SCIENCES SORBONNE UNIVERSITÉ

Master thesis proposal

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Director: Massimiliano Marangolo

Title: Design and Calculation of Phase Grating with Specific Diffraction Efficiency

Keywords: lasers, phase gratings, spectroscopy

Scientific description: The objective of this master's level internship is to investigate the design and computational modeling of a phase grating capable of splitting an incoming laser beam into two specific diffraction orders, +1 and -1, with targeted efficiencies of 33% for each order. This project will offer students an opportunity to apply theoretical concepts of optics, diffraction, and computational methods to a practical engineering challenge, contributing to the development of optical components in fields such as telecommunications, spectroscopy, and laser-based systems.

Background:

Phase gratings are widely used in optical systems to control the diffraction of light. In contrast to amplitude gratings, phase gratings offer higher efficiency by modulating the phase rather than the amplitude of the light wave. A well-designed phase grating can split a beam with minimal loss and direct energy into specific diffraction orders, making it highly useful in applications requiring precise beam steering and power distribution. In this project, the goal is to design a binary or multi-level phase grating that equally distributes laser power into the +1 and -1 diffraction orders, each receiving maximum of the incident beam's energy.

Project Scope: The intern will be responsible for performing the following tasks:

1. **Literature Review**: Understanding the principles of diffraction, phase gratings, and Fourier optics, with a focus on techniques to maximize efficiency in the desired diffraction orders.
2. **Theoretical Modeling**: Using mathematical tools such as Fourier analysis and the grating equation, the intern will develop models to predict the diffraction behavior of different grating structures. These models will involve parameters such as grating period, depth, and duty cycle. The intern will employ computational tools such as MATLAB, Python, or commercial optical design software (e.g., COMSOL, Zemax) to simulate the performance of the designed gratings.
3. **Experimental Validation (Optional)**: If feasible, the intern may have the opportunity to fabricate the designed grating using photolithography or other available techniques and validate the design through optical testing.

Applicant skills: Strong Foundation in Optics and Photonics, experience with computational tools such as MATLAB, Python

Industrial partnership: N

Possibility for a Doctoral thesis: N

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