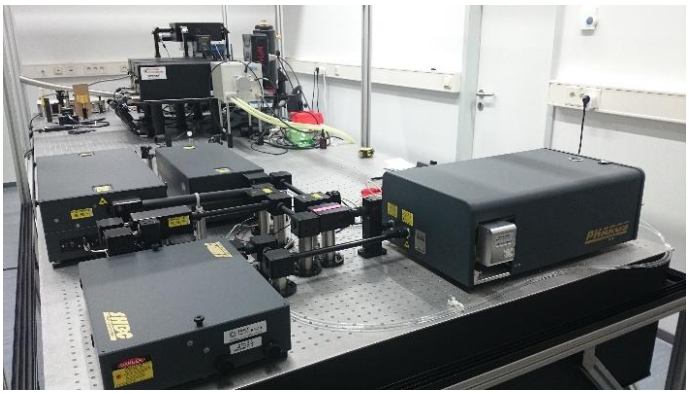
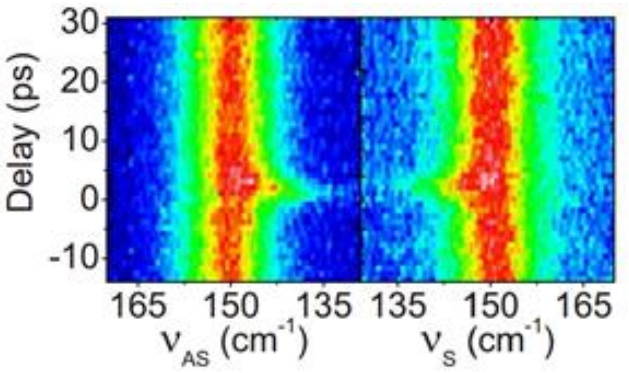
Bachelor/Master project: Time Resolved Raman Spectroscopy of Correlated Materials

The Optical Condensed Matter Physics group at the II. Physikalisches Institut of the University of Cologne is looking for a highly motivated bachelor or master Physics student interested in participating in our Time Resolved Raman project. After participation in the buildup phase you will be involved in the first experiments *on time-and-momentum dependent quasiparticle scattering*. During your project you will be able to work with our state-of-the-art LightConversion femtosecond amplified laser system, and work on a cutting edge time-resolved spectroscopy technique: *Time-resolved Spontaneous Raman Scattering*.

Complex materials show a strong interplay between different degrees of freedom. This interplay gives rise to a variety of novel ground states and excitations. Raman spectroscopy allows us to measure these excitations and determine the symmetry of the probed ground state. Various attempts have been made to upscale the Raman technique into a time-resolved version, but until now it has only found limited use in studying strongly correlated matter. The TiReRa experiment is designed to fill this gap and will be used to study symmetry changes following optically induced phase transitions, probing quasiparticle population statistics of unconventional ground states on few-picosecond timescales, and address fundamental questions regarding angular momentum transfer in complex materials.

In order to be able to selectively probe low-lying excitations such as electromagnons in multiferroics or Cooper-pair breaking in superconductors (Saichu et al.), we designed a setup which utilizes small bandwidth few-picosecond pulses, generated by the LightConversion PicoSecond Optical Parametric Amplifier (OPA), combined with a double subtractive spectrometer. Selective optical excitation is realized by means of a FemtoSecond OPA.





Left: Our new TiReRa laser lab. Right: Photoinduced phase transition in Antimony observed with time-resolved Raman scattering. (Fausti et al.)

After the buildup phase you will be involved in the first series of experiments focusing on *time-and momentum-dependent scattering of fundamental excitations*. By probing the 2-phonon and 2-magnon peak in GaAs and MnF_2 respectively, one can disentangle the phonon/magnon quasiparticle distribution in **k**-space (momentum space). The time-resolved version of this experiment allows us to probe momentum dependent quasiparticle scattering and redistribution after perturbation of the electronic structure.

For more information contact Prof. Dr. Paul H.M. Van Loosdrecht (pvl@ph2.uni-koeln.de)

(D. Fausti et al.) *Ultrafast photoinduced structure phase transition in antimony single crystals*, PRB **80**, 2009
(R.P. Saichu et al.) *Two-Component Dynamics of the Order Parameter of High Temperature $Bi_2Sr_2CaCu_2O_{8+\delta}$ Superconductors Revealed by Time-Resolved Raman Scattering*,PRL **10,** 2009
(K.Kang et al.) *Lifetimes of optical phonons in graphene and graphite by time-resolved incoherent anti-Stokes Raman scattering*, PRB **81,** 2010
Website of LightConversion: http://www.lightcon.com