MO 10: Strong laser fields - I (joint session A/MO)

Time: Tuesday 14:00–15:45   Location: K 2.019

Invited Talk   MO 10.1   Tue 14:00   K 2.019
Multiphoton Ionization of Chiral Molecules — •Thomas
Baumert — Institut fuer Physik der Universitaet Kassel, Germany

Molecular chirality is widely recognized for its relevance to the building
blocks of life and its vital role for medicine and health. Chiral recog-
nition in the gas phase using electromagnetic radiation is an emerging
research field and promising for fundamental research as well as for
applications due to the non-interacting nature of molecules in the gas
phase. Photoelectron angular distributions after one photon or mul-
tiphoton ionization turned out to be especially sensitive to that end
and are usually measured by velocity map imaging (VMI) techniques.
The corresponding circular dichroism is termed photoelectron circular
dichroism (PECD). Based on electric dipole interaction, its magnitude
of up to a few ten percent typically surpasses that of other chiroptical
techniques and can be turned into a highly sensitive analytic tool with
respect to investigation of enantiomeric excess. Resonance-enhanced
multi-photon ionization (REMPI) gives access to electronic intermedi-
ates and, with the help of femtosecond laser excitation and ionization,
PECD has been demonstrated on bicyclic ketones. As more angular
momentum can be transferred in a multiphoton process in compar-
ison to single photon ionization, higher order nodal structures were
observed. An exploration of the nuclear and electron dynamics of the
intermediate resonance may stimulate the development of laser driven
purification schemes. In this talk I will present the field and our exper-
iments. References are compiled for example in our latest publication:
Kastner et al. JCP 2017, Vol. 147, 013926 (9 pp)

MO 10.2   Tue 14:30   K 2.019
Non-linear dichroism in atomic ionization — •Jiri
Hofbrucker[1,2], Andrey V. Volotka[1], and Stephan Fritzsche[1,2]
— [1]Helmholtz Institute, Jena, Germany — [2]Friedrich-Schiller Univer-
sity Jena

Dichroic behavior is usually associated with an interaction of polar-
ized atomic or chiral molecular target and circularly polarized light.
However, in a non-linear interaction regime, elliptically polarized light
ionizing symmetric target also produces a dichroic photoelectron angu-
lar distributions. The fundamental origin of this asymmetry explains
why is the elliptical dichroism strictly a feature of multi-photon pro-
cesses only, and why it is never observed in the single photon ionization
process. Being energy and system specific, this phenomena give us an
opportunity to study many-electron effects as well as fundamentals of
non-linear light-matter interaction. Observation of this phenomena in
two-photon ionization of an inner-shell shell electron of a rare gas atom
is proposed.

MO 10.3   Tue 14:45   K 2.019
**Spin polarization and spin filtering of free electrons in bichro-
matic laser fields** — Matthias M. Dellweg and •Carsten
Müller — Institut für Theoretische Physik I, Heinrich-Heine-
Universität Düsseldorf

Coherent electron scattering from intense laser fields of high frequency
is studied theoretically. By solving the time-dependent Dirac equa-
tion it is shown that the combination of a fundamental laser mode
with a counterpropagating second harmonic may act as a spin filter
for free electrons, provided the field polarizations are chosen properly
[1]. Besides, a spin-polarizing interferometric electron beam splitter is
presented which relies on an arrangement of three pairs of counterprop-
agating laser waves [2]. The proposed laser field configuration is shown
to exert the same effect on free electrons as an ordinary Stern-Gerlach
magnet does on atoms.
[1] M. M. Dellweg and C. Müller, Phys. Rev. A 95, 042124 (2017)
[2] M. M. Dellweg and C. Müller, Phys. Rev. Lett. 118, 070403 (2017)

MO 10.4   Tue 15:00   K 2.019
Deterministic control with sequences of intense pulses —
•Stefano M. Cavaletto, Zoltan Harman, Thomas Pfeifer, and
Christoph H. Keitel — Max Planck Institute for Nuclear Physics,
Heidelberg, Germany

