Light coupling to light: nonlinear interactions in semiconductor microlasers

Abstract

Lasers are present in our daily live appliances, like in CD players and bar code readers in the supermarket. This might suggest that the physics of lasers is nowadays completely understood. Recently developed microlasers, however, remain a challenge for conventional laser theory. These ultrasmall lasers produce coherent light with the help of a resonator that can trap and amplify light on a scale of just a few micrometers. The way light bounces around in these tiny resonators is so complex that it is very difficult to predict in which direction and at which color the laser is actually going to shine. Yet for any practical application it is important to understand and control this intricate behavior. We therefore propose to establish a new theoretical framework for microlasers, which can capture their complicated physics with the help of techniques that applied mathematicians have developed over many years. We will implement this novel framework in a computer program and run it on very large computing facilities to obtain accurate predictions for microlasers. These results will be compared with real measurements that we plan to carry out in the laboratory. From such a comparison we expect to get new insights into the complicated physics of microlasers and ideas for how to design them in a new and improved way.

Keywords:

Microlasers, numerical simulation, finite element and boundary element methods, Helmholtz equation, nonlinear differential equations, interactions of light, spatial hole burning

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Further links about the involved persons and regarding the project you can find at
https://archiv.wwtf.at/programmes/mathematics/MA09-030