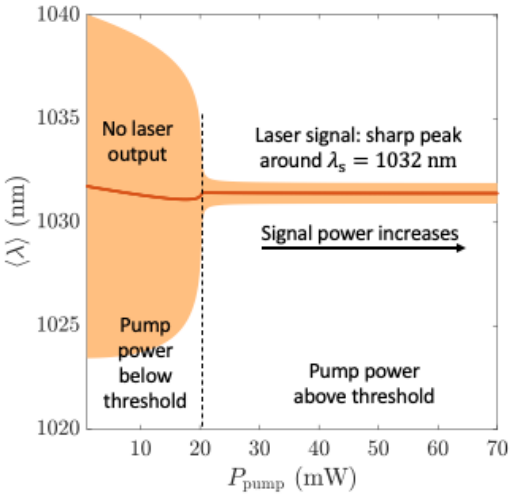
Modeling of strongly pumped fiber lasers and applications

Bakgrund: Fiber lasers have emerged as a versatile tool with diverse applications in research and technology. These lasers use optical fibers as the gain medium, allowing for a compact and efficient design. In research, fiber lasers have proven invaluable due to their precise and high-quality beam characteristics, making them ideal for applications in fields such as spectroscopy, medical diagnostics, and material processing. Their ability to generate high-intensity, coherent light has also made them essential tools in telecommunications, e.g., for transmitting data over long distances. Furthermore, they are employed for cutting, welding, and marking a wide range of materials. Fiber lasers represent a powerful and versatile technology that is essential in various scientific and industrial domains.



Problembeskrivning: This project aims at studying numerically the model of strongly pumped fiber lasers and utilize it for specific applications. We will start from the laser rate equations and implement an exact numerical solution by finite differences under the assumption that le laser is in the steady state. Then, we will use the code for the numerical solution in combination with a specific physics scenario, which will be discussed with the students: the focus can be on a specific application where a fiber laser is utilized (such as, for example, intracavity optical trapping) or on the investigation of the effects on the solution due to changes in the properties of the fiber itself.

Arbetssätt: This study will start with building the code for a numerical solution for the laser rate equations describing a strongly pumped fiber laser under the assumption of steady state. Then, we will use the code in the investigation of a physics scenario agreed with the students.
Numerical simulations can be in any suitable programming language. A reference code is available in Matlab (but the students will have to build their code themselves in the initial weeks). Prerequisites: some experience in programming. Knowledge of numerical solutions by finite differences helps. The thesis and presentation can be in Swedish.

Gruppstorlek: 3-6 studenter.

Målgrupp: F, GU-fysik, TM, E, Z, D, IT eller motsvarande.

Litteraturtips:
(1) I. Kelson and A. A. Hardy, “Strongly pumped fiber lasers,” IEEE J. Quantum Electron 34, 1570–1577 (1998) and references cited therein [for the model definition and laser rate equations]
(2) Kalantarifard, F., Elahi, P., Makey, G. et al. Intracavity optical trapping of microscopic particles in a ring-cavity fiber laser. Nat Commun 10, 2683 (2019). [example application]

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