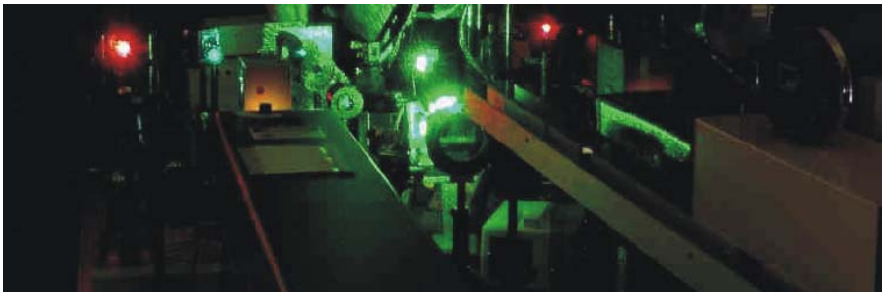
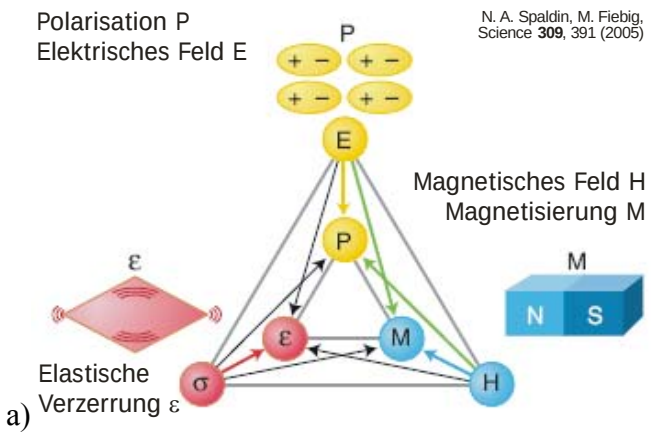
## Spectroscopy of local correlations and molecular systems
## Group: Prof. Dr. Peter Lemmens and Dr. Pushpendra Kumar

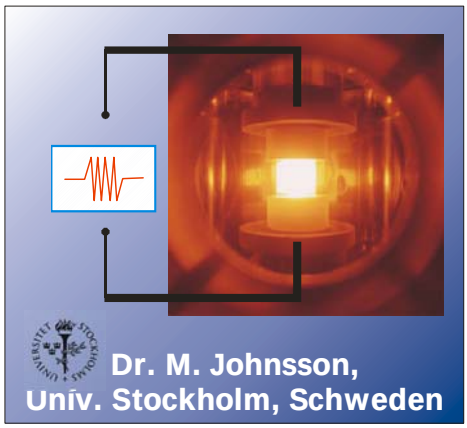
The properties of molecular and electronically correlated materials depend strongly on external fields and interactions. This is valid for the bulk but even more at interfaces and on nanoscales. Colossal effects in the resistivity and the dielectric constant can be used in sensors and information technology. An important condition for any application is a microscopic understanding and optimization of properties. With this respect we investigate single molecules and composites with nanoscale components and modify the systems by doping, photo-doping, pressure and by changing the interfaces.



Our experimental techniques are Light scattering (also nanosoptics), ultrasound spectroscopy and preparation of composites and nanoporous systems with small length scales. Especially the last activity involves intensive collaborations with other groups.



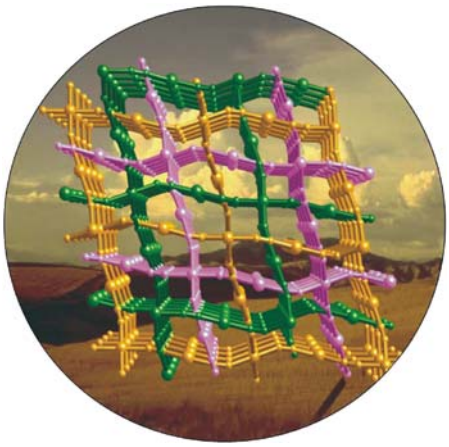

a)




b)

In functional materials with **multiferroic properties** the dielectric, elastic, and magnetic properties are mutually coupled. Such materials are interesting, e.g. for future storage technologies. Presently intrinsic compounds, composites and thin film systems compete with respect to largest coupling constants.

**Plasma spark sintering** uses pressure and a short current pulse to sinter nanoscale powders from different ferromagnetic/dielectric components. This leads to enormous interfaces that allow a coupling of the properties. Virtually any material combinations can be realized. The characterization is performed via magnetization and dielectric measurements.



Angewandte Chemie
V. Niel, et al.,

Nano magnets or **molecular magnets** are smallest magnetic units including several magnetic moments which properties can be tuned using light or a magnetic field. Organic as well as inorganic chemistry opens a very rich field of coordinations and functionalities of these molecules and their interactions.

We setup a microscope based on a scanning tip. **Tip-enhanced Raman scattering** allows catching *finger prints* of the molecules on surfaces and is important for life sciences. Amplifications of the signal by $10^6$ and a lateral resolution of 10 nm (nm=$10^{-9}$m) have been reported.

International, intensive collaborations exist with physicists and chemists in topical projects of the DFG (→ Molecular Magnetism), European projects (→ Network of the European Science Foundation) and non-European research centres, e.g. in Japan. In detail collaborations exist with the Institute of Inorganic Chemistry, Univ. Stockholm, the CNRS-IMN, Nantes, the Institute of Chemistry, Univ. Kyoto, the ILP Kharkov and the Phystech in Donetsk.

**Lectures and outreach:**
- Nano technology and physics of molecular systems
- Scanning probe techniques: microscopes for the nano world
- Experimental methods of solid state physics
- Ferroelectricity and multiferroic effects
- Magnetism and electronic correlations

**Lab course:**
- Ultrasound spectroscopy on nanoscale composites
- Nano Lab and Raman scattering

Further information: see http://www.ipkm.tu-bs.de/ and www.peter-lemmens.de .