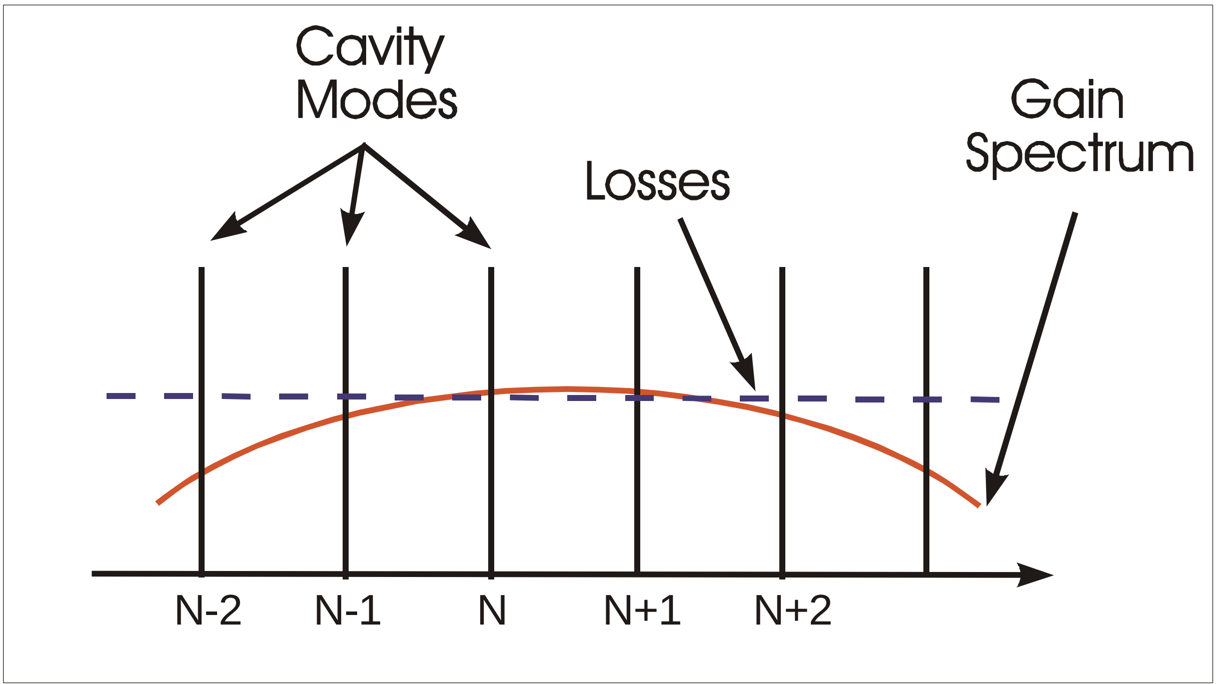
Technical Note – No. 15



Cavity Modes of External Cavity Diode Lasers

The emission frequency of Fabry Perot Lasers Systems are determined by the laser modes. Formally, the laser modes are described as the Eigenfrequencies of the laser cavity. Each laser mode can be described by the number of the wave-knots within the laser cavity which gives the mode number N. Typical mode numbers are in the order of N=4,000 for a diode laser and between N=10,000 and N=100,000 for external cavity diode lasers. The laser emits with the mode with the highest effective gain. A modehop is the change of the laser emission from mode N to N+/-ΔN, where ΔN is an integer.

