Two-color experiments at the Gasphase beamline @ ELETTRA – CW and time-resolved studies

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Time resolved pump-probe experiments allow the determination of the energy and lifetimes of excited states, the study of internal and intra-molecular energy distribution after a photo-absorption process or the exploration of vibrational levels out of the Franck-Condon region. In addition the interaction of laser radiation with atoms and molecules is known to change their electronic structure and give rise to new physical phenomena. The relative importance of various effects depends on the intensity of the laser field and ranges from harmonic generation, the AC Stark effect, above threshold ionization to electromagnetically induced transparency. The understanding of such effects is also important for the development of new techniques and tools in optics. If appropriate conditions can be found, laser coupling offers the possibility of shortening synchrotron light pulses (in principle) even into the fs region, without any modification to the machine. In a first approximation, the duration of the light pulse is expected to be equal to the duration of the laser pulse.

A mode-locked tunable Ti:Sapphire oscillator is synchronized with the time structure of the storage ring and can be used to study the photoionization dynamics. In multibunch operation of the ring the setup permits the direct observation of the dynamics from a few nanoseconds down to the 10's of picoseconds range. Experiments can be performed both in the frequency domain, taking advantage of the high energy resolution of the picosecond sources, and in the time domain. The characteristics of the setup are demonstrated by examining recent results on two-color ionization of noble gases and molecular nitrogen. Experiments on effects of laser-induced coupling between bound levels of noble gases on the length of the synchrotron radiation pulse will also be discussed.