**The 22nd International Conference on Ultrafast Phenomena (UP 2020)**

16-19 November 2020

**Room 1**

08:30 -- 09:45

**M1A • Strong-Field Terahertz Science**

*Presider: Franz Kaertner; Universität Hamburg, Germany*

**M1A.1 • 08:30** *(Invited)*

**THz-induced Strongly Nonlinear Phenomena,** Keith A. Nelson; *Chemistry Dept., Rm. 6-235, Massachusetts Inst. of Technology, USA.*

Abstract not available.

**M1A.2 • 09:00** *(Invited)*

**Spintronic Terahertz Emission with Manipulated Polarization (STEMP),** Xiaojun Wu; *Beihang Univ., China.*

Circularly polarized broadband terahertz waves have been successfully generated from ferromagnetic metals-based and heavy metal or topological insulator combined heterostructures. The chirality, azimuthal angle and ellipticity of the terahertz beams can also be arbitrarily manipulated.

**M1A.3 • 09:30**

**Minimally dissipative all-coherent spin switching at terahertz clock rates,** Stefan Schlauderer, Christoph Lange, Christoph P. Schmid, Anatoly K. Zvezdin, Alexey V. Kimel, Rostislav V. Mikhailovskiy, Rupert Huber; *Univ. of Regensburg, Germany; Prokhorov General Physics Inst. and P.N. Lebedev Physical Inst., Russia; Inst. for Molecules and Materials, Radboud Univ., Netherlands; Moscow Technological Univ. (MIREA), Russia; Moscow Inst. of Physics and Technology (State Univ.), Russia; Dept. of Physics, Lancaster Univ., UK.*

Antenna-enhanced single-cycle terahertz transients ballistically switch spins in antiferromagnetic TmFeO$_3$ between metastable states separated by a potential energy barrier. We directly trace the temporal and spectral fingerprints of this ultrafast and minimally dissipative dynamics.

**Room 1**

10:30 -- 12:15

**M2A • Biological Systems**

*Presider: Tahei Tahara; RIKEN, Japan*

**M2A.1 • 10:30** *(Invited)*

**Impact of RNA Melting on Hydrating Water Structure Mapped by Femtosecond 2D-IR Spectroscopy,** Benjamin Fingerhut, Achintya Kundu, Jakob Schauss, Thomas Elsaesser; *Max-Born-Institut, Germany.*

We discern hydration geometries around the sugar-phosphate-backbone of an RNA double helix at the molecular level. RNA disordering upon melting is connected with a transition from ordered water structures towards local phosphate group hydration shells.

**M2A.2 • 11:00**

**Ultrafast Protein Dynamics Probed by Site Specific Transient IR Spectroscopy,** Stephen R. Meech; *Univ. of East Anglia, UK.*

Ultrafast spectroscopy can measure real-time protein dynamics, but yields limited structural information. Here we use unnatural amino acid substitution to place an IR absorber at specific locations in light activated proteins. Ultrafast pump - transient IR probe spectroscopy then yields unique site-specific data on protein structural dynamics.
M2A.3 • 11:15
Mapping Ultrafast Energy Transfer Across Electronic and Nuclear Degrees of Freedom, Eric A. Arsenault1,2, Yusuke Yoneda1,2, Masakazu Iwai1,3, Krishna K. Niyogi1,3, Graham R. Fleming1,2. 1Dept. of Chemistry, Univ. of California, Berkeley, USA; 2Molecular Biophysics and Integrated Bioimaging Division, Lawrence Berkeley National Laboratory, USA; 3Dept. of Plant and Microbial Biology, Univ. of California, Berkeley, USA. This work reinvestigates the subpicosecond energy transfer (ET) dynamics of light-harvesting complex II with two-dimensional electronic-vibrational spectroscopy (2DEV). With the help of a straightforward theoretical model, emphasis is also more generally placed on the manifestation of ET in 2DEV.

M2A.4 • 11:30
Excitonic structure and charge transfer in the Heliobacterial Reaction Center probed by multispectral multidimensional spectroscopy, Yin Song1, Riley Sechrist1, William Johnson2, Kevin Redding2, Jennifer Ogilvie1. 1Univ. of Michigan, USA; 2Arizona State Univ., USA. Using multidimensional multispectral spectroscopy and global-target analysis, we reveal excitonic structure and the charge transfer mechanism in the heliobacterial reaction center—the proposed closest homolog to the common ancestor of all photosynthetic reaction centers.

M2A.5 • 11:45
Electronic Multidimensional Spectroscopy Reveals the Functional Charge Transfer State in Bacterial Reaction Centers, Egle Bukarte1, David Palecek1, Petra Edlund2, Sebastian Westenhoff2, Donatas Zigmantas1. 1Chemical Physics, Lunds Universitet, Sweden; 2Dept. of Chemistry & Molecular Biology, Univ. of Gothenburg, Sweden. The high efficiency of the special pair in initiating electron transfer in reaction centers is not well understood. By using 2DES, we identified the charge transfer state, which is responsible for the charge separation function.

M2A.6 • 12:00
Non-Resonant 2 Color 2-Dimensional Electronic Spectroscopy Reveals Ground State Coherences of Light Harvesting Complex II, Shawn Irgen-Gioro1, Elad Harel1,2; 1Northwestern Univ., USA; 2Michigan State Univ., USA. Overlapping contributions from ground and excited state signals cloud interpretation of 2-Dimensional Electronic Spectroscopy. Using non-resonant interactions to suppress excited state pathways, unambiguous assignment of ground state coherences is obtained for Light Harvesting Complex II.

Room 1
13:45 -- 16:00
M3A • 2D Materials
Presider: Munira Khalil; Univ. of Washington, USA

M3A.1 • 13:45
Probing Electron-Phonon Couplings in Halide Perovskite Crystals by Temperature-dependent Ultrafast Two-dimensional Electronic Spectroscopy, Xuan Trung Nguyen1, Daniel Timmer2, Yevgeny Rakita2, David Cahen3, Alexander Steinhoff3, Frank Jahnke3, Christoph Lienau1, Antonietta De Sio1; 1Institut für Physik, Universität Oldenburg, Germany; 2Weizmann Inst. of Science, Israel; 3Institut für Theoretische Physik, Universität Bremen, Germany. We track ultrafast charge carrier relaxation and the concurrent build-up of dynamical exciton screening on a 30-fs timescale, and probe strong electron-phonon couplings in halide perovskite crystals by temperature-dependent two-dimensional electronic spectroscopy.

M3A.2 • 14:00
Ultrafast charge and energy transfer in a MoSe2/WSe2 heterostructure, Steven T. Cundiff1, Torben Purz1, Eric Martin1,2, Pasqual Rivera1, Xiaodong Xu1; 1Dept. of Physics, Univ. of Michigan, USA; 2MONSTR Sense Technologies, USA; 3Dept. of Physics, Univ. of Washington, USA. We examine ultrafast charge and energy transfer in a MoSe2/WSe2
heterostructure using multi-dimensional coherent spectroscopy. This technique identifies transfer processes and indicates charge and energy transfer times below 200 fs and 900 fs, respectively.

M3A.3 • 14:15
Time-resolved ARPES of excitons in an atomically thin semiconductor, Julien Madeo¹, Michael Man¹, Chakradhar Sahoo¹, Marshall Campbell², Vivek Pareek¹, Elaine Wong¹, Abdullah Al Mahboob¹, Nicholas Chan¹, Arka Karmakar¹, Bala Murali Krishna Mariserla¹, Xiaoqin Li², Tony Heinz³⁴, Ting Cao³⁵, Keshav Dani³; ¹Okinawa Inst of Science & Technology, Japan; ²Univ. of Texas at Austin, USA; ³Stanford Univ., USA; ⁴SLAC National Accelerator Laboratory, USA; ⁵Univ. of Washington, USA. We use a table-top time-resolved ARPES based on a MHz XUV source to directly observe direct and momentum-forbidden excitons in the full first Brillouin zone of WSe₂ monolayer and measure their ultrafast dynamics.

M3A.4 • 14:30
Ultrafast Signatures of Exciton-Phonon Coupling in TiSe₂, Bradley J. Siwick¹, Martin R. Otto¹, Jan H. Pohls¹, Laurent Rene de Cotret², Mark Stern¹, Mark Sutton¹; ¹Physics, McGill Univ., Canada. We present ultrafast electron diffuse scattering measurements of semi-metallic 1T-TiSe₂ subject to selective photo-carrier doping. Wavevector-specific renormalization of a soft phonon frequency is followed by wavevector-independent electron-phonon equilibration implicating strong exciton-phonon coupling.

