Long time dynamics and blow-up for the focusing inhomogeneous nonlinear Schrödinger equation with spatially growing nonlinearity

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ABSTRACT

We investigate the Cauchy problem for the focusing inhomogeneous nonlinear Schrödinger equation $i\partial_t u + \Delta u = -|x|^b |u|^{p-1} u$ in the radial Sobolev space $H_r^1(\mathbb{R}^N)$, where $b > 0$ and $p > 1$. We show the global existence and energy scattering in the intercritical regime, i.e., $p > \frac{N-4+2b}{N}$ and $p < \frac{N+2+2b}{N-2}$ if $N \geq 3$. We also obtain blowing-up solutions for the mass-critical and mass-supercritical nonlinearities. The main difficulty, coming from the spatial growing nonlinearity, is overcome by refined Gagliardo–Nirenberg-type inequalities. Our proofs are based on improved Gagliardo–Nirenberg inequalities, the Morawetz–Sobolev approach of Dodson and Murphy [Proc. Am. Math. Soc. 145(11), 4859–4867 (2017)], radial Sobolev embeddings, and localized virial estimates.

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I. INTRODUCTION

In this paper, we consider the Cauchy problem for the following focusing inhomogeneous nonlinear Schrödinger equation:

$$i\partial_t u + \Delta u = -|x|^b |u|^{p-1} u, \qquad (t,x) \in \mathbb{R}_+ \times \mathbb{R}^N, \tag{1.1}$$

where $b > 0$ and $p > 1$. Equation (1.1) is a special case of a more general inhomogeneous nonlinear Schrödinger equation given by

$$i\partial_t u + \Delta u = -K(x)|u|^{p-1} u, \tag{1.2}$$

which arises in various physical contexts such as the propagation of a laser beam and plasma waves. Here, u is the electric field in laser optics and K is proportional to the electric density. For $p = 3$, Eq. (1.1) can be viewed as a model of dilute Bose–Einstein condensate when the two-body interactions of the condensate are considered.

The Cauchy problem for (1.2) was first investigated by Merle who proves the existence of blow-up solutions in the mass-critical regime and under some assumptions on K including in particular $k_1 \leq K(x) \leq k_2$ with k_1, k_2 being positive constants. Later on, the stability of standing waves was studied in Refs. 7 and 8 for $K(x) = K(\varepsilon|x|)$ with $K \in C^4(\mathbb{R}^N) \cap L^\infty(\mathbb{R}^N)$, $\varepsilon > 0$ small, and $p \geq 1 + \frac{4}{N}$. Recently, the Cauchy problem

