MA16-066 - Schrödinger Equations for QUantum EXperiments (SEQUEX)

Abstract

We develop improved mathematical models & numerical techniques for time dependent Schrödinger equations (SEs) describing dynamical quantum systems used in the experiments of 3 groups at the Atom-Institut Wien. We deal both with linear SEs for 1-2 boson systems and nonlinear "effective 1-particle" Schrödinger equations as mean field approximations in a hierarchy of models approximating the exact linear many particle Schrödinger equation. One has to go beyond simple models with a single deterministic Gross Pitaevskii equation (GPE) that cannot capture phenomena like correlation, decoherence, thermalization, quantum noise,... that are observed in state-of-the-art experiments. In particular we deal with systems of coupled GPEs and MCTDHB as well as "stochastic" SEs. We also use "optimal control theory" as a mathematical technique proven useful for designing experiments. Our goal are efficient simulation codes (on parallel supercomputers (VSC3)). The project core team consists of a specialist on Schrödinger equations and 2 experimental quantum physicists (all WPI full members via START, Wittgenstein, ERC awards, etc.) PI: N. J. Mauser, J. Schmiedmayer, T. Schumm. The project team also includes an additional senior experimentalist: A. Rauschenbeutel, a senior theoretical/numerical physicist specialist on OCT: U. Hohenester (University of Graz), and 3 senior postdocs: I. Mazets (theoretical physics) (WPI c/o ATI) K. Sakmann (theoretical/numerical physics) (ATI) H.P. Stimming (appl. math) (WPI c/o University of Vienna). The 2 Postdocs and the PhD student funded by the project will work on numerical techniques and simulations, in direct contact with the physicists.

Scientific disciplines:
Numerical mathematics (50%) | Quantum mechanics (30%) | Experimental physics (20%)

Keywords:
Schrödinger equation, Gross Pitaevskii equation, stochastic Schrödinger equation, MCTDH, optimal control

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Further links to the persons involved and to the project can be found under
https://wwtf.at/funding/programmes/past/ma/MA16-066/