

Getting control over the rates and products of chemical reactions has always been a chemist's dream. There are many ways to speed up a given reaction, which usually also leads to increased yield: change of temperature, pressure, solvent parameters (polarity, viscosity). Yet another approach – on which photochemistry is based – involves excitation to a higher electronic state, in which a molecule can have completely different properties.

In recent years, a new research area is being intensely developed. It involves changing chemical reactivity by placing molecules in so-called photonic cavities: small volume elements of micro- or nanometer dimensions. These systems consist of, e.g., two closely-spaced parallel mirrors, which transmit only certain radiation wavelengths. If the wavelength corresponds to the energy of a molecular transition, efficient mixing of radiation and matter states occurs. Such interaction is called strong coupling, and the resulting state was named a polariton. It is predicted that the chemistry of polaritonic systems may be completely different from the chemistry of “normal” molecules.

We plan to investigate, in the strong coupling regime, the basic chemical reactions: proton and electron transfer. The objects of interest include molecules previously studied by us, of which the reactivity is well-known. The experiments will be based on the measurements of absorption, emission, and scattering of light and IR radiation by molecules placed in cavities. Observation of significant changes in reactivity under such conditions may have strong impact on further development, not only in the area of chemical synthesis, but also in spectroscopy, photophysics or materials science.