in extended continuous systems Nonlinear Evolution of Spatio-Temporal Structures in Dissipative Continuous Systems F.H. Busse, L. Kramer, 2012-12-06

This volume contains papers contributed to the NATO Advanced Research Workshop Nonlinear Evolution of Spatio Temporal Structures in Dissipative Continuous Systems held in Streithberg Fed Rep Germany Sept 24 through 30 1989 The purpose of the rather long title has been to focus attention on a particularly fruitful direction of research within the broad field covered by terms like Nonlinear Dynamics or Non Equilibrium Systems After physicists have been occupied for several decades mainly with the microscopic structure of matter recent years have witnessed a resurgence of interest in macroscopic patterns and dynamics Research on these latter phenomena has not been dormant of course since fluid dynamicists interested in the origin of turbulence meteorologists studying weather patterns and numerous other scientists have continued to advance the understanding of the structures relevant to their disciplines The recent progress in the dynamics of nonlinear systems with few degrees of freedom and the discovery of universal laws such as the Feigenbaum scaling of period doubling cascades has given rise to new hopes for the understanding of common principles underlying the spontaneous formation of structures in extended continuous systems

Evolution of Spontaneous Structures in Dissipative Continuous Systems Friedrich H. Busse, Stefan C. Müller, 2003-07-01

In the decades the of the formation of structures past subject spontaneous in far from has into a branch of systems equilibrium major physics grown search with ties to It has become evident that strong neighboring disciplines a diverse of can be understood within a common mathematical framework which has been called nonlinear of continuous dynamics This name the close to the field of nonlinear systems emphasizes relationship of with few of freedom which has evolved into a dynamics systems degrees mature in the recent features mathematically subject past Many dynamical of

continuous be described reduction few can a to a systems actually through of freedom and of the latter of continue to degrees properties type systems of continuous the inspire study systems The of this book is to demonstrate the numerous goal through examples that exist for the of nonlinear the opportunities study phenomena through tools of mathematical and use of common analyses dynamical interpretations Instead of overview of the a providing comprehensive rapidly evolving field the contributors to this book are to communicate to a wide scientific trying audience the of what have learnt about the formation of essence they spon neous structures in continuous and about the dissipative systems competition between order and chaos that characterizes these It is that systems hoped the book will be even to those scientists whose not helpful are disciplines the authors

Complexity, Chaos, and Biological Evolution Erik Mosekilde, Lis Mosekilde, 2013-03-08 From time to time perhaps a few times each century a revolution occurs that questions some of our basic beliefs and sweeps across otherwise well guarded disciplinary boundaries These are the periods when science is fun when new paradigms have to be formulated and when young scientists can do serious work without first having to acquire all the knowledge of their teachers The emergence of nonlinear science appears to be one such revolution In a surprising manner this new science has disclosed a number of misconceptions in our traditional understanding of determinism In particular it has been shown that the notion of predictability according to which the trajectory of a system can be precisely determined if one knows the equations of motion and the initial conditions is related to textbook examples of simple integrable systems This predictability does not extend to nonlinear conservative systems in general Dissipative systems can also show unpredictability provided that the motion is sustained by externally supplied energy and or resources These discoveries and the associated discovery that even relatively simple nonlinear systems can show extremely complex behavior have brought about an unprecedented feeling of common interest among scientists from many different disciplines During the last decade or two we have come to understand that there are universal routes to chaos we have learned about stretching and folding and we have discovered the beautiful fractal geometry underlying chaotic attractors

