Title: Study of protein structure and dynamics by means of optical spectroscopy

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Abstract: The aim of this thesis is to improve understanding of protein structure and dynamics and extend experimental setup and data processing for such studies. We focus on the extension of experimental feasability of vibrational optical activity (VOA). We have demonstrated a usability of intensity calibration in the field of Raman optical activity. Advantages for measurements on multiple instruments and/or using different configurations have been shown. A new instrumental setup has been developed for microsampling measurements of vibrational circular dichroism spectra with a spatial resolution of 1 mm. Using this technique, spatial inhomogeneities in a sample of protein fibrils have been observed. Model compounds for amide nonplanarity have been investigated utilizing several methods of optical spectroscopy and key spectral features for determination of amide nonplanarity and the absolute configuration have been identified. A comprehensive set of Raman spectra of proteinogenic amino acids has been measured. Sample concentration dependencies and consequent phase transitions have been identified and discussed. Decision rules for two-dimensional correlation analysis (2DCoS) have been extended to bisignate spectra. 2DCoS for model VOA (bisignate) spectra have been computed and analysed. A process of protein oligomerization has been studied utilizing vibrational spectroscopy and 2DCoS. Differences in behaviour of two phenotypes of human haptoglobin have been studied using hetero-sample 2DCoS. Dynamics of α_1-acid glycoprotein and its complex with a ligand has been investigated using Raman spectroscopy and principal component analysis. Differences in behaviour of both systems have been identified and discussed. Process of protein fibrillation in H_2O/D_2O has been investigated using vibrational circular dichroism and bands arising from amide I vibrations have been identified.

Keywords: two-dimensional correlation analysis, peptides and proteins, vibrational optical activity, structure and dynamics