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     Long-Time Predictions in Dynamics V.G. Szebehely,B.D. Tapley,2012-12-06 Proceedings of the NATO Advanced Study Institute Cortina D Ampezzo Italy August 3 16 1975   **Vibro-impact Dynamics** Albert C. J. Luo,Yu Guo,2013-01-25 Presents a systematic view of vibro impact dynamics based on the nonlinear dynamics analysis Comprehensive understanding of any vibro impact system is critically impeded by the lack of analytical tools viable for properly characterizing grazing bifurcation The authors establish vibro impact dynamics as a subset of the theory of discontinuous systems thus enabling all vibro impact systems to be explored and characterized for applications Vibro impact Dynamics presents an original theoretical way of analyzing the behavior of vibro impact dynamics that can be extended to discontinuous dynamics All topics are logically integrated to allow for vibro impact dynamics the central theme to be presented It provides a unified treatment on the topic with a sound theoretical base that is applicable to both continuous and discrete systems Vibro impact Dynamics Presents mapping dynamics to determine bifurcation and chaos in vibro impact systems Offers two simple vibro impact systems with comprehensive physical interpretation of complex motions Uses the theory for discontinuous dynamical systems on time varying domains to investigate the Fermi oscillator Essential reading for graduate students university professors researchers and scientists in mechanical engineering   Nonlinear Dynamics of the Lithosphere and Earthquake Prediction Vladimir Keilis-Borok,Alexandre A. Soloviev,2013-03-14 The vulnerability of our civilization to earthquakes is rapidly growing rais ing earthquakes to the ranks of major threats faced by humankind Earth quake prediction is necessary to reduce that threat by undertaking disaster preparedness measures This is one of the critically urgent problems whose solution requires fundamental research At the same time prediction is a ma jor tool of basic science a source of heuristic constraints and the final test of theories This volume summarizes the state of the art in earthquake prediction Its following aspects are considered Existing prediction algorithms and the quality of predictions they pro vide Application of such predictions for damage reduction given their current accuracy so far limited Fundamental understanding of the lithosphere gained in earthquake prediction research Emerging possibilities for major improvements of earthquake prediction methods Potential implications for predicting other disasters besides earthquakes Methodologies At the heart of the research described here is the inte gration of three methodologies phenomenological analysis of observations universal models of complex systems such as those considered in statistical physics and nonlinear dynamics and Earth specific models of tectonic fault networks In addition the theory of optimal control is used to link earthquake prediction with earthquake preparedness   Regular and Chaotic Motions in Dynamic Systems A. S. Wightman,2013-06-29 The fifth International School Mathematical Physics was held at the Ettore Majorana Centro della Culture Scientifica Erice Sicily 2 to 14 July 1983 The present volume collects lecture notes on the session which was devoted to Regular and Chaotic Motions in Dynamlcal Systems The School was a NATO Advanced Study Institute sponsored by the Italian Ministry of Public Education

the Italian Ministry of Scientific and Technological Research and the Regional Sicilian Government Many of the fundamental problems of this subject go back to Poincare and have been recognized in recent years as being of basic importance in a variety of physical contexts stability of orbits in accelerators and in plasma and galactic dynamics occurrence of chaotic motions in the excitations of solids etc This period of intense interest on the part of physicists followed nearly a half a century of neglect in which research in the subject was almost entirely carried out by mathematicians It is an in dication of the difficulty of some of the problems involved that even after a century we do not have anything like a satisfactory solution

   Literature 1976, Part 1 S. Böhme,U. Esser,W. Fricke,U. Güntzel-Lingner,I. Heinrich,F. Henn,D. Krahn,L. D. Schmadel,H. Scholl,G. Zech,2013-11-11 Astronomy and Astrophysics Abstracts which has appeared in semi annual volumes since 1969 is de voted to the recording summarizing and indexing of astronomical publications throughout the world It is prepared under the auspices of the International Astronomical Union according to a resolution adopted at the 14th General Assembly in 1970 Astronomy and Astrophysics Abstracts aims to present a comprehensive documentation of literature in all fields of astronomy and astrophysics Every effort will be made to ensure that the averagetime interval between the date of receipt of the original literature and publication ofthe abstracts will not exceed eight months This time interval is near to that achieved by monthly abstracting journals com pared to which our system of accumulating abstracts for about six months offers the advantage of greater convenience for the user Volume 17 contains literature published in 1976 and received before August 15 1976 some older literature which was received late and which is not recorded in earlier volumes is also included We acknowledge with thanks contributions to this volume by Dr J Bouska who surveyed journals and publications in the Czech languageand supplied us with abstracts in English and by the Common wealth Scientific and Industrial Research Organization C S I R O Sydney for providing titles and abstracts of papers on radio astronomy We want to acknowledge valuable contributions to this vol ume by Zentralstelle fur Atomkernenergie Dokumentation Leopoldshafen which supported our ab stracting service by sending us retrospective literature searches   Nonlinear Dynamics, Chaotic and Complex Systems Eryk Infeld,R. Zelazny,A. Galkowski,1997-06-19 The physics and mathematics of nonlinear dynamics chaotic and complex systems constitute some of the most fascinating developments of late twentieth century science It turns out that chaotic bahaviour can be understood and even utilized to a far greater degree than had been suspected Surprisingly universal constants have been discovered The implications have changed our understanding of important phenomena in physics biology chemistry economics medicine and numerous other fields of human endeavor In this book two dozen scientists and mathematicians who were deeply involved in the nonlinear revolution cover most of the basic aspects of the field   **Deep Learning in Multi-step Prediction of Chaotic Dynamics** Matteo Sangiorgio,Fabio Dercole,Giorgio Guariso,2022-02-14 The book represents the first attempt to systematically deal with the use of deep neural networks to forecast chaotic time series Differently from most of the current literature it implements a multi step approach i e the forecast of an entire interval of future values This is relevant for many