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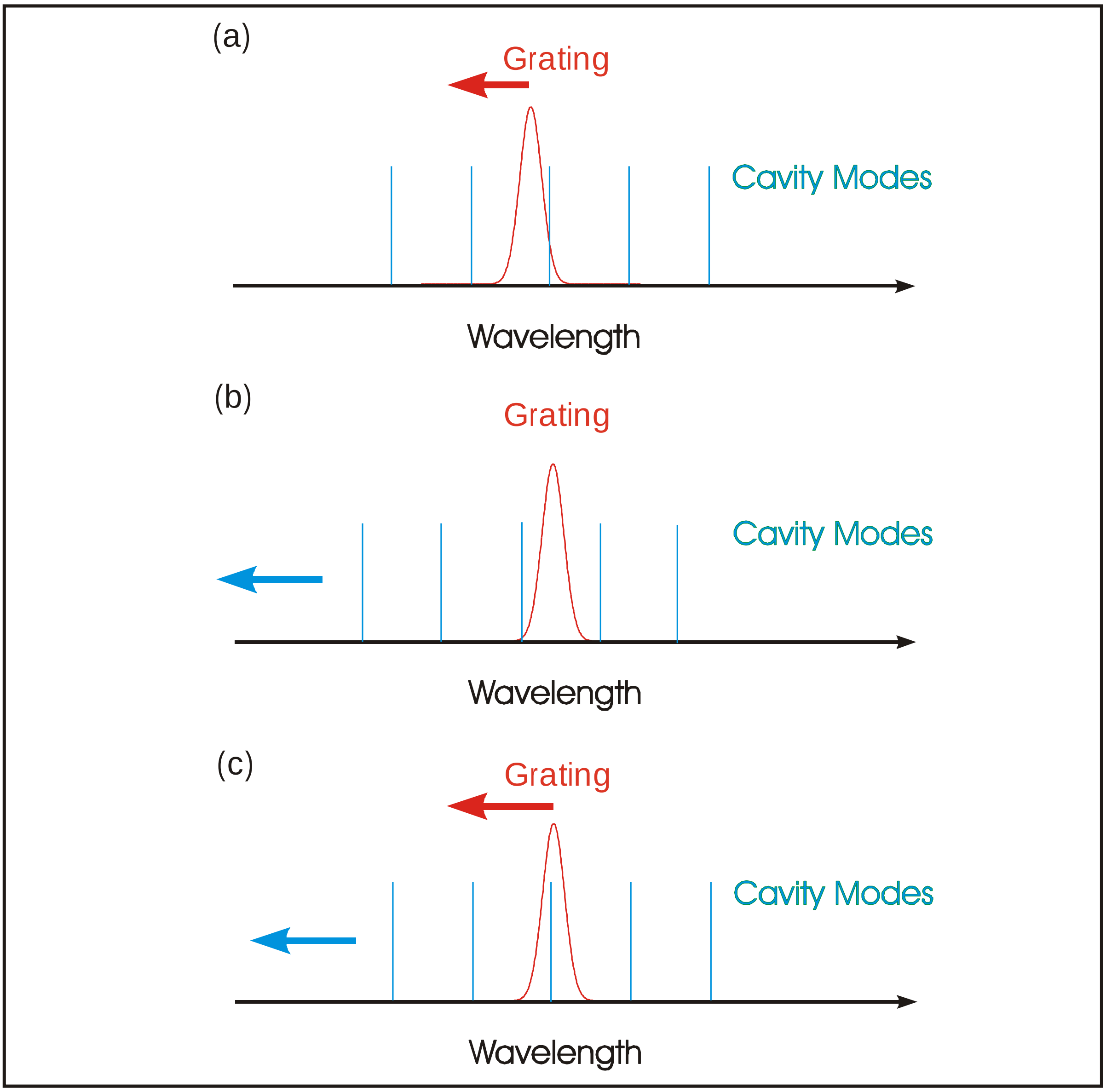
Modehops of External Cavity Diode Lasers



External cavity diode lasers are laser systems which are determined by two frequency determining elements. The first element is the laser cavity. The second element is the laser grating which acts as a frequency filter. A modehop arises if both frequency determining elements are not synchronized. There are three different cases to be distinguished:

(a) Only the laser grating is tuned and the cavity length remains constant.
(b) Only the cavity length is changed and the grating angle remains constant.
(c) The laser grating and the cavity length are tuned in a synchronized mode. Only this method of tuning results in a modehop-free tuning behavior.

Sacher Lasertechnik laser systems are designed for a perfect synchronization between grating frequency and cavity modes, US Patent No.: 5,867,512.