M3A.5 • 14:45
Investigating Excitonic Physics in Two-Dimensional Semiconductors by Coherent Two-Dimensional Microscopy, Donghai Li¹, Chiara Trovatello², Stefano Dal Conte², Matthias Nuß¹, Giancarlo Soavi³⁴, Gang Wang³, Andrea C. Ferrari³, Giulio Cerullo²⁵, Tobias Brixner¹; ¹Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Germany; ²Dipartimento di Fisica, Politecnico di Milano, Italy; ³Cambridge Graphene Centre, Univ. of Cambridge, UK; ⁴Inst. for Solid State Physics, Abbe Center of Photonics, Friedrich-Schiller-Univ. Jena, Germany; ⁵IFN-CNR, Italy. Excitonic interactions determine the photoelectric properties of two-dimensional semiconductors. By using spatially resolved coherent two-dimensional micro-spectroscopy, we are able to determine the strength of exciton–phonon coupling in single-layer MoSe₂ at room temperature.

M3A.6 • 15:00
Fast Adiabatic Switching of Floquet-Bloch States in Monolayer WS₂ Reveals Coherent Dynamics, Jeffrey A. Davis¹, Stuart Earl¹, Mitchell Conway¹, Jack Muir¹, Jonathan Tollerud¹; ¹Swinburne Univ. of Technology, Australia. Floquet engineering allows transient control of electronic bandstructures. We show the Floquet induced AC Stark shift follows the instantaneous field of <33fs pulses. By measuring electronic coherence we demonstrate that this process is adiabatic.

M3A.7 • 15:15
Photoinduced Intersubband Absorption and Enhanced Photobleaching in Twisted Bilayer Graphene, Eva Arianna Aurelia Pogna¹², Xianchong Miao¹, Drielle von Dreifus¹, Thonimar V. Alencar⁴, Marcus V. O. Moutinho⁶, Pedro Venezuela⁷, Po-Wen Chiu⁸, Cristian Manzoni², Giulio Cerullo⁹, Minbiao Ji³, Ana Maria De Paula¹; ¹NEST-CNR Nano, Italy; ²CNR-IFN, Italy; ³Physics, Laboratory of Surface Physics, Fudan Univ., China; ⁴Departamento de Física, Instituto de Ciências Exatas e Biológicas, Universidade Federal de Ouro Preto, Brazil; ⁵Departamento de Física, Universidade Federal de Minas Gerais, Brazil; ⁶Núcleo Multidisciplinar de Pesquisas em Computação, Universidade Federal do Rio de Janeiro, Brazil; ⁷Instituto de Física, Universidade Federal Fluminense, Brazil; ⁸Dep. of Electrical Engineering, National Tsing Hua Univ., Taiwan; ⁹Fisica, Politecnico di Milano, Italy. High-sensitivity femtosecond microscopy with broad spectral coverage reveals photoinduced intersubband absorption and enhanced photobleaching bands in twisted bilayer graphene endowed with picosecond relaxation time and twist angle tunable energy position.
Ultrafast nano-imaging of polaron dynamics in lead halide perovskites, Jun Nishida\textsuperscript{1}, Peter T. Chang\textsuperscript{1}, Jiselle Ye\textsuperscript{2,3}, Sean E. Shaheen\textsuperscript{2,3}, Markus B. Raschke\textsuperscript{1}; \textsuperscript{1}Dept. of Physics, Dept. of Chemistry, and JILA, Univ. of Colorado, USA; \textsuperscript{2}Dept. of Electrical, Computer, and Energy Engineering, and Dept. of Physics, Univ. of Colorado, USA; \textsuperscript{3}Renewable and Sustainable Energy Inst., Univ. of Colorado, USA. To investigate the spatio-temporal heterogeneity in the ultrafast soft-lattice and polaron dynamics of lead halide perovskites, we develop ultrafast heterodyne-detected infrared nano-imaging resolving nanoscale disorder in polaron formation, coupling, and dynamics.

Room 2
13:45 -- 15:30
M3B • Photoemission and X-Ray Spectroscopy
Presider: Christoph Lienau; Carl V. Ossietzky Univ Oldenburg, Germany

M3B.1 • 13:45 (Invited)
Multidimensional Photoemission Spectroscopy of Excitons, Ralph Ernstorfer\textsuperscript{1}; \textsuperscript{1}Glienicker Str 100, Helmholtz-Zentrum Berlin für Materialien, Germany. Abstract not available.

M3B.2 • 14:15
Determination of mode-projected electron-phonon coupling from time-domain observations of microscopic scattering processes, MengXing Na\textsuperscript{1,2}, Arthur K. Mills\textsuperscript{1,2}, Fabio Boschini\textsuperscript{1}, Matteo Michiardi\textsuperscript{1,2}, Benjamin Nosarzewski\textsuperscript{3}, Ryan P. Day\textsuperscript{1,2}, Elia Razzoli\textsuperscript{1,2}, Aleander Sheyerman\textsuperscript{1,2}, Michael Schneider\textsuperscript{1,2}, Giorgio Levy\textsuperscript{1,2}, Sergey Zhdanovich\textsuperscript{1,2}, Thomas P. Deveraux\textsuperscript{3}, Alexander F. Kemper\textsuperscript{4}, David J. Jones\textsuperscript{1,2}, Andrea Damascelli\textsuperscript{1,2}; \textsuperscript{1}Univ. of British Columbia, Canada; \textsuperscript{2}Quantum Matter Inst., Canada; \textsuperscript{3}Stanford Univ., USA; \textsuperscript{4}North Carolina State Univ., USA. Using a femtosecond extreme ultraviolet source with a narrow linewidth, we observe electrons in graphite scattering with the A1' phonon from optically-populated initial states to well-defined final states, and extract the electron-phonon matrix element.

M3B.3 • 14:30
Few-femtosecond dynamics of CO\textsubscript{2} super-excited states, Rocio Borrego-Varillas\textsuperscript{1}, Matteo Lucchini\textsuperscript{2,1}, Thomas Schnappinger\textsuperscript{1}, Mario Murari\textsuperscript{2,1}, Giacinto D. Lucarelli\textsuperscript{2,1}, Filippo Daniele\textsuperscript{2}, Fabio Frassetto\textsuperscript{4}, Luca Poletto\textsuperscript{4}, Regina de Vivie-Riedle\textsuperscript{1}, Mauro Nisoli\textsuperscript{2,1}; \textsuperscript{1}Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche, Italy; \textsuperscript{2}Dipartimento di Fisica, Politecnico di Milano, Italy; \textsuperscript{3}Dept. of Chemistry, LMU Munich, Germany; \textsuperscript{4}Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche, Italy. Super-excited states of CO\textsubscript{2} are studied by time-resolved photoelectron spectroscopy exploiting sub-15 fs vacuum-ultraviolet pulses. Comparison with quantum mechanical simulations allows us to identify the ultrafast mechanisms which dictate the super-excited state lifetime and coherence.

M3B.4 • 14:45
Observation of intermolecular Coulombic decay in liquid water, Pengju Zhang\textsuperscript{1}, Conaill Perry\textsuperscript{1}, Tran Trung Luu\textsuperscript{3}, Hans Jakob Woerner\textsuperscript{1}; \textsuperscript{1}ETH Zurich, Switzerland. Intermolecular Coulombic decay has been observed in liquid water for the first time. This was achieved using monochromatized high-harmonic radiation coupled to a liquid microjet and an electron-electron coincidence spectrometer.
M3B.5 • 15:00
Core-level Time Resolved Spectroscopy of Photoelectron Circular Dichroism in Fenchone, Davide Faccialà, Michele Devetta, Sandra Beauvarlet, Nick Besley, Francesca Calegari, Carlo Calegari, Daniele Catone, Eugenio L. Cinquanta, Anna G. Cirio, Lorenzo Colaiuzzi, Marcello Coreno, Gabriele Crippa, Giovanni De Ninno, Michele Di Fraia, Mara Galli, Gustavo García, Yann Mairesse, Matteo Negro, Oksana Plekan, Ivan Powis, Prabhass Prasannan Geetha, Kevin Prince, Aditya Pusala, Salvatore Stagira, Stefano Turchini, Kiyoshi Ueda, Daehyun You, Nicola Zema; 1Istituto di Fotonica e Nanotecnologie CNR-IFN, Italy; 2CELIA, Université de Bordeaux-CNRS-CEA, France; 3Univ. of Nottingham, UK; 4Center for Free-Electron Laser Science, DESY, Germany; 5Hamburg Univ., Physics Dept., Germany; 6Elettra-Sincrotrone Trieste, Italy; 7Istituto di Struttura della Materia CNR-ISM, Italy; 8Politecnico di Milano, Italy; 9Laboratory of Quantum Optics, Univ. of Nova Gorica, Slovenia; 10Synchrotron Soleil, France; 11Inst. of Multidisciplinary Research for Advanced Materials, Tohoku Univ., Japan. We measured the chiral relaxation of photoexcited Fenchone at the Carbon K-edge. Our results demonstrate that ultrafast chiral dynamics can be probed using core level spectroscopy with circularly polarized free-electron laser pulses.