applications such as model predictive control that requires predicting the values for the whole receding horizon Going progressively from deterministic models with different degrees of complexity and chaoticity to noisy systems and then to real world cases the book compares the performances of various neural network architectures feed forward and recurrent It also introduces an innovative and powerful approach for training recurrent structures specific for sequence to sequence tasks The book also presents one of the first attempts in the context of environmental time series forecasting of applying transfer learning techniques such as domain adaptation *Hamiltonian Dynamical Systems* R.S MacKay,J.D Meiss,2020-08-18 Classical mechanics is a subject that is teeming with life However most of the interesting results are scattered around in the specialist literature which means that potential readers may be somewhat discouraged by the effort required to obtain them Addressing this situation Hamiltonian Dynamical Systems includes some of the most significant papers in Hamiltonian dynamics published during the last 60 years The book covers bifurcation of periodic orbits the break up of invariant tori chaotic behavior in hyperbolic systems and the intricacies of real systems that contain coexisting order and chaos It begins with an introductory survey of the subjects to help readers appreciate the underlying themes that unite an apparently diverse collection of articles The book concludes with a selection of papers on applications including in celestial mechanics plasma physics chemistry accelerator physics fluid mechanics and solid state mechanics and contains an extensive bibliography The book provides a worthy introduction to the subject for anyone with an undergraduate background in physics or mathematics and an indispensable reference work for researchers and graduate students interested in any aspect of classical mechanics

Navier-Stokes Predictions of Dynamic Stability Derivatives James DeSpirito,Sidra I. Silton,Paul Weinacht,2008 The prediction of the dynamic stability derivatives roll damping Magnus and pitch damping moments were evaluated for three spin stabilized projectiles using steady state computational fluid dynamic CFD calculations Roll damping CFD predictions were found to be very good across the Mach number range investigated Magnus moment predictions were very good in the supersonic flight regime however the accuracy varied in the subsonic and transonic flight regime The best Magnus moment prediction in the subsonic flight regime was for the square base projectile that did not exhibit highly nonlinear Magnus moments A primary contribution of this report is the demonstration that the pitch damping moment can be adequately predicted via steady state methods rather than resorting to unsteady techniques The predicted pitch damping moment compared very well to experimental data for the three projectiles investigated For one configuration the pitch damping moment was predicted by several CFD codes two different steady state methods and a time accurate planar pitching motion method All methods compared very well to each other and to the experimental data **Nonlinear Dynamics And Chaos: Proceedings Of The Fourth Physics Summer School** Robert L Dewar,B I Henry,1992-01-24 Articles in this collection discuss basic concepts and modern developments in the field Suitable for both theorists and experimentalists