The Global Geometry of Turbulence Javier Jiménez, 2012-12-06 The aim of this Advanced Research Workshop was to bring together Physicists Applied Mathematicians and Fluid Dynamicists including very specially experimentalists to review the available knowledge on the global structural aspects of turbulent flows with an especial emphasis on open systems and to try to reach a consensus on their possible relationship to recent advances in the understanding of the behaviour of low dimensional dynamical systems and amplitude equations A lot has been learned during recent years on the non equilibrium behaviour of low dimensional dynamical systems including some fluid flows Rayleigh Benard Taylor Couette etc These are mostly closed flows and many of the global structural features of the low dimensional systems have been observed in them including chaotic behaviour period doubling intermit tency etc It has also been shown that some of these flows are intrinsically low dimensional which accounts for much of the observed similarities Open flows seem to be different and experimental observations point to an intrinsic high dimensionality However some of the tran

sitional features of the low dimensional systems have been observed in them specially in the intermittent behaviour of subcritical flows pipes channels boundary layers with suction etc and in the large scale geometry of coherent structures of free shear flows mixing layers jets and wakes

Ordered and Turbulent Patterns in Taylor-Couette Flow C. David Andereck, F. Hayot, 2012-12-06 Seldom does a physical system particularly one as apparently simple as the flow of a Newtonian fluid between concentric rotating cylinders retain the interest of scientists applied mathematicians and engineers for very long Yet as this volume goes to press it has been nearly 70 years since G I Taylor's outstanding experimental and theoretical study of the linear stability of this flow was published and a century since the first experiments were performed on rotating cylinder viscometers Since then the study of this system has progressed enormously but new features of the flow patterns are still being uncovered Interesting variations on the basic system abound Connections with open flows are being made More complex fluids are used in some experiments The vigor of the research going on in this particular example of nonequilibrium systems was very apparent at the NATO Advanced Research Workshop on Ordered and Turbulent Patterns in Taylor Couette Flow held in Columbus Ohio USA May 22-24 1991 A primary goal of this ARW was to bring together those interested in pattern formation in the classic Taylor Couette problem with those looking at variations on the basic system and with those interested in related systems in order to better define the interesting areas for the future the open questions and the features common and not common to closed and open systems This volume contains many of the contributions presented during the workshop

Vortices in Nonlinear Fields Len M. Pismen, 1999 Although natural phenomena can be described by a few simple and symmetric basic laws they exhibit an astounding variety of behaviours This can be explained by a process known as symmetry breaking which can cause an ordered state to form with topological defects The dynamics of further evolution are determined to a large extent by the dynamics of such defects This book covers the structure and dynamics of vortices in a variety of nonlinear field models with spontaneously broken symmetry Point vortices or vortex lines can correspond depending on the physical setting to quantized vortices in superfluids or superconductors dislocations in non equilibrium patterns rotating spiral waves disclinations in liquid crystals singularities in optical fields or strings in relativistic field theories This book is unique in considering vortices in these different settings but also emphasizes the analytical methods that allow an understanding of the common theoretical structure underlying defect dynamics

Soft Order in Physical Systems R. Bruinsma, Y. Rabin, 2012-12-06 A humoristic view of the physics of soft matter which nevertheless has a ring of truth to it is that it is an ill defined subject which deals with ill condensed matter by ill defined methods Although since the Nobel prize was awarded to Pierre Gilles de Gennes this subject can be no longer shrugged away as sludge physics by the physics community it is still not viewed universally as main stream physics While at first glance this may be considered as another example of inertia a case of the establishment against the newcomer the roots of this prejudice are much deeper and can be traced back to Roger Bacon's conception about the objectivity of science All of us would agree with the weaker

form of this idea which simply says that the final results of our work should be phrased in an observer independent way and be communicable to anybody who made the effort to learn this language There exists however a stronger form of this idea according to which the above criteria of objectivity and communicability apply also to the process of scientific inquiry The fact that major progress in the physics of soft matter was made in apparent violation of this approach by applying intuition to problems which appeared to defy rigorous analysis may explain why many physicists feel somewhat ill at ease with this subject

Experimental Chaos - Proceedings Of The 3rd Conference Robert G Harrison, Louis M Pecora, Mark L Spano, Sandeep Vohra, Weiping Lu, William L Ditto, 1996-10-16 This volume the third in our unique series on experimental chaos brings together from a broad range of disciplines some of the exciting developments of the last two years concerned with the observations measurements and applications of nonlinear dynamical behaviour Included are chaos spatio temporal chaos and patterns control of chaos time series analysis and characterization pattern recognitions and signal processing The subjects covered include optics fluids condensed matter astrophysics biological chemical and medical sciences engineering meteorology and oceanography

