

# Lichtausbreitung in Glasfasern

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## Zur Vorbereitung

- Modes in optical fibers, LP (linearly polarized modes), single mode and multimode fibers, fiber couplers, coupled modes in optical waveguides.

## Durchführung

- **Fiber modes**

List of equipment:

HeNe laser (JDSU, 632.8 nm); SMF-28 fiber with integrated coupling lens; web camera and PC

Experimental procedure:

Build a set-up as it is indicated in Fig. 1. The laser output beam is directed to the fiber end equipped with collimating lens and the intensity of propagating modes is visualized (and recorded) by the CCD camera connected to the computer.

We use a standard SMF-28 fiber which has a cut-off wavelength at 1260 nm. Therefore, by coupling a laser radiation of shorter wavelength (in this case 632.8 nm) which is well above cut-off frequency, higher order modes can be easily excited. The coupling efficiency (the ratio between laser output and coupled into the fiber radiation power) is not important here, so you can excite higher modes simply by adjusting angle and position of the laser beam as well as bending the fiber. Try to obtain at least three out of four allowed modes ( $LP_{01}$ ,  $LP_{11}$ ,  $LP_{21}$ ,  $LP_{02}$ ).

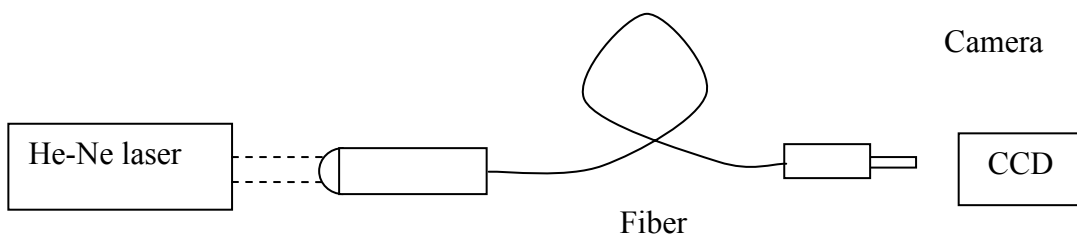


Fig. 1. Set-up for visual observation of fiber modes in multimode optical fiber.

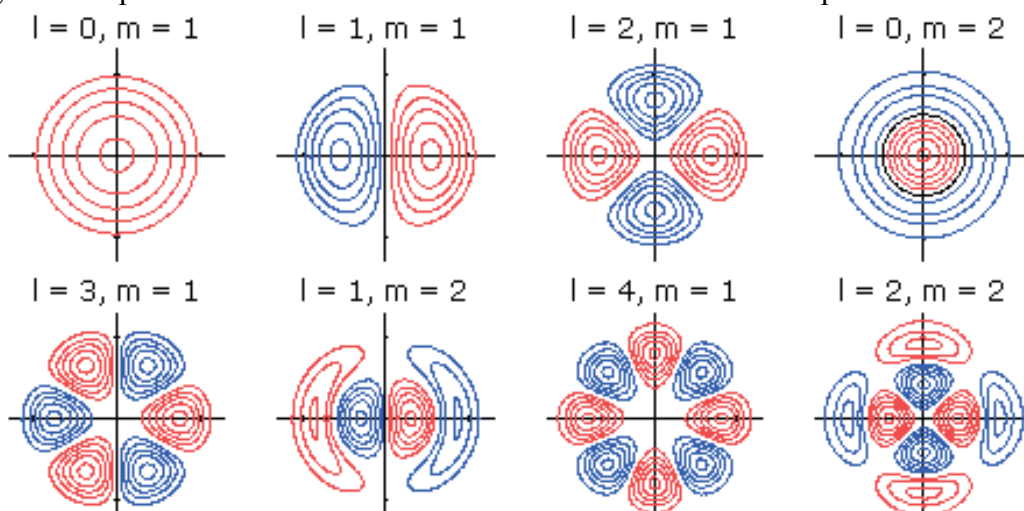


Fig. 2. Field distribution for several LP modes.

- **Light coupling and splitting experiments**

List of equipment:

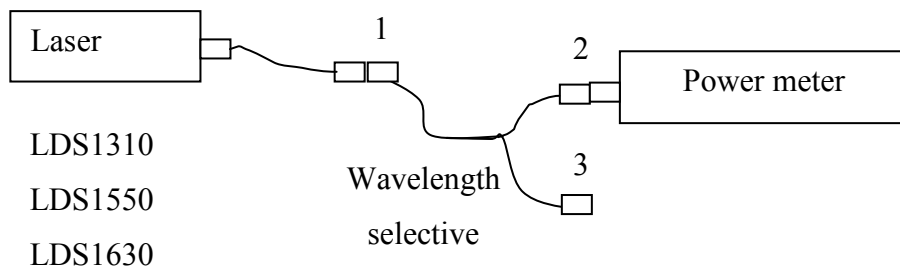
Lasers LDS1550 (1550 nm), LDS1630 (1630 nm) and LDS1310 (1310 nm);

Fiber patch cord, 2x2 fiber coupler, 1x2 wavelength selective fiber coupler

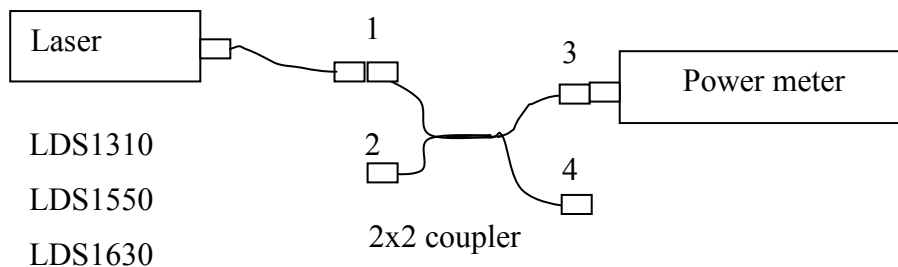
Power meter

Experimental procedure:

**A.** First attach the fiber patch to the laser and measure the output power with the power meter. Note the ratio between the set value and registered output value. When insert the wavelength selective fiber coupler and measure signals at its both outputs. Evaluate the signal discrimination (in dB) between outputs as well as connection loss. Repeat same measurements using all three lasers.



**B.** Now characterize the 2x2 coupler. Select one input and measure output amplitudes on both ends as well as power at the complimentary input. Evaluate input connector loss and output splitting ratio for different outputs. Repeat the measurement by coupling to complimentary input connector. Perform measurements with all three lasers.



**Besondere Hinweise zum Versuch**

- Please keep attention that all lasers are of class 3. Do not stare in the outputs of fiber couplers and keep unused outputs closed during whole experiment time.

## **Material zur Vorbereitung**

### **Empfohlene Literatur**

K. Okamoto, *Fundamentals of optical waveguides*. Amsterdam; Boston: Elsevier, 2006.

H.-G. Unger and U. Unrau, *Optische Wellenleiter*. Heidelberg: Hüthig, 1990.