Physikalisches Institut
Albert-Ludwigs-Universität Freiburg
Molekül- und Nanophysik
Prof. Frank Stienkemeier

BSc/MSc thesis

at the University of Freiburg

in the field of **High-resolution spectroscopy of molecules and clusters**

The project aims at investigating interactions between excited organic molecules used for photovoltaic applications. Such interactions and collective effects (singlet fission, exciton annihilation, superradiance) can only occur when several molecules are in close vicinity to each other and have the potential to greatly enhance or decrease the efficiency of organic photovoltaic cells and the operation of other optoelectronic devices. To study such collective effects of organic molecules, we attach molecules to rare gas clusters or Helium nanodroplets. Those clusters or droplets serve as a cold substrate for the study of molecules and their interactions with each other and allow to control the number of molecules interacting. The ensemble of molecules on the surface of the cluster are excited by nanosecond or femtosecond laser pulses. Quantum dynamical processes like singlet fission (creation of two low-energy triplet excitations from on high-energy singlet excitation) or superradiance (coherent spontaneous emission) are studied. These effects lead to changes of excitation lifetimes and quantum yields, which are crucial parameters in organic photovoltaics and optoelectronic devices. We are investigating those effects by Laser-induced fluorescence (absorption) spectroscopy, emission spectroscopy and time-correlated single photon counting. In collaboration with theoretical groups the excitation dynamics and energetics of these ensembles of organic molecules can be revealed. Alternative detection schemes like photoionization, enabling the detection of optically dark states, are being implemented.

We are looking for highly-motivated students, to work in experimental molecular physics. Joining this project would involve working on a high-vacuum setup, ultrafast or high-resolution laser systems, pulsed cluster sources, mass spectrometry, automated data acquisition, signal processing and various detection techniques.

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