Instabilities and Nonequilibrium Structures III E. Tirapegui, W. Zeller, 2012-12-06 Proceedings of the 3rd Workshop on Instabilities and Nonequilibrium Structures

Interactive Dynamics of Convection and Solidification S.H. Davis, H.E. Huppert, U. Müller, M.G. Worster, 2012-12-06 The phase transformation from liquid to solid is a phenomenon central to a wide range of manufacturing and natural processes The presence of phase transformation can drive convection in the melt through the liberation of latent heat the rejection of solute and the change of density upon freezing The fluid mechanics itself can play a central role the phase transformation can be strongly altered by convective transport in the liquid through the modification of the thermal and solutal environment of the solid liquid interface these local fields control the freezing characteristics at the interface The convection can be generated naturally by buoyancy forces arising from gradients of temperature and concentration in the liquid by density changes upon freezing and by thermocapillary and solutocapillary forces on liquid solid interfaces The interactive coupling between solidification and convection forms the subject of this volume Such coupled processes are significant on a large range of scales Among the applications of interest are the manufacture of single crystals the processing of surfaces using laser or molecular beams and the processes of soldering and welding One wants to understand and predict macrosegregation in castings transport and fractionation in geological and geophysical systems and heat accumulation in energy redistribution and storage systems This volume contains papers presented at the NATO Advanced Research Workshop on Interactive Dynamics of Convection and Solidification held in Chamonix France March 8-13 1992

Singularities in Fluids, Plasmas and Optics Russel Caflisch, George C. Papanicolaou, 2012-12-06 Singularities in Fluids Plasmas and Optics which contains the proceedings of a NATO Workshop held in Heraklion Greece in July 1992 provides a survey of the state of the art in the analysis and computation of singularities in physical problems drawn from fluid mechanics plasma physics and nonlinear optics The

singularities include curvature singularities on fluid interfaces the onset of turbulence in 3 D inviscid flows focusing singularities for laser beams and magnetic reconnection The highlights of the book include the nonlinear Schrödinger equation for describing laser beam focusing the method of complex variables for the analysis and computation of singularities on fluid interfaces and studies of singularities for the 3 D Euler equations The book is suitable for graduate students and researchers in these areas

Microscopic Aspects of Nonlinearity in Condensed Matter Alan R. Bishop, V.L. Pokrovsky, V. Tognetti, 2012-12-06 Proceedings of a NATO ARW held in Florence Italy June 7 13 1990

Chaos, Order, and Patterns Roberto Artuso, P. Cvitanovic, Giulio Casati, 2012-12-06 Proceedings of a NATO ASI held in Lake Como Italy June 25 July 6 1990

Asymptotics beyond All Orders Harvey Segur, Saleh Tanveer, Herbert J. Levine, 2012-12-06 An asymptotic expansion is a series that provides a sequence of increasingly accurate approximations to a function in a particular limit The formal definition given by Poincaré 1886 Acta Math 8 295 is as follows Given a function

Microscopic Simulations of Complex Hydrodynamic Phenomena Michel Mareschal, Brad Lee Holian, 2013-11-11 This volume contains the proceedings of a NATO Advanced Study Institute which was held in Alghero Sardinia in July 1991 The development of computers in the recent years has led to the emergence of unconventional ideas aiming at solving old problems Among these the possibility of computing directly fluid flows from the trajectories of constituent particles has been much exploited in the last few years lattice gases cellular automata and more generally Molecular Dynamics have been used to reproduce and study complex flows Whether or not these methods may someday compete with more traditional approaches is a question which cannot be answered at the present time it will depend on the new computer architectures as well as on the possibility to develop very simple models to reproduce the most complex phenomena taking place in the approach of fully developed turbulence or plastic flows In any event these molecular methods are already used and sometimes in an applied engineering context to study strong shock waves chemistry induced shocks or motion of dislocations in plastic flows that is in domains where a fully continuum description appears insufficient The main topic of our Institute was the molecular simulations of fluid flows The project to hold this Institute was made three years ago in the summer of 1989 during a NATO workshop in Brussels on the same subject