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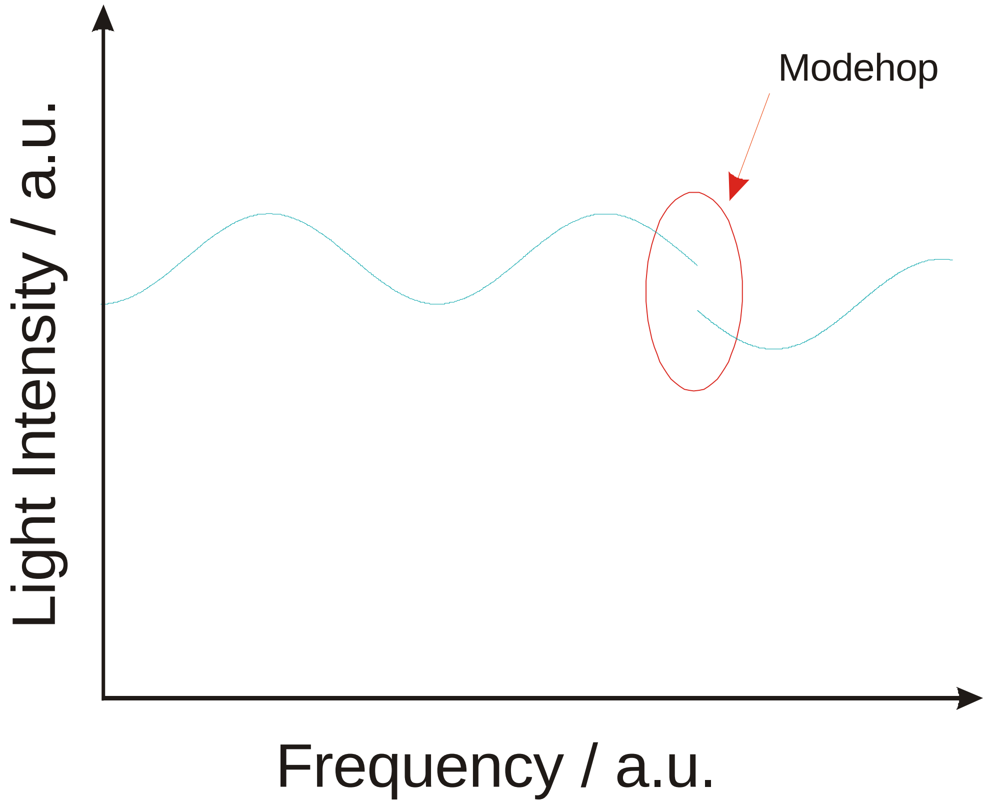
Modehop induced Change of the Output Power of External Cavity Diode Lasers



The output power of a diode laser is determined by different parameters as the laser gain, the waveguide losses and the mirror losses. A mismatching between the laser cavity and the laser grating causes increased losses and therefore a reduced output power. In case of a modehop, the laser mode changes e.g. from a mode with higher losses to a mode with lower losses. Therefore, a modehop is always associated with a sudden discontinuous change in the output power during a wavelength scan.

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Several ways of determining a modehop during a wavelength scan

(a) Fabry Perot Interferometer Method
The laser system is monitored with a Fabry Perot interferometer during a wavelength scan. A modehop can be identified by a sudden, discontinuous change of the wavelength relative to the scanning parameter. A typical scanning parameter for external cavity diode lasers is the applied piezo voltage.

(b) Wavemeter Method
The laser system is monitored with a wavemeter. A modehop is indicated by an error signal shown at the wavemeter.

(c) Output Power Method
The laser system is monitored with a power meter during a wavelength scan. A modehop can be identified by a sudden, discontinuous change of the output power relative to the scanning parameter. A typical scanning parameter for external cavity diode lasers is the applied piezo voltage.

All three methods are easy to apply. The less cost effective method is method (c). This method can be easily realized with the Sacher Lasertechnik laser controller. It is only necessary to connect an oscilloscope to the time base of our laser driver unit and to monitor the emitted output power. As long as there is a smooth power curve displayed at the oscilloscope, the laser system is operating modehop-free. If there are sudden changes or jumps visible in the output power trace, a modehop appears.

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