Coherent-control methods and pulse-shaping technology have revolu-
tionized our access to the quantum properties of matter. However, with
widely used measurement-driven techniques, such as adaptive feedback
control, the complex reaction pathways followed by an optimally con-
trolled system often remain concealed. With intense time-dependent
pulses dressing the atomic level structure, only a limited number of
effective pulse-shaping strategies have been identified. Here, we put
forward a deterministic scheme to fully reconstruct the action of an in-
tense pulse on a quantum system from absorption-spectroscopy mea-
surements, including the dependence upon possibly unknown pulse
properties and atomic structures [S. M. Cavaletto *et al.*, *Phys. Rev. A*
95, 043413 (2017)]. An optimal pulse sequence based on this extracted
information can then be designed, facilitating manipulation and inter-
pretation of the chosen control strategy. The scheme may be imple-
mented also at x-ray energies with intense pulses from free-electron
lasers, representing an effective route to x-ray quantum control.

MO 10.5   Tue 15:15   K 2.019
**Isotopic shifts measured via strong-field laser-atom interac-
tion** — •Nicolas Camus, Sofia Botsi, Lutz Fechner, Jose Cre-
spo López-Urrutia, Thomas Pfeifer, and Robert Moshammer
— Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Hei-
delberg, Germany

High-precision measurements of isotopic shifts in the energy levels of
atoms can provide sensitive tests of our understanding of relativis-
tic and QED effects [1]. We present a novel spectroscopic method
to measure small isotopic shifts utilizing the coherent population of
different states arising from strong-field ionization. We experimen-
tally measure the isotope shift between ^{36}Ar, ^{38}Ar and ^{40}Ar for the
$3s^2 3p^5$ ($^2P_{3/2} \rightarrow {}^2P_{1/2}$) transition in singly charged argon ions. We
measure it by implementing a Ramsey-like scheme using two ultrashort
(6 fs) laser pulses. The first laser pulse excites the system into a coher-
ent superposition of the aforementioned states by removing an electron
from the atomic p-shell of the neutral atom. This superposition leads
to a spin-orbit wave packet (SOWP) oscillating with a period of T
= 23.3 fs that lasts for long times (tens of ns). The second delayed
pulse probes, after ∼170.000 cycles, the wavepacket dynamics of the
system by further ionization, allowing for a precision determination of
the spin-orbit frequency at the $\Delta E/E \sim 10^{-7}$ level . The detection of
the different argon isotopes is made by a time-of-flight spectrometer.
[1]. I. I. Tupitsyn et al., PRA 68, 022511 (2003)

MO 10.6   Tue 15:30   K 2.019
**Two pulse characterization by interferometric imaging of self-
diffraction** — •Christoph Leithold[1], Jan Reislöhner[1], Holger
Gies[2,3], and Adrian N. Pfeiffer[1] — [1]Institute of Optics and Quan-
tum Electronics, Abbe Center of Photonics, Friedrich Schiller Uni-
versity Jena, Germany — [2]Theoretisch-Physikalisches Institut, Abbe
Center of Photonics, Friedrich Schiller University Jena, Germany —
[3]Helmholtz-Institut Jena, Germany

A pulse characterization scheme based on interferometric, spectrally
resolved imaging of self-diffraction [1] is presented. Similar to interfer-
ometric FROG [2] and MEFISTO [3], interferograms of the nonlinear
signal are recorded for different pulse delays. Due to the noncollinear
nature of the setup, it can be applied to over octave spanning wave-
forms by separating signals on the spatial frequency axis. Additionally
to the temporal waveform the method also resolves one spatial di-
mension and is therefore not limited by geometrical effects like beam
smearing [4], known from other noncollinear schemes. In fact, both
fundamental pulses can be recovered from the same measurement. The
retrieval of the pulses is carried out solely in the (temporal) frequency
domain and can be done analytically as well as iterative numerically
which is more robust when dealing with noisy data. [1] C. Leithold, J.
Reislöhner, H. Gies and A.N. Pfeiffer Opt. Lett. 42, No. 23 in press.
[2] G. Stibenz and G. Steinmeyer, Opt. Express 13, 2617 (2005). [3]
Amat-Roldan, I. G. Cormack, P. Loza-Alvarez, and D. Artigas, Opt.
Lett. 30, 1063 (2005). [4] A. C. Tien, S. Kane, J. Squier, B. Kohler,
and K. Wilson, J. Opt. Soc. Am. B 13, 1160 (1996).