M3B.6 • 15:15
Determination of spin-orbit splitting of Kr and Kr by ultrafast motion of the valence electrons, Toshiaki Ando, Alex Liu, Atsushi Iwasaki, Kaoru Yamanouchi; 1Univ. of Tokyo, Japan. We determine the spin-orbit splitting energies of Kr and Kr with high precision by monitoring the yields of Kr in real-time by the pump-probe measurements using few-cycle near-infrared laser pulses.

Poster Room 1
16:00 – 18:00
M4A • Poster Session I

M4A.1
Phase-locked RF cavities for ultrafast electron diffraction and scattering applications, Tristan Britt, Martin R. Otto, Laurent Rene de Cotret, Bradley J. Siwick; 1McGill Univ., Canada. The LOCKBOX synchronization system was developed for UED instruments, yielding demonstrated timing stability of 5 fs RMS and sub-50 fs arrival time stability. This performance enables multimodal compression and electron energy loss spectroscopy experiments.

M4A.2
Laser-induced periodic surface structures on Yttria-stabilized Zirconia ceramics formed with time-dependent polarization pulses, Masayuki Kakehata, Hidehiko Yashiro; 1Natl Inst of Adv Industr Sci & Tech, Japan. Time-dependent polarization pulses generated by combinations of two pulses (orthogonal polarized or counter-rotating circularly polarized) were irradiated on yttria-stabilized zirconia ceramics and formed laser-induced periodic surface structures. Formed structures show effects of evolution of the polarization state and intensity.

M4A.3
Picossecond time-resolved imaging using a single-pixel detector, Xiaobo Tan, Can Li, Yongzhuang Zhou, Shaorong Chen; 1School of Electronic Science, National Univ. of Defense Technology, China; 2College of Arts and Science, National Univ. of Defense Technology, China; 3School of Physics and Astronomy, Univ. of Glasgow, UK. We propose a single-pixel ultrafast imaging (SPUI) method based on single-pixel imaging and time-correlated-single-photon counting (TCSPC). Time-resolved imaging of laser pulse propagation, reflection and total internal reflection in water is demonstrated as an example.
M4A.4
Ultrafast probing of soot dynamics using near-infrared filament pump and UV laser probe, Hongwei Zang¹, Yao Fu¹, Mengyao Hou¹, Helong Li¹, Kaoru Yamanouchi², Huailiang Xu³; ¹Jilin Univ., China; ²Univ. of Tokyo, Japan. We propose a near-infrared filament pump and an ultraviolet light probe approach to measure the dynamics of soot in flames with femtosecond time resolution, and demonstrate unexpected ultrafast swelling and shrinking processes of soot nanoparticles.

M4A.5
Ultrafast transient holographic imaging, Matz Liebel¹, Franco V. Camargo², Niek van Hulst¹,⁵, Giulio Cerullo²; ¹ICFO - The Inst. of Photonic Science, Spain; ²Politecnico Univ. of Milan, Italy; ⁵ICREA -Institució Catalana de Recerca i Estudis Avanats, Spain. We introduce an ultrafast holographic microscope that allows lock-in like 3D widefield imaging and spectroscopy with standard CMOS cameras and use this platform for highly multiplexed single nanoparticle spectroscopy as well as 3D single-particle-tracking.

M4A.6
Population inversion of ionized nitrogen molecules built by 800 nm femtosecond laser pulses, Wei Zheng¹; ¹Peking Univ., China. Laser-like emissions are observed from ionized nitrogen molecules by 800 nm femtosecond laser pulses. Direct evidences are provided for the population inversion between related quantum states of the emission.

M4A.7
Chemical Species Imaging in Flames Using Frequency-Tripled Tunable Amplified Femtosecond Laser Pulses, Yejun Wang¹, Pradeep Parajuli¹, Ayush Jain¹, Waruna Kulatilaka¹; ¹Texas A&M Univ., USA. A direct frequency-conversion third-harmonic-generation system pumped by a tunable amplified femtosecond laser is developed for OH and CO planar imaging. Increased output energies and the robust operation enables high-fidelity single-shot OH images in turbulent flames.

M4A.8
Heteromolecular Exciton Delocalization and Heterofission in Tetracene – Pentacene Blends, Clemens Zeiser¹, Luca Moretti³, Daniel Lepple³, Margherita Maiuri³, Giulio Cerullo³, Katharina Broch¹; ¹Univ. of Tuebingen, Germany; ³Politecnico di Milano, Italy. Singlet exciton fission in heteromolecular systems holds great potential for application in organic photovoltaics. We study tetracene:pentacene mixed films using femtosecond transient absorption spectroscopy and find signs of heteromolecular interaction upon excitation of pentacene.

M4A.9
The development of high performance streak cameras and their applications, Jinshou Tian¹, Xing Wang¹; ¹Chinese Academy of Sciences, Xi’an Inst. of Optics and Precision Mechanics, China. Several kinds of streak cameras for different applications were produced in XIOPM and here we will give a brief review about the performance and their applications.

M4A.10
Modeling of Ultrafast Propagation and Quantum Kinetics for Laser-Generated Electron-Hole Plasmas in Nanowires, Jeremy R. Gulley¹, Danhong Huang²; ¹Kennesaw State Univ., USA; ²Space Vehicles Directorate, Air Force Research Lab, USA. Simulations solve a quantum-kinetic model for ultrafast carrier dynamics in nanowires coupled to resonant scattering of laser pulses. Both transverse and resulting longitudinal electric fields play significant roles in the nanowire dynamics.
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M4A.11

**Element-Selective Probing of Photo-Driven Structural Changes in All-Inorganic Lead Perovskites**, Oliviero Cannelli², Thomas Rossi², Dominik Kinschel², James Budarz², Janina Löfler², Anne M. March¹, Gilles Doumy¹, Andre Al Haddad¹, Ming-Feng Tu¹, Yoshiaki Kumagai¹, Donald Walko¹, Grigory Smolentsev³, Franziska Krieg⁴, Maksym V. Kovalenko⁴,⁵, Giulia F. Mancini², Majed Chergui²; ¹Argonne National Laboratory, USA; ²Ecole Polytechnique Federale de Lausanne, Switzerland; ³Paul Scherrer Inst., Switzerland; ⁴ETH Zürich, Switzerland; ⁵EMPA, Switzerland.

Out-of-equilibrium photo-induced structural changes are probed with element-selectivity in CsPbBr₃ perovskite nanoparticles using 100 ps resolution time-resolved X-ray absorption spectroscopy.

M4A.12

**Dual Nature of the Spin Relaxation Mechanism in Layered Hybrid Perovskites**, Franco Valduga de Almeida Camargo¹, Soumen Ghosh¹, Sean A. Bourelle², Ravichandran Shivanna², Richard H. Friend², Giulio Cerullo¹, Felix Deschler¹,²,³; ¹Physics, Politecnico di Milano, Italy; ²Cavendish Laboratory, Univ. of Cambridge, UK; ³Physics, Technical Univ. Munich, Germany.

Two-dimensional layered perovskites are promising for spintronics, as crystal symmetry and spin-orbit coupling are tunable. We study a lead-iodide Ruddlesden-Popper hybrid perovskite with ultrafast Faraday rotation, finding different spin relaxation mechanisms for different absorption bands.

M4A.13

**Attosecond Spectroscopy of Ultrafast Carrier Dynamics in Nanoparticles**, Florian Lackner¹, Julia A. Gessner²,³, Florian Siegert²,³, Alexander Schiffmann¹, Roman Messner¹, Maximilian Lasserus¹, Martin Schnedlitz², Benjamin W. Toulson⁴, Daniel Kneze⁵, Ferdinand Hofer⁵, Oliver Gessner⁵, Wolfgang E. Ernst⁵, Martin Schultze¹,²; ¹Inst. of Experimental Physics, Graz Univ. of Technology, Austria; ²Max-Planck-Inst. of Quantum Optics, Germany; ³Fakultät für Physik, Ludwig-Maximilians-Universität München, Germany; ⁴Chemical Sciences Division, Lawrence Berkeley National Laboratory, USA; ⁵Inst. of Electron Microscopy and Nanoanalysis and Graz Centre for Electron Microscopy, Graz Univ. of Technology, Austria.

The electronic response of surface deposited nanoparticles to a few-cycle near infrared pump pulse is traced by attosecond XUV transient absorption spectroscopy.

