Nonlinear Optics – Instruction Notes

Keywords: Nd:YAG, KTP crystal, diode laser, second – harmonic generation, electric susceptibility

I. GOALS OF THE EXPERIMENT

Nonlinear optical effects are consequences of the modification of the optical properties of a material induced by the interaction with light of sufficient intensity as lasers.

This experiment will provide insights into the modern laser technology as well as an introduction to nonlinear optics. For this purpose, a diode-laser-pumped Nd:YAG laser is assembled. Its infrared output is frequency doubled with an optically nonlinear crystal (KTP) to give green light. Furthermore, by introducing a saturable absorber (LiF_2), the quality factor of the resonator can be changed as function of the intensity, and thus the laser can be pulsed (Q-switch).

A substantial part of this experiment concerns the handling and the adjustment of the optical components. In addition to this, the students have the opportunity to learn how to use some optical measuring devices (power meters, wavelength meters).

II. LEARNING CONTENT

- laser theory
- optical resonators
- semiconductor lasers (operation, types)
- Nd:YAG laser (continuous and pulsed operation, pumping)
- nonlinear optics (frequency mixing processes, optical parametric amplifier, saturable absorber)
- optical detectors: power and wavelength measurements
- laser safety

III. PROCEDURE

FIRST LAB SESSION

- initial operation of the diode laser, function of the control unit, examination of the beam with laser safety goggles and indicator card, insertion and adjustment of the collimator, wavelength measurement, power measurement with power meter and photodiode
- determine the laser threshold IS and laser characteristics (I, T), P (I, T)
- I and T for constant output power at different wavelengths
- determine the emission lifetime of the Nd:YAG laser

SECOND LAB SESSION

- assemble and adjust the Nd:YAG laser with 2% mirror in different modes
- determine the power of the Nd:YAG laser for different wavelengths at a specific pump power
- determine the power of the Nd:YAG laser for different pump powers
- set up and adjust the Nd:YAG laser with 0.02% mirror
- incorporate the KTP crystal and adjust the frequency-doubled laser
- determine the power of the frequency-doubled output as a function of the power of the Nd:YAG laser

IV. REFERENCES:

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