Lecture Course: Nonlinear Schrödinger Equations

3 hours (ECTS 5.0)

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Time: Wed 16.30-17.50 and Thu 16.30-17.50

Lecture room: C 714, Nordbergsstr. 15, Fak. Mathematik ("Green tower")

Starting: Thursday. March 10, 2011, Contact : mauser@courant.nyu.edu

NLS are a fascinating class of partial differential equations, occurring in a variety of applications. They present hard problems both for "pure mathematicians" and for "applied mathematicians". *We show how involved it is to answer the elementary questions: Does a solution exist ? Is it unique ? Does it exist for large times ? Can I calculate solutions ? Can I trust the curves the computer produces ? How do one particle NLS approximate the linear many particle Schrödinger equation ?*

We address both mathematicians, physicists, chemists, astronomers, … and focus on basic problems and methods for analytical treatment of time dependent NLS and the connection of mathematical theory to physical modeling, with emphasis on quantum dynamics. Starting from this combination we present and discuss methods of numerical simulations and present/discuss also simulations that show the wealth of complexity of solutions of NLS.

Contents:

Analysis: Existence and uniqueness of solutions of NLS with local and non-local nonlinearity, scattering, finite blow-up, asymptotic analysis for the semi-classical limit,…

Modeling: Motivation / derivation of NLS models in quantum dynamics incl. Time Dependent Density Functional Theory, (MC)TDH(F), models for Bose Einstein condensates, NLS models in nonlinear optics, …

Numerics: Time splitting spectral methods, relaxation schemes, …, validation of simulation results, boundary conditions : periodic / zero BC, absorbing / inflow BC