M4A.14

**Strong Exciton-Coherent Phonon Coupling in Single-Layer MoS₂**, Chiara Trovatello¹, Henrique P. C. Miranda³, Alejandro Molina-Sanchez⁴, Rocío Borrego-Varillas⁴, Cristian Manzoni⁵, Luca Moretti⁵, Lucia Ganzer⁶, Margherita Mairi⁶, Junjia Wang⁷, Dumitru Dumcenco⁷, Andreas Kieß⁷, Giancarlo Soavi⁷, Andrea Marini⁶, Ludger Wirtz⁷, Andrea C. Ferrari⁷, Giulio Cerullo¹,², Davide Sangalli⁸, Stefano Dal Conte⁹; ¹Politecnico di Milano, Italy; ²CNR-IFN, Italy; ³Université catholique de Louvain, Belgium; ⁴Univ. of Valencia, Spain; ⁵Univ. of Cambridge, UK; ⁶CNR-ISM, Italy; ⁷Université du Luxembourg, Luxembourg; ⁸EPFL, Switzerland.

Broadband transient absorption with sub-20fs temporal resolution, supported by ab-initio calculations, quantitatively provides the strength of electron-coherent phonon coupling in 1L-MoS₂, showing a resonant profile around the C exciton.

M4A.15

**Transient Extreme Ultraviolet Measurement of Carrier Dynamics in Solar Fuel Materials**, Scott Cushing¹; ¹California Inst. of Technology, USA.

Element-specific charge transfer dynamics are measured in solar fuel materials using ultrafast extreme ultraviolet pulses. This includes hole transport in a Si-TiO2-Ni photoelectrode and the role of polarons in metal oxide photocatalysts.
M4A.16
Phonon-Assisted Exciton Polarization to Population Transfer in a 2D Semiconductor, Chiara Trovatello¹, Florian Katsch², Malte Selig², Nicholas Borys³,⁵, Kaiyuan Yao⁴,⁶, Rocio Borrego-Varillas⁷, Francesco Scotognella¹, Alex Zettl³,⁴, P. James Schuck³,⁶, Andreas Knorr², Giuilo Cerullo¹,⁷, Stefano Dal Conte¹; ¹Politecnico di Milano, Italy; ²Technische Universität Berlin, Germany; ³Lawrence Berkeley National Laboratory, USA; ⁴Univ. of California, USA; ⁵Montana Univ., USA; ⁶Columbia Univ., USA; ⁷IFN-CNR, Italy. Here we exploit transient reflectivity with sub-20fs temporal resolution to extract the exciton formation timescale from the build-up of A/B exciton dynamics of 1L-MoS₂. The timescale for this process ranges from ~15fs to ~35fs.

M4A.17
Angle-tunable intersubband photoabsorption and enhanced photobleaching in twisted bilayer graphene, Eva Pogna², Xianchong Miao³, Driele von Dreifus⁴, Thonimar Alencar⁵, Marcus Moutinho⁶, Pedro Venezuela⁷, Po-Wen Chiu⁸, Cristian Manzoni⁹, Minbiao Ji¹, giuilo Cerullo⁹, Ana Maria De Paula¹; ¹IFN-CNR, Italy; ²Istituto di Nanoscienze CNR-NANO, Laboratorio NEST, Italy, Italy; ³Laboratory of Surface Physics and Dept. of Physics, Fudan Univ., China; ⁴Departamento de Fisica, Instituto de Ciencias Exatas, Universidade Federal de Minas Gerais, Brazil; ⁵Departamento de Fisica, Instituto de Ciencias Exatas e Biologicas, Universidade Federal de Ouro Preto, 35400-000 Ouro Preto-MG, Brazil, , Minas Gerais, Brazil; ⁶Nucleo Multidisciplinar de Pesquisas em Computacao - NUMPEX-COMP, Campus Duque de Caxias, Universidade Federal do Rio de Janeiro, Duque de Caxias, 25245-390, RJ, Brazil, Brazil; ⁷Instituto de Fisica, Universidade Federal Fluminense, UFF, Brazil; ⁸Dept. of Electrical Engineering, National Tsing Hua Univ., Taiwan; ⁹Dipartimento di Fisica, Politecnico di Milano, Italy. We perform femtosecond transient absorption microscopy of twisted bilayer graphene. We observe twist-angle-dependent photobleaching and photoinduced absorption peaks, assigned to Pauli blocking of interband transitions at van-Hove singularities and to photo-activated intersubband transitions, respectively.

M4A.18
A Topological View on Metasurfaces Susceptibilities, Prasoon Saurabh¹; ¹East China Normal Univeristy, China. We present an alternative approach to understanding purely topological origin of the optical signals in the arbitrarily shaped metasurfaces by combining traditional non-local Green’s functions treatment for microscopic material descriptions with the tools of differential geometry.

M4A.19
Partially-Bright Triplet Excitons in CsPbI₃ Perovskite Nanocrystals and their Coherent Dynamics, Steven T. Cundiff¹, Albert Liu¹, Diogo Almeida², Luiz Bonato³, Gabriel Nagamine², Luiz Zagonel², Ana Noguiera³, Lazaro Padilha²; ¹Dept. of Physics, Univ. of Michigan, USA; ²Instituto de Fisica “Gleb Wataghin”, Universidade Estadual de Campinas, Brazil; ³Instituto de Quimica, Universidade Estadual de Campinas, Brazil. Multi-dimensional coherent spectroscopy is applied to CsPbI₃ perovskite nanocrystals at cryogenic temperatures. Coherence times of the non-degenerate triplet state fine-structure are characterized. Evidence of a partially-bright level ordering is presented.

M4A.20
Ultrafast photoinduced mechanical distortion of carbon nanotubes via electronic excitation, Tomohito Nakayama¹,², Takeshi Tanaka³, Atsushi Hirano², Muneaki Hase³; ¹Faculty of Pure and Applied Sciences, Univ. of Tsukuba, Japan; ²Nanomaterial Research Inst., National Inst. of Advanced Industrial Science and Technology, Japan. Using ultrafast pump-probe spectroscopy combined with a time-partitioning Fourier transform, we demonstrate transient mechanical distortion of Single-wall carbon nanotubes by photoexcitation assisted by protein adsorption.
M4A.21
Time-Resolved Resonance Raman Probing Excited State Dynamics in Confined Long Linear Carbon Chains, Jingyi Zhu\textsuperscript{1,2}, Robin Bernhardt\textsuperscript{1}, Weili Cui\textsuperscript{2}, Raphael German\textsuperscript{1}, Julian Wagner\textsuperscript{1}, Boris Senkovskiy\textsuperscript{3}, Alexander Grüneis\textsuperscript{1}, Thomas Pichler\textsuperscript{2}, Rulin Liu\textsuperscript{3}, Xi Zhu\textsuperscript{3}, Paul Van Loosdrecht\textsuperscript{1}, Lei Shi\textsuperscript{1,2}; \textsuperscript{1}KölN Univ., Germany; \textsuperscript{2}Univ. of Vienna, Austria; \textsuperscript{3}The Chinese Univ. of Hong Kong, China; \textsuperscript{4}Sun Yat-sen Univ., China. We demonstrated the excited states dynamics of the confined long linear carbon chains and their carbon tube hosts can be investigated by monitoring the time-resolved resonance Raman scattering of the well-resolved phonon vibration modes.

M4A.22
Ultrafast excited state dynamics and transient band structure renormalizations in endohedral metallo-fullerenes, Sebastian Hedwig\textsuperscript{1}, Sebastian Emmerich\textsuperscript{1}, Benito Arnoldi\textsuperscript{1}, Johannes Stöckl\textsuperscript{1}, Benjamin Stadtmüller\textsuperscript{1}, Martin Aeschlimann\textsuperscript{1}; \textsuperscript{1}Dept. of Physics and Research Center OPTIMAS, Univ. of Kaiserslautern, Germany. Using time-resolved photoemission, we investigated the femtosecond exciton dynamics of the endohedral metallofullerene Sc\textsubscript{3}N@C\textsubscript{80} and the corresponding many-body response of the molecular film. We demonstrate a significant increase of exciton decay rate upon K intercalation.

M4A.23
Ultrafast Dynamics in Ge\textsubscript{2}Sb\textsubscript{2}Te\textsubscript{5} Thin Films during Laser-Induced Successive Surface Modification, Masataka Kobayashi\textsuperscript{1}, Yuusuke Arashida\textsuperscript{1,2}, Kanta Asakawa\textsuperscript{1,3}, Kuniaki Konishi\textsuperscript{4}, Junji Yumoto\textsuperscript{5}, Makoto Kuwata-Gonokami\textsuperscript{6}, Jun Takeda\textsuperscript{1}, Ikufumi Katayama\textsuperscript{3}; \textsuperscript{1}Yokohama National Univ., Japan; \textsuperscript{2}Univ. of Tsukuba, Japan; \textsuperscript{3}Tokyo Univ. of Agriculture and Technology, Japan; \textsuperscript{4}the Univ. of Tokyo, Japan. Laser-induced multi-timescale surface modification of Ge\textsubscript{2}Sb\textsubscript{2}Te\textsubscript{5} thin films was investigated using high-repetition-rate single-shot pump-probe spectroscopy. The successive measurement of ultrafast dynamics during laser-induced periodic surface structure reveals pulse-to-pulse reduction of the relaxation time.