Machinery, Materials Science and Engineering Applications Fei Lei,Qiang Xu,Guangde Zhang,2017-03-31 This

conference proceeding contains papers presented at the 6th International Conference on Machinery Materials Science and Engineering Applications MMSE 2016 held 28 30 October 2016 in Wuhan China The conference proceeding contributions cover a large number of topics both theoretical and applied including Material science Electrical Engineering and Automation Control Electronic Engineering Applied Mechanics Mechanical Engineering Aerospace Science and Technology Computer Science and Information technology and other related engineering topics MMSE provides a perfect platform for scientists and engineering researchers to exchange ideas build cooperative relationships and discuss the latest scientific achievements MMSE will be of interest for academics and professionals working in a wide range of industrial governmental and academic sectors including Material Science Electrical and Electronic Engineering Information Technology and Telecommunications Civil Engineering Energy Production Manufacturing Mechanical Engineering Nuclear Engineering Transportation and Aerospace Science and Technology **The Dynamical Behaviour of our Planetary System** Rudolf Dvorak,Jacques Henrard,2012-12-06 It is now a well established tradition that every four years at the end of winter a group of celestial mechanicians from all over the world gather at the Alpen gasthof Peter Rosegger in the Styrian Alps Ramsau Austria This time the colloquium was held from March 17 to March 23 1996 and was devoted to the Dynamical Behaviour of our Planetary System The papers covered a large range of questions of current interest theoretical questions re nances universal properties non integrability transport and questions about numerical tools symplectic maps indicators of chaos were particularly well represented the never ending problem of the sculpting of the asteroid belt was also qui te popular You will find in the following pages a pot pourri of what we listen to you will miss of course the diversity of accents with which the tunes were delivered from China from Japan from Brazil from the United States of America and from all over Europe East and West Let us not forget that the comet 199682 Hyakutake came to visit us many an evening was spent on the deck of the Alpengasthof contemplating this celestial visitor who liked to play hide and seek behind the spruce trees *The Basis of Atmospheric Mesoscale Dynamics and a Dynamical Method of Predicting Rainstorms* Shouting Gao,Lingkun Ran,Xiaofan Li,2021-07-28 This book serves to deepen the theoretical understanding of mesoscale dynamics and makes its basic concepts clear reflecting new research results It emphasizes important theories that have not been given enough attention in recent years such as generalized potential temperature and the moist potential vorticity theory of non uniform saturated moist atmospheres By integrating theory with practice the book also introduces the forecast method of rainstorms and other disastrous weathers using dynamic factors This book can be used as a point of reference for operational forecasters researchers and graduate and undergraduate students whose research interests are atmospheric sciences and ocean and water sciences It will also be of interest to scholars who study geological disasters such as multiphase flow mountains debris flows and landslides as well as geological seismologists Data-Driven Modeling & Scientific Computation J. Nathan Kutz,2013-08-08 The burgeoning field of data analysis is expanding at an incredible pace due to the proliferation of data

collection in almost every area of science The enormous data sets now routinely encountered in the sciences provide an incentive to develop mathematical techniques and computational algorithms that help synthesize interpret and give meaning to the data in the context of its scientific setting A specific aim of this book is to integrate standard scientific computing methods with data analysis By doing so it brings together in a self consistent fashion the key ideas from statistics time frequency analysis and low dimensional reductions The blend of these ideas provides meaningful insight into the data sets one is faced with in every scientific subject today including those generated from complex dynamical systems This is a particularly exciting field and much of the final part of the book is driven by intuitive examples from it showing how the three areas can be used in combination to give critical insight into the fundamental workings of various problems Data Driven Modeling and Scientific Computation is a survey of practical numerical solution techniques for ordinary and partial differential equations as well as algorithms for data manipulation and analysis Emphasis is on the implementation of numerical schemes to practical problems in the engineering biological and physical sciences An accessible introductory to advanced text this book fully integrates MATLAB and its versatile and high level programming functionality while bringing together computational and data skills for both undergraduate and graduate students in scientific computing *Variational Methods in Geosciences* Y.K. Sasaki,2012-12-02 The last few decades have seen a spectacular growth in the use of variational methods one of the most classic and elegant methods in physical and mathematical sciences as powerful tools of optimization and numerical analysis The tremendous accumulation of information on the use of variational methods in the area of the geosciences which includes meteorology oceanography hydrology geophysics and seismology indicated the need for the first symposium on Variational Methods in Geosciences to be organized and held in Norman on October 15 17 1985 The value of this symposium was enhanced by the number of stimulating and informative papers presented Computer Supported Cooperative Work and Social Computing Yuqing Sun,Tun Lu,Tong Wang,Hongfei Fan,Dongning Liu,Bowen Du,2024-01-04 This two volume set constitutes the revised selected papers of the 18th CCF Conference on Computer Supported Cooperative Work and Social Computing ChineseCSCW 2023 held in Harbin China in August 2023 The 54 full papers and 28 short papers presented in these proceedings were carefully reviewed and selected from 221 submissions The papers are organized in the following topical sections Social Media and Online Communities Collaborative Mechanisms Models Approaches Algorithms and Systems Crowd Intelligence and Crowd Cooperative Computing Cooperative Evolutionary Computation and Human like Intelligent Collaboration Domain Specific Collaborative Applications Advances in Neural Networks – ISNN 2016 Long Cheng,Qingshan Liu,Andrey Ronzhin,2016-07-01 This book constitutes the refereed proceedings of the 13th International Symposium on Neural Networks ISNN 2016 held in St Petersburg Russia in July 2016 The 84 revised full papers presented in this volume were carefully reviewed and selected from 104 submissions The papers cover many topics of neural network related research including signal and image processing dynamical behaviors of recurrent neural networks intelligent control