Chaotic Dynamics T. Bountis, 2012-12-06 Many conferences meetings workshops summer schools and symposia on nonlinear dynamical systems are being organized these days dealing with a great variety of topics and themes classical and quantum theoretical and experimental Some focus on integrability or discuss the mathematical foundations of chaos Others explore the beauty of fractals or examine endless possibilities of applications to problems of physics chemistry biology and other sciences A new scientific discipline has thus emerged with its own distinct philosophical viewpoint and an impressive arsenal of new methods and techniques which may be called Chaotic Dynamics Perhaps its most outstanding achievement so far has been to shed new light on many long standing issues involving complicated irregular or chaotic nonlinear phenomena The concepts of randomness complexity and unpredictability have been critically re examined and the

fundamental importance of scaling self similarity and sensitive dependence on parameters and initial conditions has been firmly established In this NATO ASI held at the seaside Greek city of Patras between July 11 20 1991 a serious effort was made to bring together scientists representing many of the different aspects of Chaotic Dynamics Our main aim was to review recent advances evaluate the current state of the art and identify some of the more promising directions for research in Chaotic Dynamics

Exploiting Symmetry in Applied and Numerical Analysis Eugene L. Allgower, Kurt Georg, Rick Miranda, Symmetry plays an important role in theoretical physics applied analysis classical differential equations and bifurcation theory Although numerical analysis has incorporated aspects of symmetry on an ad hoc basis there is now a growing collection of numerical analysts who are currently attempting to use symmetry groups and representation theory as fundamental tools in their work This book contains the proceedings of an AMS SIAM Summer Seminar in Applied Mathematics held in 1992 at Colorado State University The seminar which drew about 100 scientists from around the world was intended to stimulate the systematic incorporation of symmetry and group theoretical concepts into numerical methods The papers in this volume have been refereed and will not be published elsewhere

Strong resonances of a field of oscillators and defect bifurcation Kjartan Emilsson, 1994-06-01 There are two subjects in this thesis In the first part a qualitative method to classify and predict the structure of defects in reaction diffusion systems is introduced This qualitative approach makes it easier to analyze the behavior of defects in complex systems It also gives us information about the inner structure of the defect and from that point of view it makes it possible to approach the concept of defect bifurcation in a novel manner In the second part we study the normal form governing the evolution of a spatially extended homogeneous temporal instability in the presence of a temporal forcing This is equivalent to studying strong resonances of a field of nonlinear oscillators A detailed analysis of the phase space of this normal form reveals a rich dynamical structure which gives rise to a variety of spatial structures These include excitable pulses excitable spirals fronts and spatially periodic structures These structures are studied and their possible bifurcations are analyzed from a qualitative point of view

From Newton to Chaos Archie E. Roy, B.A. Steves, 2013-06-29 The reader will find in this volume the Proceedings of the NATO Advanced Study Institute held in Cortina d Ampezzo Italy between July 25 and August 6 1993 under the title From Newton to Chaos Modern Techniques for Understanding and Coping With Chaos in N Body Dynamical Systems This institute was the latest in a series of meetings held every three years from 1972 to 1990 in dynamical astronomy theoretical mechanics and celestial mechanics The proceedings from these institutes have been well received in the international community of research workers in these disciplines The present institute was well attended with 15 series of lectures being given by invited speakers in addition some 40 presentations were made by the other participants The majority of these contributions are included in these proceedings The all pervading influence of chaos in dynamical systems of even a few variables has now been universally recognised by researchers a recognition forced on us by our ability using powerful computer hardware and software to tackle

dynamical problems that until twenty five years ago were intractable Doubtless it was felt by many that these new techniques provided a break through in celestial mechanics and its related disciplines And so they were

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