M4A.24
Sub-100 fs Hole Transfer Dynamics in WS\textsubscript{2}/MoS\textsubscript{2} Heterostructure Probed by Two-Dimensional Electronic Spectroscopy, Veronica Policht\textsuperscript{1}, Mattia Russo\textsuperscript{1}, Chiara Trovatello\textsuperscript{1}, Fang Liu\textsuperscript{2}, Sandro De Silvestri\textsuperscript{1}, Margherita Maiuri\textsuperscript{1}, Stefano Dal Conte\textsuperscript{1}, Xiaoyang Zhu\textsuperscript{2}, Giulio Cerullo\textsuperscript{1}; \textsuperscript{1}Politecnico di Milano, Italy; \textsuperscript{2}Dept. of Chemistry, Columbia Univ., USA. We study the exciton and carrier dynamics in large-area WS\textsubscript{2}/MoS\textsubscript{2} heterostructures using ultrafast two-dimensional electronic spectroscopy. With 30 fs resolution we are able to resolve interlayer hole transfer on sub-100 fs timescale.

M4A.25
Valence and Core Electron Dynamics in Inorganic Lead Halide Perovskites Semiconductors Probed by Time- and Angle-resolved Photoelectron Spectroscopy, Michele Puppin\textsuperscript{1}, Serhii Polischuck\textsuperscript{1}, Alberto Crepaldi\textsuperscript{2}, Nicola Colonna\textsuperscript{3}, Riccardo de Gennaro\textsuperscript{2}, Dmytri Dirin\textsuperscript{2}, Olga Nazarenko\textsuperscript{2}, Gianmarco Gatti\textsuperscript{2}, Silvan Roth\textsuperscript{3}, Rui Xian\textsuperscript{4}, Laurenz Rettig\textsuperscript{4}, Ralph Ernststorfer\textsuperscript{3}, Kovalenko Maksym\textsuperscript{2}, Nicola Marzari\textsuperscript{3}, Marco Grioni\textsuperscript{1}, Majed Chergui\textsuperscript{1}; \textsuperscript{1}Ecole Polytechnique Federale de Lausanne, Switzerland; \textsuperscript{2}ETH, Switzerland; \textsuperscript{3}Fritz-Haber Institut, Germany. We study the electronic response upon photoexcitation of the perovskite semiconductor CsPbBr\textsubscript{3}. An extreme ultraviolet photoemission experiment is used to access zone-boundary conduction electronic states and simultaneously track the spectral evolution of core states.

M4A.26
Hot Carrier Tunneling in Graphene/WS\textsubscript{2} Heterostructures, Chiara Trovatello\textsuperscript{1}, Giulia Piccinini\textsuperscript{2,3}, Stiven Forti\textsuperscript{2}, Filippo Fabbri\textsuperscript{2}, Antonio Rossi\textsuperscript{1,2}, Camilla Coletti\textsuperscript{2,3}, Giulio Cerullo\textsuperscript{1}, Stefano Dal Conte\textsuperscript{1}; \textsuperscript{1}Politecnico di Milano, Italy; \textsuperscript{2}IIIT, Italy; \textsuperscript{3}NEST - Scuola Normale Superiore, Italy. We investigate charge transfer dynamics in graphene/WS\textsubscript{2} heterostructures via transient reflection spectroscopy. By selectively exciting graphene with NIR sub-20fs pulses we resolve the buildup of the WS\textsubscript{2} excitonic transitions due to the hot-carriers tunneling.
M4A.27
Ultrafast generation of coherent acoustic phonons with THz picoseconds pulses in metals and topological insulators nanofilms, Vincent Juve¹, Artem Levchuk², Gwenâélle Vaudel¹, Bbortosz Wilk¹, François Labbé¹, Brice Arnaud¹, Katarzyna Balin¹, Jacek Szade¹, Pascal Ruello¹; ¹Institut des Molécules et Matériaux du Mans, UMR 6283 CNRS, Le Mans Université, 72085 Le Mans, France, France; ²A. Chelkowski Inst. of Physics and Silesian Center for Education and Interdisciplinary Research, 75 Pulku Piechoty 1A, 41-500 Chorzow, Univ. of Silesia, Poland, Poland. We report for the first time the generation of coherent acoustic phonons in materials with terahertz ultrashort pulses. This is demonstrated in metals and topological insulators by exciting acoustic eigenmode in nanometric sized thin films.

M4A.28
Nanoscale thermal transport across a GaAs/AlGaAs heterostructure interface probed by ultrafast electron diffraction, Matthew Gorfien², Hailong Wang³, Long Chen³, Dong Liu⁷, Xuan Wang¹, Jianhua Zhao³, Jianming Cao²; ¹CAS, Inst. of Physics, China; ²Physics Dept. and National High Magnetic Field laboratory, Florida State Univ., USA; ³State Key Laboratory of Superlattices and Microstructures, Inst. of Semiconductors, Chinese Academy of Sciences, China; ⁴Beijing Academy of Quantum Information Science, China; ⁵School of Physical Science and Technology, Southwest Jiaotong Univ., China; ⁶Center for Ultrafast Science and Technology, Key Laboratory for Laser Plasmas (Ministry of Education) and School of Physics and Astronomy, Shanghai Jiao Tong Univ., China; ⁷School of Science, Shandong Jiaotong Univ., China. We measured the thermal boundary Resistance (TBR) across a GaAs/AlGaAs interface using ultrafast electron diffraction. The TBR was found to decrease with the temperature imbalance across the interface, even beyond the Debye temperature.

M4A.29
Surface Electron Dynamics in TiO₂ Probed by Ultrafast XUV Spectroscopy: Understanding the Role of O Vacancy Defects, Robert Baker¹, Emily Hruska¹, Jakub Husek¹; ¹Ohio State Univ., USA. Using XUV reflection-absorption spectroscopy, we study the ultrafast surface electron dynamics in TiO₂ with emphasis on the role of O vacancies and excitation wavelength. We identify unique photoexcited states as a function of excitation wavelength.

M4A.30
Femtosecond time-resolved spectroscopy of incommensurate LaVS₃ crystal, Mateusz Weis³, Davide Boschetto³; ³LOA ENSTA, France. Showed femtosecond time-resolved spectroscopy measurements in LaVS₃, are consistent with the existence of coupling between excited carriers and A1g-mode. Observed metastable state can be attributed to low inter-plane conductivity or carrier trapping in vanadium cluster.

M4A.31
Effect of Laser Pulse Fluence, Waveform and Film Thickness on Ultrafast Magnetization Dynamics in Nickel, Saeedeh Mokarian Zanjani¹, Mehmet C. Onbasli¹,²; ¹Materials Science and Engineering, Koc Univ., Turkey; ²Electrical and Electronics Engineering, Koc Univ., Turkey. The effect of femtosecond laser pulse parameters on ultrafast magnetization dynamics in Nickel films is modeled. For Gaussian laser pulse (unlike sinc), Ni recovers its magnetization in one picosecond within an optimal laser fluence range.

M4A.32
Plasmon Induced Ultrafast Excited State Interfacial Electron Dynamics of Tetrathiafulvalene Sensitizers, Chinmoy Biswas¹, Krishnakanth Naga Katturi², Naresh Duvva³, Giribabu Lingamallu³, Venugopal Rao Soma⁴, Sai Santosh Kumar Raavi¹; ¹Indian Inst. of Technology Hyderabad, India; ²ACRHEM, Univ. of Hyderabad, India; ³Indian Inst. of Chemical Technology, India. Silver (Ag) nanoparticle-induced ultrafast and enhanced electron-injection and reduced charge-recombination dynamics in two thioalkyl substituted tetrathiafulvalene dye (G1 and G3)- sensitized mesoporous TiO₂ layers have been investigated using femtosecond transient-absorption spectroscopy with 400 nm excitation.
Ultrafast metrology for understanding laser micro-machining, Alexander Horn\textsuperscript{1}, Theo Pflug\textsuperscript{1}, Philipp Lungwitz\textsuperscript{1}, Markus Olbrich\textsuperscript{1}; \textsuperscript{1}Laser Institut Hochschule Mittweida, Germany. A novel spatially resolved pump-probe ellipsometer is developed and applied to investigate the dynamics of excitation of metals in the visible spectral range and organic dielectrics in the mid-IR spectral range within a femtosecond to nanosecond time scale.

