

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

Cite as: J. Math. Phys. 64, 081509 (2023); doi: 10.1063/5.0143716

Submitted: 25 January 2023 • Accepted: 17 July 2023 •

Published Online: 18 August 2023



Van Duong Dinh,^{1,2} Mohamed Majdoub,^{3,4} and Tarek Saanouni^{3,4,5}

AFFILIATIONS

¹École Normale Supérieure de Lyon & CNRS, UMPA (UMR 5069), Lyon, France
and Department of Mathematics, HCMC University of Education, 280 An Duong Vuong, Ho Chi Minh City, Vietnam

²Department of Mathematics, College of Science, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam, Saudi Arabia and Basic and Applied Scientific Research Center, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, 31441 Dammam, Saudi Arabia

³Department of Mathematics, College of Sciences and Arts of Uqailat Asugout, Qassim University, Buraydah, Saudi Arabia

⁴E-mail: contact@vduongdinh.com

⁵E-mail: mmajdoub@iau.edu.sa

⁶Author to whom correspondence should be addressed: t.saanouni@qu.edu.sa

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

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

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

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

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

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.

The Cauchy problem for (1.2) was first investigated by Merle³ 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 $K(x) = K(|x|)$ with $K \in C^2(\mathbb{R}^N) \cap L^\infty(\mathbb{R}^N)$, $\epsilon > 0$ small, and $p \geq 1 + \frac{2}{N}$. Recently, the Cauchy problem

Long Time Prediction In Dynamics

**Martin Rosenberger, Manfred
Plöchl, Klaus Six, Johannes Edelmann**



Long Time Prediction 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 **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 raising 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 major 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 provide 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 integration 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

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 **Deep**

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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 behaviour 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 Hamiltonian Dynamical Systems R.S MacKay, J.D Meiss, 2020-08-17 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

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 devoted 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

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Advanced Technologies in Flow Dynamics and Combustion in Propulsion and Power Lei Luo, Bengt Aake Sundén, Songtao Wang, Xiao Liu, 2022-08-05 *Dynamic Meteorology* S. Panchev, 2012-12-06 1

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