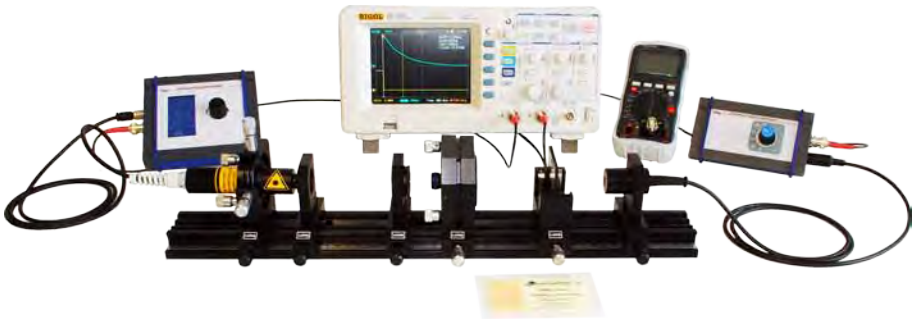
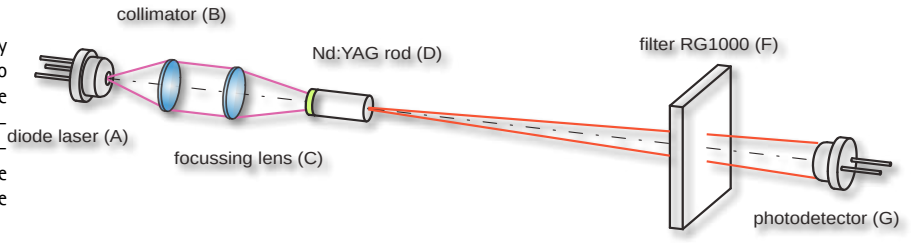
P5853 Emission and Absorption (Optical Pumping)

- ✓ *Diode laser*
- ✓ *Nd:YAG crystal*
- ✓ *Optical pumping*
- ✓ *Absorption spectra*
- ✓ *Lifetime of excited states*
- ✓ *Einstein coefficients*

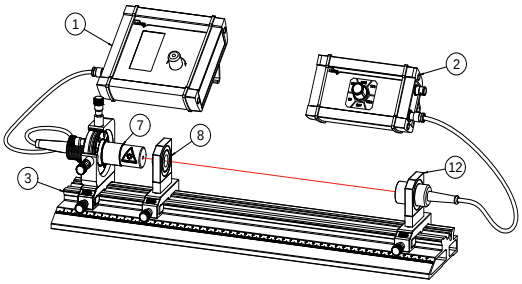


Principle of operation

The radiation of the diode laser is focused by means of the collimator(B) and lens (C) into the Nd:YAG rod (D). The filter (F) absorbs the residual pump light and transmits the stimulated emission. The relative intensity is measured by the photodetector (G). Without the filter the transmission or absorption of the pump light is measured.

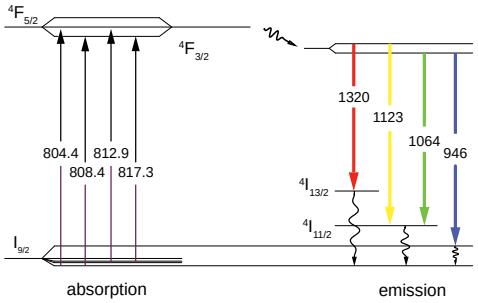


Examples of investigation and measurement



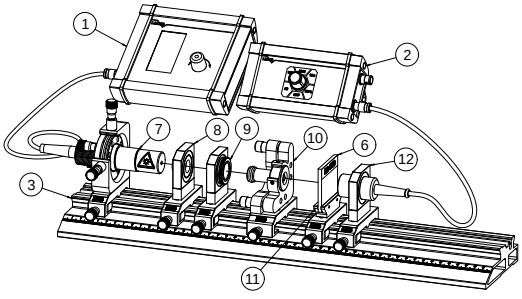
Characterization of the diode laser

In a basic set-up the characteristic parameters of the laser diode are measured. The diode laser is mounted into a housing (9) in contact with a Peltier element to control the temperature. The full digitally controller (2) sets and maintains the value for injection current, temperature and modulation frequency of the diode laser (9). The characteristic data of the diode laser is measured in relative units. For this purpose the signal conditioner (3) is used. The photodiode (14) is connected to this box where the input impedance can be selected. The output is available at a BNC connector for further connection to an oscilloscope or multimeter. The collimator (9) is used to set the beam divergence in such a way that the photodetector will not be saturated.



Absorption and Emission

The relevant energy levels of Nd:YAG for optical pumping with laser diodes having wavelengths around 805 nm. Some energy levels of the Nd atom are illustrated in the figure shown on the left. Here, only those are shown which are important for optical pumping with laser diodes. The levels are labelled with their spectroscopic notations. Since the Nd atoms are situated within the YAG host crystal, the otherwise degenerated energy levels of the isolated Nd atom split into a number of states.
This gives rise to the ground state $^4I_{9/2}$ from 5 sub-states and the state $^4F_{5/2}$, which can be pumped from 5 sub-states. Since the wavelength of the pump-light source (diode laser) can vary within low limits, a total of three to four transitions can be pumped with high efficiency.



Optical pumping and spectroscopy

To the previous set-up the focussing lens (10) and the Nd:YAG rod (11) with its holder are added. The transmission spectrum of the laser diode radiation is measured by changing the temperature and therewith the emission wavelength. By means of the well known absorption lines the emission wavelength of the laser diode can be determined exactly. Adding the filter RG1000 (7) in front of the detector blocks the diode laser radiation and the fluorescence caused by optical pumping can be measured as function of the pump laser wavelength (temperature). At the maximum of the fluorescence emission the modulation of the diode laser is activated and the timely response displayed on an oscilloscope. From this curve the mean lief time of the exited laser state of the Nd:YAG material can be derived which inverse value represents the important Einstein coefficient for spontaneous emission.

P5853 Emission & Absorption / Optical Pumping consisting of:

Item	Qty	Description
1	1	Digital diode laser controller
2	1	Photodetector signal conditioning box
3	1	Profile rail MG-65, 500 mm
4	1	Crossed hair target mounted in holder 25 mm
5	1	Infrared display card, spectral range 0.8 -1.6 µm
6	1	RG1000 Coloured glass filter 50x50x4 mm
7	1	Module A - Diode laser head, adjustment holder
8	1	Module B - Collimating optics on carrier MG-65
9	1	Module C - Focussing optics, f=60 mm
10	1	Module D - Adjustment holder with Nd:YAG rod
11	1	Module F - Filter plate holder
12	1	Module G - SiPIN photodetector
Required Options:		
	1	BNC-Banana adapter connection leads 2 x 4 mm
	1	Digital multimeter 3 1/2 digits
Options:		
	1	Oscilloscope 100 MHz digital, two channel