Comparing the Energy Transfer Dynamics at 77 K of Siphonous Alga \textit{Bryopsis corticulans} and Higher Plants Studied using Two-Dimensional Electronic Spectroscopy, Thanh Nhut Do\textsuperscript{1}, Hoang Long Nguyen\textsuperscript{1}, Parveen Akhtar\textsuperscript{2,3}, Petar H. Lambrev\textsuperscript{2}, Howe-Siang Tan\textsuperscript{1}; \textsuperscript{1}Division of Chemistry and Biological Chemistry, Nanyang Technological Univ., Singapore; \textsuperscript{2}Biological Research Center, Hungary; \textsuperscript{3}ELI-ALPS, ELI-HU Nonprofit Ltd., Hungary. We use two-dimensional electronic spectroscopy (2DES) to investigate the differences in energy transfer dynamics between Light-harvesting complex II (LHCII) of a marine alga \textit{Bryopsis corticulans} (B. corticulans), and higher plants. The impact of these differences on the adaptability of marine algae is discussed.

Exciton trapping dynamics in DNA oligonucleotides tracked with sub-20 fs UV pulses, Rocio Borrego-Varillas\textsuperscript{1}, Giulio Cerullo\textsuperscript{2}, Dimitra Markovitsi\textsuperscript{3}; \textsuperscript{1}Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche, Italy; \textsuperscript{2}Dipartimento di Fisica, Politecnico di Milano, Italy; \textsuperscript{3}Université Paris-Saclay, CEA, CNRS, France. We report transient absorption measurements on adenine single strands with unprecedented temporal resolution of 30 fs. We show that internal conversion among exciton states occurs within 100 fs, while charge-transfer states form within 3 ps.

Mapping out Photoprotective Dissipation in Green Plants Using Ultrabroadband 2D Electronic Spectroscopy, Minjung Son\textsuperscript{1}, Alberta Pinnola\textsuperscript{2,3}, Roberto Bassi\textsuperscript{1,4}, Gabriela Schlau-Cohen\textsuperscript{1}; \textsuperscript{1}MIT, USA; \textsuperscript{2}Univ. of Pavia, Italy; \textsuperscript{3}Univ. of Verona, Italy; \textsuperscript{4}Accademia Nazionale di Lincei, Italy. Plants protect against photodamage by dissipating harmful excess sunlight. Using ultrabroadband 2D electronic spectroscopy, we directly resolve sub-ps chlorophyll-to-carotenoid energy transfer in LHCII, the major light-harvesting complex, a hypothesized but previously unobserved pathway for dissipation.

Energy Transfer pathways in PSI-LHCl probed by Two-Dimensional Electronic Spectroscopy, Mattia Russo\textsuperscript{1}, Anna Paola Casazza\textsuperscript{1}, Giulio Cerullo\textsuperscript{1}, Stefano Santabarbara\textsuperscript{1}, Margherita Maiuri\textsuperscript{1}; \textsuperscript{1}Dipartimento di Fisica, Politecnico di Milano, Italy; \textsuperscript{2}Istituto di Biologia e Biotecnologia Agraria, Consiglio Nazionale delle Ricerche, Italy; \textsuperscript{3}Centro studi sulla Biologia Cellulare e Molecolare delle Piante, Consiglio Nazionale delle Ricerche, Italy. By combining broadband two-dimensional electronic spectroscopy and global analysis, we temporally and spectrally resolve ultrafast energy transfer processes in the isolated Photosystem I-Light Harvesting Complex I (PSI-LHCl) supercomplex of spinach with open reaction centers.

The ultrafast excited state relaxation dynamics of nano-assemblies of Chlorophyll a, Yogita Silori\textsuperscript{1}, Sakshi Chawla\textsuperscript{1}, Arijit K. De\textsuperscript{1}; \textsuperscript{1}IISER Mohali, India. Using femtosecond pump-probe spectroscopy, we explore the ultrafast excited state relaxation dynamics of two types of supramolecular assemblies (rod-shaped and spherical micelles) of chlorophyll-a, formed at different ratios of ACN/water.
M4B.6
Investigations of the Energy Transfer in the Phycobilisome Antenna of Arthrospira Plantesis Using Time Resolved Absorption and Fluorescence Spectroscopy, Alexandra Falamas1, Sebastian A. Porav1, N Dragos2, V Tosa1; 1INCDTIM, Romania; 2Institute for Biological Research, Romania. We present the ultrafast dynamics in a phycobilisome and its components, phycocyanin and allophycocyanin phycobiliproteins. Transient absorption, as well as time correlated single photon counting investigations are presented and discussed.

M4B.7
Ultrafast Excited State Dynamics of Epigenetic DNA, Xueli Wang1, Zhongneng Zhou1, Rui Xu1, Jianhua Xu1, Jinquan Chen1; 1East China Normal Univ., China. Epigenetic DNA can induce heritable changes in gene function and the potential photodamage risk of the epigenetic DNA was studied by multiply ultrafast time-resolved spectroscopy techniques.

M4B.8
Solvent Assisted Excited State Proton Transfer in Indigo Carmine Investigated by Two Dimensional Electronic Vibrational Spectroscopy, Partha P. Roy1,2, James Shee3, Eric A. Arsenault1,2, Yusuke Yoneda1,2, Katelyn Feuling1,4, Martin Head-Gordon1,2, Graham R. Fleming1,2; 1Dept. of Chemistry, Univ. of California, Berkeley, USA; 2Molecular Biophysics and Integrated Bioimaging Division, Lawrence Berkeley National Laboratory, USA; 3Dept. of Chemistry, Kenneth S. Pitzer Center for Theoretical Chemistry, USA; 4Dept. of Chemistry, Univ. of Minnesota, USA. The solvent dependent electronic excited state deactivation dynamics of Indigo Carmine is mapped by the two-dimensional electronic-vibrational spectroscopy. The hydrogen bonding ability of the solvent has been found to assist excited state proton transfer.

M4B.9
Structural Discrimination of Phosphate Contact Ion Pairs in Water by Femtosecond 2D-IR Spectroscopy, Achintya Kundu1, Jakob Schauss1, Benjamin Fingerhut1, Thomas Elsaesser1; 1Max-Born-Institut für Nichtlineare Optik, Germany. The distinct structures of contact ion pairs in water are identified. Nonlinear infrared (IR) spectroscopy and theoretical calculations allow for the separation and assignment of spectral features and interactions.

M4B.10
Tracking Ultrafast Charge Separation in a PBI-based Biomimetic Complex for Oxygen Evolution, Margherita Maiuri1, Mattia Russo1, Luca Moretti1, Vasilis Petropoulos1, Francesco Rigodanza2, Andrea Sartorel1, Maurizio Prato3, Giulio Cerullo1, Marcella Bonchio1; 1Politecnico di Milano, Italy; 2CNR-ITM and Dipartimento di Scienze Chimiche, Univ. of Padova, Italy; 3Dept. of Chemical and Pharmaceutical Sciences, Univ. of Trieste, Italy. Multidimensional spectroscopies reveal a two-step process in a biomimetic supracomplex for oxygen evolution. A sub-ps charge-separation within the light-sensitizer moiety is followed by hole transfer from the catalyst counterpart, forming productive charges.

M4B.11
Ultrafast intersystem crossing in 4-thiothymidine proceeds through a vibrational coherently accessed dark intermediate state, Danielle C. Teles Ferreira1,4, Ivo H. Stokkum1, Rocio Borrego-Varillas2, Lucia Ganzer2, Cristian Manzoni2, Sandro De Silvestri2, Giulio Cerullo1, Ana Maria De Paula1; 1Dept. of Physics and Astronomy, Vrije Universiteit Amsterdam De Boelelaan, Netherlands; 2Dipartimento di Fisica, Politecnico di Milano, Italy; 3Departamento de Fisica, Universidade Federal de Minas Gerais, Brazil; 4Federal Inst. of Minas Gerais, Brazil. 4-Thiothymidine 20 fs broadband Transient Transmission Spectroscopy results and analysis provide evidence that along the photoexcited relaxation pathway, the intersystem crossing originates primarily from a dark intermediate state, which is vibrationally coherent accessible.
M4B.12
Two-Step Charge-Separation through the Partial Charge-Transfer State in a Molecular Dyad, Taeyeon Kim1, Woojae Kim1, Daniel Gryko2, Dongho Kim1; 1Yonsei Univ., Korea (the Republic of); 2Polish Academy of Sciences, Poland. We present a two-step charge-separation in a diketopyrrolopyrrole-pyrrolopyrrole dyad starting from the bright exciton and undergoes partial charge-transfer before reaching the charge-separated state using transient absorption, fluorescence up-conversion, and transient impulsive stimulated Raman measurements.

M4B.13
Switching Between Ultrafast Proton Vacancy and Excess Proton Transfer along a Methanol Solvent Bridge, Marius-Andrei Codescu1, Oleg Kornilov1, Erik T.J. Nibbering2; 1Max Born Inst., Germany. We show how ultrafast acid-base proton transfer neutralization reactions along methanol solvent bridges can be steered from a sequential methoxide to a sequential excess proton transport pathway.

