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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 $H^1_r(\mathbb{R}^N)$, where $b > 0$ and $p > 1$. We show the global existence and energy scattering in the intercritical regime, i.e., $p > 1 + \frac{2+2b}{N}$ 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:

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

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.[1,2] 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.[3,4]

The Cauchy problem for (1.2) was first investigated by Merle[5] 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 $K \in C^3(\mathbb{R}^N) \cap L^\infty(\mathbb{R}^N)$, $\varepsilon > 0$ small, and $p \geq 1 + \frac{2}{N}$. Recently, the Cauchy problem

Long Time Predicton In Dynamics

S. Böhme,U. Esser,W. Fricke,U. Güntzel-Lingner,I. Heinrich,F. Henn,D. Krahn,L. D. Schmadel,H. Scholl,G. Zech

Long Time Predicton In Dynamics:

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 The Dynamics of Vehicles on Roads and Tracks Martin Rosenberger,Manfred Plöchl,Klaus Six,Johannes Edelmann,2016-03-30 The IAVSD Symposium is the leading international conference in the field of ground vehicle dynamics bringing together scientists and engineers from academia and industry The biennial IAVSD symposia have been held in internationally renowned locations In 2015 the 24th Symposium of the International Association for Vehicle

System Dynamics IAVSD **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 *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 **Applied Symbolic Dynamics and Chaos** Bai-lin Hao,Wei-Mou Zheng,1998 Symbolic dynamics is a coarse grained description of dynamics It provides a rigorous way to understand the global systematics of periodic and chaotic motion in a system In the last decade it has been applied to nonlinear systems described by one and two dimensional maps as well as by ordinary differential equations This book will help practitioners in nonlinear science and engineering to master that powerful tool *Understanding and Predicting the Gulf of Mexico Ocean Dynamics*

Julio Sheinbaum,Eric Chassignet,Steven L. Morey,Ruoying He,2024-04-08 For the past several years a number of research programs have funded significant efforts to advance understanding of and forecasting capabilities for the Gulf of Mexico circulation including the Loop Current its associated eddies and abyssal dynamics One such program is the National Academies Understanding Gulf Ocean Systems initiative which focuses on improving forecasts of the physical dynamics of the open Gulf of Mexico in space and time scales useful for the reduction of risks to offshore energy exploration and production as well as for other challenges such as forecasting hurricane intensification and managing fisheries What has been learned how can this scientific progress be incorporated into operational models and what are the remaining gaps in knowledge impeding predictive skill *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 **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 **Theoretical Approaches to Biological Control** Bradford A. Hawkins,Howard V. Cornell,2008-10-14 Biological control is the suppression of pest populations using predators parasitoids and pathogens Historically biological control has largely been on a trial and error basis and has failed more often than it has succeeded However by developing theories based upon fundamental population principles and the biological characteristics of the pest and agent we can gain a much better understanding of when and how to use biological control This book gathers together recent theoretical developments and provides a balanced guide to the important issues that need to be considered in applying ecological theory to biological control It will be a source of productive and stimulating thought for all those interested in pest management theoretical ecology and population biology *Production Technology for Deep Reservoirs* Yan Peng,Yishan Liu,Hongyan Qu,Feng Dong,Jiehao Wang,2024-11-28 Underground energy is important for the whole society development but conventional underground energy is becoming exhausted The energy for deep reservoirs usually 3500m for petroleum engineering 1000m for mining engineering is diverse including not limited shale gas oil tight gas oil hot dry rock geothermal reservoirs and coal gasification Although it has abundant reserves the energy production from deep reservoirs is difficult in stimulations because the geological conditions for those deep reservoirs are tougher than those for conventional reservoirs such as high in situ stress obvious heterogeneity in rock properties and complex natural fracture networks Meanwhile common technologies also have environmental impacts The development trend of production technology for deep reservoirs requires it to be environment friendly or decrease environmental impacts at least CO2 utilization may achieve this environmental aim In order to efficiently produce energy from deep reservoirs technological innovation is booming around North America Europe and Asia 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 **Time Series Modeling of Neuroscience Data** Tohru Ozaki,2012-01-26 Recent advances in brain science measurement technology have given researchers access to very large scale time series data such as EEG MEG data 20 to 100 dimensional and fMRI 140 000 dimensional data To analyze such massive data efficient computational and statistical methods are required Time Series Modeling of Neuroscience Data shows how to Comprehensive Biotechnology ,2019-07-17 Comprehensive Biotechnology Third Edition

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of the essential mathematics necessary to unlock the mysteries of the natural world *The Transition to Chaos* Linda Reichl,2013-11-11 Based on courses given at the universities of Texas in Austin and California in San Diego this book deals with the basic mechanisms that determine the dynamic evolution of classical and quantum systems It presents in as simple a manner as possible the basic mechanisms that determine the dynamical evolution of both classical and quantum systems in sufficient generality to include quantum phenomena The book begins with a discussion of Noether s theorem integrability KAM theory and a definition of chaotic behavior it continues with a detailed discussion of area preserving maps integrable quantum systems spectral properties path integrals and periodically driven systems and it concludes by showing how to apply the ideas to stochastic systems The presentation is complete and self contained appendices provide much of the needed mathematical background and there are extensive references to the current literature Problems at the ends of chapters help students clarify their understanding In this new edition the presentation will be brought up to date throughout and a new chapter on open quantum systems will be added *Link Travel Time Prediction for Dynamic Route Guidance in Vehicular Traffic Networks* Karl Eric Wunderlich,1994

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