Project 3.4. Ultrafast chemical reactions in the dark

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ICP PAS Group: Dynamics of light-induced bimolecular reactions.

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Background:

Most of the knowledge acquired about the early events around chemical reactivity comes from photochemistry. This means that the best studied chemical reactions are photo-induced, meaning, triggered by light and happening in metastable excited electronic states. This way most of the physical knowledge and theories of chemical reactivity are based on this kind of experiments. However, most of chemical reactions are thermally activated, happen in the absence of photo-triggering. Current developed technologies in our Laser Center allow for dreaming about studying these dark reactions with a very good time resolution, i.e., in the sub-picosecond time scale. The technique is based on the Raman effect, which provides structural information of the sample. In order to trigger the reaction an infrared short pulse induces an increase of vibrational energy of the reactants, enough to alter the chemical equilibrium in the solution. The relaxation of the vibrationally excited molecules is followed by means of the Raman scattering, which shows the evolutions of concentration of all substrates and products of the reaction studied., The set-up is currently completed, although the presented idea needs to be tested. In addition to this technique the student will have access to several other ultrafast measurements of optical transient absorption and fluorescence. A comparison of dark and photo-induced reactions using these latter would reveal the peculiarities of the reactions in the excited electronic states.

Aim:

To develop an experimental method and analysis of ultrafast reactions not photo-induced. At the end of the thesis knowledge should have been acquired about how to experimentally study fast chemical processes in the electronic ground state. In addition to that an analysis methodology to interpret the Raman data of this kind of experiments should have been developed. In the ideal case, the study should provide with the ability to predict when a ground state reaction will be ultrafast.

Requirements:

- Master in Physics or Chemistry,
- the preference will be given to those candidates who graduated with specialization in Optics or Laser Spectroscopy,
- Good command of English.