M4B.14
Ultrafast spin cross-over in heme proteins: femtosecond X-ray emission spectroscopy, Dominik Kinschel1, Camila Bacellar1, Oliviero Cannelli1, Boris Sorokin1, Tetsuo Katayama2, Giulia F. Mancini1, Jérémy Rouxel1, Yuki Obara3, Junichi Nishitani4, Hironori Ito1, Terumasa Ito3, Naoya Kurahashi3, Chika Higashimura4, Shota Kudo4, Theo Keane6, Frederico Lima7, Wojciech Gawelda7, Peter Zalden7, Sebastian Schulz7, James Budarz1, Dmitry Khakhulin7, Andreas Galler7, Christian Bressler7, Christopher J. Milne8, Thomas Penfold6, Makina Yabashi2, Toshinori Suzuki4, Kazuhiro Misawa3, Majed Chergui1; 1EPFL, Switzerland; 2Japan Synchrotron Radiation Research Inst., Japan; 3Tokyo Univ. of Agriculture and Technology, Japan; 4Kyoto Univ., Japan; 5Sofia Univ., Japan; 6Newcastle Univ., UK; 7European XFEL, Germany; 8PSI, Switzerland. Femtosecond Fe Kα and Kβ non-resonant X-ray emission spectroscopy (XES) at an X-ray free-electron laser was used to probe the photoinduced switch from the low spin (S=1/2) MbNO to the high spin (S = 2) deoxy-myoglobin (deoxyMb).

M4B.15
Investigation of Complex Relaxation Dynamics of Nearly Degenerated Rydberg States in Acetone, Pascal Heim1, Sebastian Mai2, Bernhard Thaler2, Stefan Cesnik2, Davide Avagliano1, Dimitra Bella-Velidou1, Wolfgang E. Ernst2, Leticia Gonzáles3, Markus Koch3; 1Institut for Theoretical Chemistry, Univ. of Vienna, Austria; 2Institut of experimental physics, Graz Univ. of Technology, Austria. By combining time-resolved photoelectron spectroscopy with surface-hopping simulations we disentangle for the first time the ultrafast population transfer between the closely spaced and strongly coupled n3p Rydberg states of acetone. ©2020The Authors

M4B.16
Probing coherent molecular rotational dynamics with high-harmonic spectroscopy, Lixin He1; 1Huazhong Univ of Science and Technology, China. An angle-resolved high-order-harmonic spectroscopy in combination with the machine learning algorithm is demonstrated to probe molecular rotational dynamics. This method is also explored to measure the rotational dynamics of high-order molecular fractional echoes.

M4B.17
Single and Double Ionization of Aligned NO Radical in Intense Femtosecond Laser Fields, Shinichi Fukahori1, Atsushi Iwasaki2, Kaoru Yamanouchi2, Hirokazu Hasegawa1; 1Komaba Inst. for Science, Graduate School of Arts and Sciences, The Univ. of Tokyo, Japan; 2Dept. of Chemistry, School of Science, The Univ. of Tokyo, Japan. The alignment-dependent sequential-double-ionization probability of NO in intense laser fields is determined by the shape of the 5σ orbital, from which the second photoelectron is ejected associated with the saturation of the first ionization.
M4B.18
Ultrafast $Z \to E$ and $E \to Z$ Photoswitching Dynamics of Oxadiazocine Unveiled by Femtosecond Transient Electronic Absorption Spectroscopy, Dennis Bank, Falk Renth, Melanie Hammerich, Pascal Lentes, Rainer Herges, Friedrich Temps; ¹Organic Chemistry, Christian-Albrechts-Univ., Germany; ²Physical Chemistry, Christian-Albrechts-Univ., Germany. We investigated the $Z \to E$ and $E \to Z$ photoswitching dynamics of oxadiazocine by fs electronic absorption spectroscopy supported by ab initio calculations. The $E_{\text{twist}}$ isomer is formed via an $E_{\text{chair}}$ intermediate in $\sim 15$ ps, the $Z_{\text{boat}}$ isomer results from $E_{\text{twist}}$ via a direct route in $\sim 230$ fs.

M4B.19
Long-lived Excited States in 7- and 9-Methylpurine Probed by fs Time-Resolved Vibrational Absorption Spectroscopy, Rebecca Holtmann, Amke Nimmrich, Hendrik Böhnke, Friedrich Temps; ¹Inst. of Physical Chemistry, Christian-Albrechts-Univ., Germany. Transient vibrational absorption spectroscopy elucidates common deactivation pathways after UV photoexcitation for 7- and 9-methylpurine. However, 9-methylpurine exhibits an additional relaxation channel revealed by indirect observation of the excited $^1\pi\pi^*$ state.

M4B.20
A Theoretical Study of Polarization Selective Two-Dimensional Vibronic Spectroscopies of Multimode Systems, Robert B. Weakly, James D. Gaynor, Munira Khalil; ¹Univ. of Washington, USA; ²Chemistry, Univ. of California, USA. A model vibronic Hamiltonian composed of coupled anharmonic vibrational modes and two electronic states provides a quantitative framework for understanding how vibronic couplings and dipole orientations are encoded in two-dimensional vibronic spectroscopy.

M4B.21
Systematical Investigation on Spatial Coherence in Size-Defined Merocyanine Dye Stacks, Seongsoo Kang, Taeyeon Kim, Frank Würthner, Dongho Kim; ¹Yonsei Univ., Korea (the Republic of); ²Universität Würzburg, Germany. We examined ultrafast coherence dynamics of the Frenkel exciton in the size-defined self-assembly aggregates based on merocyanine dyes by using fs-transient absorption and fs-transient absorption anisotropy spectroscopic measurements.

M4B.22
Conformation Controlled Excited State Dynamics of Hückel [26] and Möbius[28] Pd(II) Hexaphyrins Probed by Time-resolved Electronic and Vibrational Spectroscopies, Jinseok Kim, Juwon Oh, Atsuhiro Osuka, Dongho Kim; ¹Yonsei Univ., Korea (the Republic of); ²Kyoto Univ., Japan. Understanding the metal-ligand interaction in metal coordinated expanded porphyrin systems enables precise control of their functional molecular properties and promising applications. We investigated metal-ligand interaction in conformation modified aromatic mono-Pd(II) hexaphyrins by time-resolved optical spectroscopies.

M4B.23
Ultrafast processes of atoms and molecules inside a quantum fluid, Bernhard Thaler, Pascal Heim, Miriam Meyer, Leonhard Treiber, Michael Stadlober, Wolfgang E. Ernst, Markus Koch; ¹Inst. of Experimental Physics, Graz Univ. of Technology, Austria. Helium nanodroplets offer fascinating opportunities for ultrafast studies in cold, controlled environments. We explore this potential by studying femtosecond dynamics of solvated atoms and diatomics, and find distinctive signatures of both intramolecular and solvent-specific dynamics.
M4B.24
Direct Observation and Kinetic Mapping of Point-to-Point Proton Transfer to Multiple Competing Molecular Sites,
Ehud D. Pines1, Dina Pines3, Dan Huppert2; 1Dept. of Chemistry, Ben-Gurion Univ. of the Negev, Israel; 2Raymond and Beverly Sackler Faculty of Exact Sciences, School of Chemistry, Tel Aviv Univ., Israel. The complex ps-resolved fluorescence-decay profiles of a photoacid undergoing reversible geminate-recombination reaction is used to kinetically analyze point-to-point proton transfer to three competing molecular recombination sites which are identified by their characteristic proton retention times.

M4B.25
Molecular dissociation driven by plasmonic near-fields of shaped mid-infrared pulses: Impact of down-chirping, Ikki Morichika1, Satoshi Ashihara1; 1Inst. of Industrial Science, The Univ. of Tokyo, Japan. We demonstrate vibrationally-mediated dissociation of condensed-phase molecules by employing intense plasmonic near-fields of temporally-shaped mid-infrared pulses. Furthermore, we numerically investigate the impact of down-chirping on the plasmon-enhanced vibrational ladder climbing.

M4B.26
Primary photoinduced processes in tryptophan tracked with sub-20-fs UV pulses, Piotr Kabacinski1, Rocio Borrego-Varillas1, Barbara E. Nogueira de Faria2, Marzio G. Gentile3, Irene Conti3, Sandro De Silvestri1, Marco Garavelli3, Ana Maria De Paula2, Giulio Cerullo1; 1IFN-CNR Dipartimento di Fisica, Politecnico di Milano, Italy; 2Departamento de Fisica, Universidade Federal de Minas Gerais, Brazil; 3Dipartimento di Chimica Industriale, Universita degli Studi di Bologna, Italy. We report sub-20-fs resolution UV transient absorption measurements, supported by ab-initio simulations, of the primary photoinduced processes of tryptophan in solution. We show internal conversion occurring in 300-fs followed by intersystem crossing in 1-ps.

