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Carotenoids and Life, Femtoseconds and Light

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Summary

This thesis consists of eight chapters. The first describes the author's personal opinion on the general place of biophysics, femtosecond spectroscopy and photosynthesis in the context of natural science. The second chapter is a theoretical introduction to the spectroscopic techniques used in works described in the rest of the thesis. It includes a brief summary of spectroscopic properties of carotenoids. The third chapter describes transient absorption experiments performed on carotenoid-phthalocyanine dyads, investigating energy transfer from phthalocyanine to carotenoids of various lengths. The results suggest the existence of excitonic couplings between dark states of carotenoids and excited states of phthalocyanine. The fourth chapter is dedicated to a wavelength modulation approach to the femtosecond stimulated Raman experiment as a way to reduce undesired background signal. This includes the measurement of time resolved vibrational dynamics of β -carotene after excitation by blue light. The fifth chapter extends the study of molecules described in the third chapter for the study of the reverse process: carotenoid to phthalocyanine energy transfer. The energy transfer efficiency was discovered to be strongly dependent on the excessive vibrational energy. Additionally it was discovered that this effects can be masked by the subsequent dynamics of lower lying excited states. The sixth chapter describes a theoretical study of the inner filter effect as a source of artifacts in femtosecond stimulated Raman experiments. The seventh chapter is focused on the examination of a femtosecond stimulated Raman experiment performed in collinear geometry actinically pumped from the side. The goal of this approach is to achieve a higher signal gain and thus facilitate more sensitive femtosecond Raman experiments. Chapter eight proposes a two-dimensional Raman experiment based on interaction of two narrowband picosecond pulses and one broadband femtosecond pulse. The approach was also experimentally tested on a solution of β -carotene.