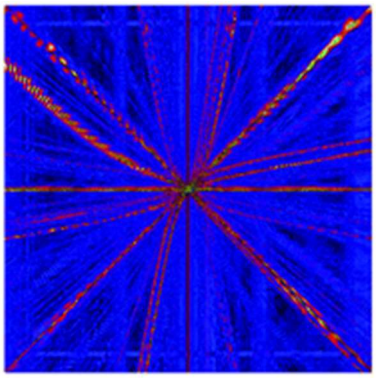
Abstracts of active research areas

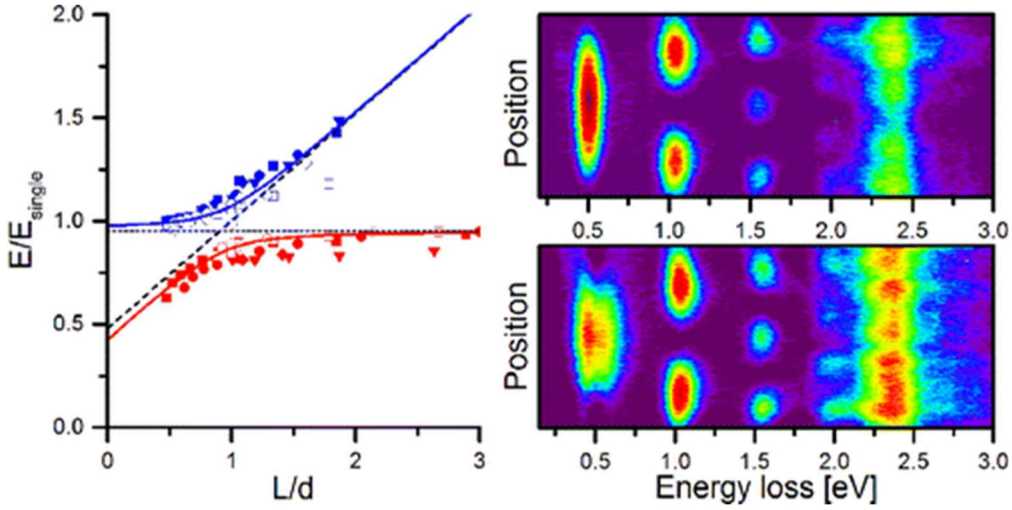
Molecular spin echoes; multiple magnetic coherences in molecule surface scattering experiments

In this research we have developed a theory for coherent propagation and scattering of molecules from solid surfaces in a magnetically controlled molecular beam experiment. We demonstrate that a molecular beam of hydrogen molecules can be magnetically manipulated to produce multiple coherences in the molecular interference pattern. Unlike spin 1/2 magnetic beam experiments, *i.e.*, neutron and helium spin echo, the nuclear and rotational magnetic moments in a molecule are strongly coupled. We show experimentally and theoretically that this coupling leads to multiple magnetic field conditions under which the magnetic moment of molecules travelling with different speeds can be coherently refocused. We also demonstrate that these multiple coherence signals are extremely sensitive to the scattering event, opening up new possibilities for measuring molecule–surface interactions.



See Refs.1-4 in the list of selected publications.

Coupling of Surface-Plasmon-Polariton-Hybridized Cavity Modes between Submicron Slits in a Thin Gold Film



In this research Electron Energy Loss Spectroscopy (EELS) in a Scanning Transmission Electron Microscope (STEM) is applied to probe extraordinary photon transmission through submicron slits in a thin gold film. Coupling of standing-wave-like cavity modes, hybridized with surface plasmon polaritons (SPP), between two adjacent slits, which strongly influences the transmission of light through the slits, is studied by systematically varying the width of the metal bar *d* that separates the slits.

Measurements on two-slit systems with different slit lengths *L* and fixed width reveal energy shifts and mode splitting of the fundamental SPP cavity mode which can be generally described as a function of a dimensionless scaling parameter *L*/*d*. A simple analytical model of mode coupling, supported by numerical simulations, agrees well with the experimental data and reveals insights into the underlying complex coupling mechanisms.

See Refs.7,8 in the list of selected publications.