

# Abstract

Two femtosecond laser pulse shaper schemes are presented, which are capable of simultaneous and independent phase, amplitude, and polarization manipulation of femtosecond pulses. The first setup enables independent manipulation over the major axis orientation and the axis ratio of the polarization ellipse. This is accomplished by integrating a 4f-shaper setup in both arms of a Mach-Zehnder interferometer and rotating the polarization by  $90^\circ$  in one of the arms before overlaying the beams. The generated pulses are resolved in a simple and intuitive detection scheme. The second setup is based on using a two pass configuration through a spatial light modulator and thereby effectively utilizing four liquid crystal arrays. This approach grants control over the femtosecond pulse phase, amplitude, and limited control over polarization, but without facing the issues of interferometric stability. This second shaper setup is used in a coherent control experiment, where the ionization process of the NaK molecule is optimized.

In the last part of this thesis a pump probe experiment is presented that shows wavepacket oscillation of ultracold rubidium molecules.