Title of the course:

The Schrödinger equation – modelling and numerics (6 lectures)

Lecturer:

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Period: first week

Abstract

The central theme of this course deals with the presentation of several numerical schemes for the discretization of the linear/non-linear Schrödinger equation in various application fields.

The non-linear Schrödinger equation furnishes a general model permitting to describe, briefly speaking, wave propagation in non-linear media. This equation (in its several different forms) arises in apparently rather different fields of application, such as quantum mechanics, nanotechnology, non-linear optics, hydrodynamics, plasma physics, biology and so on. It permits to capture the physics of some stimulating non-linear phenomena and has its specific mathematical and numerical difficulties and curiosities, this being the reason why the Schrödinger equation has had and still has more than its share of attention in the scientific community. All this shall be specified in a few words in the introduction of this course and we shall pick up in the next lessons some typical applications and behaviours of the Schrödinger equation, to investigate it.

Six lectures:

1) Introduction/Motivation (occurrence of the NLSE);

2) Introduction of the concept of multi-scale problem and numerical scheme;

3) The stationary, linear Schrödinger equation in the semi-classical regime (semi-conductor devices);

4) The time-dependent, linear Schrödinger equation in an anisotropic two-dynamics framework (phenomenon of decoherence);

5) The cubic non-linear Schrödinger equation / Gross-Pitaevskii equation (Bose-Einstein condensate);

6) Some other highly anisotropic models for the particle transport.