clustering classification modeling and forecasting evolutionary computation and cognition computation and spiking neural networks **Applied Symbolic Dynamics And Chaos (Second Edition)** Hao Bailin,Zheng Wei-mou,2018-05-11 Symbolic dynamics is a coarse grained description of dynamics It has been a long studied chapter of the mathematical theory of dynamical systems but its abstract formulation has kept many practitioners of physical sciences and engineering from appreciating its simplicity beauty and power At the same time symbolic dynamics provides almost the only rigorous way to understand global systematics of periodic and especially chaotic motion in dynamical systems In a sense everyone who enters the field of chaotic dynamics should begin with the study of symbolic dynamics However this has not been an easy task for non mathematicians On one hand the method of symbolic dynamics has been developed to such an extent that it may well become a practical tool in studying chaotic dynamics both on computers and in laboratories On the other hand most of the existing literature on symbolic dynamics is mathematics oriented This book is an attempt at partially filling up this apparent gap by emphasizing the applied aspects of symbolic dynamics without mathematical rigor Contents Preface to the Second Edition Preface to the First Edition Introduction Symbolic Dynamics of Unimodal Maps Maps with Multiple Critical Points Symbolic Dynamics of Circle Maps Symbolic Dynamics of Two Dimensional Maps Application to Ordinary Differential Equations Counting the Number of Periodic Orbits Symbolic Dynamics and Grammatical Complexity Symbolic Dynamics and Knot Theory Appendix References Index Readership Researchers and students interested in chaotic dynamics Keywords Symbolic Dynamics ChaosReview Key Features No previous knowledge of dynamical systems theory is required in order to read this book The revisions concern mainly the application to ordinary differential equations via constructing two dimensional symbolic dynamics of the corresponding Poincare maps Data-Driven Science and Engineering Steven L. Brunton,J. Nathan Kutz,2022-05-05 A textbook covering data science and machine learning methods for modelling and control in engineering and science with Python and MATLAB **Automation 2022: New Solutions and Technologies for Automation, Robotics and Measurement Techniques** Roman Szewczyk,Cezary Zieliński,Małgorzata Kaliczyńska,2022-04-15 This book presents the unique result of discussion among interdisciplinary specialists facing recent industrial and economic challenges It contains papers authored by both scientists and practitioners focused on an interdisciplinary approach to developing measuring techniques robotic and mechatronic systems industrial automation numerical modelling and simulation and application of artificial intelligence techniques required by the transformation leading to Industry 4 0 We strongly believe that the solutions and guidelines presented in this book will be useful to both researchers and engineers facing problems associated with developing cyber physical systems for global development

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