Lecture Notes in Physics

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M. Barthes J. Léon (Eds.)

Nonlinear Coherent Structures

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in Physics, Mechanics, and Biological Systems
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It is a pleasure to aknowledge the **CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE**, the **REGION LANGUEDOC-ROUSSILLON** and the **UNIVERSITE DES SCIENCES ET TECHNIQUES DU LANGUEDOC** which, by providing the workshop with financial support, have contributed to the opportunity of gathering in MONTPELLIER leading figures in both experimental and theoretical physics.

We are grateful to O. ALBERNHE and F. DUCEAU for their active collaboration in the meeting, and to all of our colleagues who helped us in many ways.

Montpellier,
June 1989

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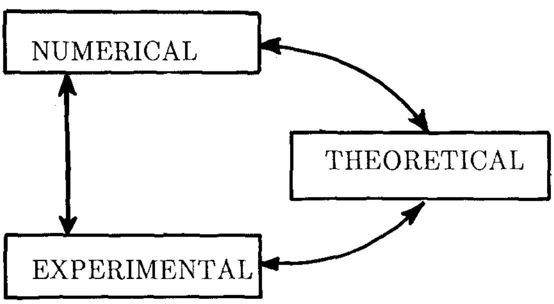
PREFACE

The 1970's were golden years for progress in the mathematical theory of solitons. The relationships between the inverse scattering method, the Bäcklund transformation, and an infinite number of conservation laws for a nonlinear wave equation became understood, and a rather large number (i.e. several dozen) of equations were found to fit into this new picture. It is important that many of these equations had arisen in practice, prior to the development of soliton theory. As the mathematical theory of solitons becomes complete, the applications of that theory to real problems in physics, mechanics, and biology become even more important, and these applications are the subject of the present volume.

In such applications it is important, in my view, that the research include three interacting components: experimental studies, numerical studies and theoretical analysis, as is indicated below.



In the "best of all possible worlds" one would find all three components interacting harmoniously within the same research group, but in our (non-Panglossian) reality this is seldom the case. Thus it is important to encourage effective interactions between numerical, experimental, and theoretical scientists who are separated by institutional and geographic barriers. Such interactions are demonstrated by many of the research studies reported here.

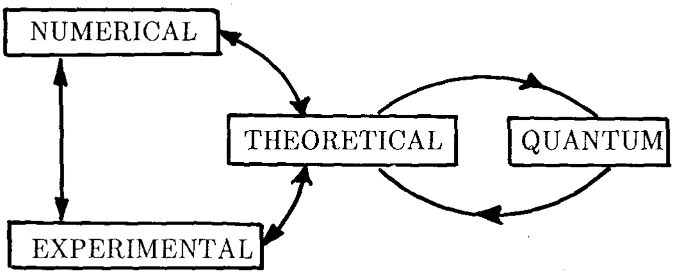
But there are problems to consider. If any one of these three research components gets too far ahead of the others, science suffers. Think of it. We all know of studies that have been too theoretical, too numerical, or even too experimental to be really good science. Also it is important that researchers in nonlinear science have the conviction, often contrary to conventional wisdom, that their research is important. In connection with this point, let me cite some examples.

One of the first scientists to work on the Josephson transmission line was Wayne Johnson who completed his doctoral research in the area twenty-one years ago this summer. When he submitted his results for publication in the Journal of Applied Physics, it was rejected because, according to the referee's report, it had "nothing to do with physics". Papers by Brian Henry on "local modes" in small molecules were similarly rejected in the mid 1970 s as being obviously incorrect. Today nonlinear coherent dynamical structures on the Josephson transmission line and small molecules are fully accepted as interesting and important subjects in applied science.

A similar situation is currently being faced by physical scientists who are studying the possibility of nonlinear coherent structures in biological molecules such as protein and DNA. A recent invited commentary on these efforts appearing in a prestigious journal (which I will not name) referred to such physical scientists as "hijackers". We cannot accept this. There are, in fact, two components of biomolecular dynamics related as indicated below.

(Note the direction of the arrow.) It is the responsibility of physical scientists, under "biophysics", to discover what dynamic effects are possible in biomolecules. As Michel Peyrard has emphasized, this search should not be limited to merely looking for solitons; it should be a broad effort to understand the true nature of the nonlinear dynamics. After this understanding has been achieved, it is the responsibility of the biological scientist to decide which of these effects actually participate in the functions of living organisms. I am happy to see that several examples of such a responsible approach to the study of biomolecular dynamics are included in this volume.

In his opening survey, Michel Remoissonet points out that more work is needed on techniques to detect solitons (especially nontopological solitons) at the microscopic level. This suggests that the "theoretical" activity shown in my first diagram should include quantum effects.



We should not expect much help from the applied mathematicians here. They seem, strangely, unconcerned with such questions. But we can't ignore quantum effects, and the present volume shows that this is not the case.

In summary, this book demonstrates that the study of "nonlinear coherent structures in physics, mechanics, and biological systems" is in a state of healthy growth. Experimental, numerical, and theoretical activities are interacting vigorously in studies of ordered and disordered solid-state systems. The well-established field of fluxon dynamics on the long Josephson junction is still showing new and unexpected phenomena. Finally a corresponding study of biomolecular dynamics seems to be well established. The future of applied soliton research is indeed bright.

Lyngby, Denmark
July 1989

Alwyn Scott

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