M4B.27
Ultrafast solvation dynamics of dimethyl sulfoxide induced by excited-state intramolecular proton transfers, Myungsam Jen1, Sebok Lee1, Yoonsoo Pang1; 1Gwangju Inst of Science & Technology, Korea (the Republic of). Excited-state intramolecular proton transfers of 1,2-dihydroxyanthraquinone in dimethyl sulfoxide (DMSO) were extensively investigated by femtosecond stimulated Raman spectroscopy, where ultrafast solvation dynamics of νS=O and νCSC of DMSO between free and aggregated forms were observed.

M4B.28
Intramolecular charge transfer state of “push-pull” dyes probed by femtosecond stimulated Raman spectroscopy, Sebok Lee1, Myungsam Jen1, Taehyung Jang1, Yoonsoo Pang1; 1Gwangju Inst of Science & Technology, Korea (the Republic of). Two distinct Raman spectra of “push-pull” dyes, DCM and LD 688, in the locally-excited and charge-transfer states separately obtained from time-resolved Raman measurements, showed the existence of twist intramolecular charge transfer state in polar solvents.

M4B.29
Gold Rush in Dynamics? Time-resolved Ion Spectroscopy Reveals Ultrafast Processes in Isomorphic, Ligated Ag/Au Coinage Metal Dimers, Christoph Riehn1, Sebastian V. Kruppa1, Marcel Schmitt1, Roumany Israil1, Merten Grupe1, Lars Schüssler1, Rolf Diller1, Wim Klopper2; 1TU Kaiserslautern, Germany; 2KIT, Germany. Ultrafast electronic dynamics and UV absorption of phosphine–ligated (L) coinage metal complexes [Ag2(L)2]2+, [AgAu(L)2]2+ and [Au2(L)2]2+ reveal the influence of intermetallic interaction on electronic states. Isomorphic exchange by Au1 presumably accelerates ISC rate.
M4B.30
Two-dimensional electronic spectroscopy reveals distinct ultrafast photophysics in tricarbocyanine dyes: Polar solvation and photo-isomerization, Yogita Silori1, Arijit K. De1; 1IISER Mohali, India. Using two-dimensional electronic spectroscopy, here we show how near-infrared tricarbocyanine dyes, DNTTCI and IR140, exhibit distinct excited-state relaxation pathways on ultrafast time-scale, polar solvation and photo-isomerization, respectively, which further depends on excitation wavelength.

M4B.31
Ultrafast Photophysical Investigations of water-soluble triphenylmethane derivative (New Fuchsin) molecule, Chinmoy Biswas1, Somdatta Bhattacharya1, Venugopal Rao Soma1, Sai Santosh Kumar Raavi1; 1Indian Inst. of Technology Hyderabad, India; 2ACRHEM, Univ. of Hyderabad, India. Ultrafast excited-state molecular relaxation process in a triphenylmethane derivative dye New Fuchsin (NF) for dye-sensitized solar cell application in solution and thin film is studied using femtosecond pump-probe spectroscopy at pump excitation wavelength 550 nm.

M4B.32
Femtosecond laser induced far-from-equilibrium dynamics of hollow AgAu nanoparticles, Guilherme Ferbonink1, Thenner Rodrigues2, Pedro Camargo3, Rodrigo Albuquerque4, Rene Nome1; 1State Univ. of Campinas, Brazil; 2UFRJ, Brazil; 3Univ. of Helsinki, Finland; 4Univ of Muenster, Germany. We present a study of resonant ultrafast dynamics of AgAu nanoshells as a function of temperature and pump intensity at higher fluence, together with atomistic molecular dynamics simulations and analysis based far-from-equilibrium statistical mechanical theory.

M4B.33
Population inversion between B^2Sigma_u+ and X^2Sigma_g+ states of N2+ assisted by rotational excitation, Youyuan ZHANG1, Erik Lötstedt1, Kaoru Yamanouchi1; 1the Univ. of Tokyo, Japan. We investigate the rotational population inversion between the electronically excited B state and the ground X state in N2+ generated in an intense laser field by including electronic, vibrational and rotational degrees of freedom.

M4B.34
Caged-Contact Pair Recombination Following Photolysis in Cooled Triiodide Solutions, Frank Y. Gao1, Yu-Hsiang Cheng1, Keith A. Nelson1; 1Massachusetts Inst. of Technology, USA. The temperature-dependent recombination of caged-contact pairs following triiodide photolysis is investigated via ultrafast single-shot pump-probe spectroscopy. We find that the fraction of contact pairs formed increases at low temperature. The decays exhibit Arrhenius behavior, allowing us to assign a binding energy to the caged species.

M4B.35
Ultrafast ion- and electron-spectroscopy with soft X-rays at the European XFEL, Daniel E. Rivas1, Patrik Grychtol1, Thomas M. Baumann1, Rebecca Boll1, Benjamin Erk1, Alberto de Fanis1, Jan Grünert1, Markus Ilichen1,3, Jia Liu1, Tommaso Mazza1, Jacobo Montaño1, Valerija Music1,3, Yevheniy Ovcharenko1, Nils Rennhack1, Arnaud Rouzée1, Aljoscha Rörig1, Philipp Schmidt1, Sergey Usenko1, René Wagner1, Pawel Ziolkowski1, Michael Meyer1; 1European XFEL, Germany; 2Deutsches Elektronen-Synchrotron DESY, Germany; 3Univ. of Kassel, Germany; 4Max-Born-Institut, Germany. We present the first pump/probe measurements performed at the SQS instrument of the European XFEL. We obtain the first characterization of the femtosecond temporal resolution and show the feasibility for the investigation of ultrafast dynamics.
**M4B.36**

X-ray Photoelectron Angular Distributions from Organic Molecules by Femtosecond Soft X-ray Free Electron Lasers at PAL-XFEL, Shinichirou Minemoto¹, Takahiro Teramoto², Takuya Majima³, Tomoya Mizuno⁴, Je Ho i Mun⁵, Akira Yagishita⁶; ¹Univ. of Tokyo, Japan; ²Osaka Univ., Japan; ³Kyoto Univ., Japan; ⁴Max Plank Korea, Korea (the Republic of); ⁵KEK, Japan. We are developing an ultrafast X-ray photoelectron diffraction by using soft X-ray FEL. On the way to the final goal, we have measured degree of alignment of iodobenzene molecules and I 3d photoelectrons from them.

**M4B.37**

Ultrafast Relaxation Processes in Perylene-TCNQ Charge Transfer Crystal, Wenjun Ni¹, Lin Ma², Peng Hu³, Christian Kloc⁴, Licheng Sun¹,⁵, Gagik Gurzadyan¹; ¹State Key Laboratory of Fine Chemicals, Dalian Univ. of Technology, China; ²Guangdong Univ. of Technology, China; ³Northwest Univ., China; ⁴Nanyang Technological Univ., Singapore; ⁵KTH Royal Inst. of Technology, Sweden. Excitation photon energy dependent photoreactions, i.e. charge transfer/recombination, spin-orbit charge transfer intersystem crossing and singlet fission, were studied in perylene-TCNQ mixed crystal by use of ultrafast transient absorption and fluorescence techniques.

**Room 1**

08:30 -- 10:00

**Tu1A • Free-Electron and Spin Dynamics**

*Presider: Bradley Siwick; McGill Univ., Canada*

**Tu1A.1 • 08:30 (Invited)**

Ultrafast Dynamics of Molecules Clocked by a Polarization-screwed Femtosecond Laser Pulse, Jian Wu¹; ¹East China Normal Univ., China. We clock the ultrafast dynamics of molecules, ranging from the photoelectron releasing to the bond stretching, by using a polarization-skewed laser pulse, which maps the starting and stopping instants to the emission directions of the photoelectrons and nuclear fragments.

**Tu1A.2 • 09:00**

Dielectric laser accelerators: attosecond electron bunch creation and measurement and complex phase-space control, Norbert Schönenberger¹, Anna Mittelbach¹, Peyman Yousefi¹, Joshua McNeur¹, Uwe Niedermayer², Ang Li³, Peter Hommelhoff¹; ¹Friedrich Alexander Univ., Germany; ²Technische Universität Darmstadt, Institute for Particles and Electromagnetic Fields (TEMF), Germany. We show that dielectric laser accelerators (DLA), photonic nano-structures illuminated by ultrashort laser pulses, can generate attosecond electron bunch trains of 280 as length and allow other complex phase-space manipulation.

**Tu1A.3 • 09:15**

Twist-Angle-Dependent Photoresponse in MoS₂-Graphene Van der Waals Heterostructures Probed by Ultrafast Electron Diffraction, Duan Luo¹,², Jian Tang³, Xiaohao Shen³, Fuhao Ji³, Jie Yang³, Stephen Weathersby⁴, Michael E. Kozina², Zhijiang Chen⁴, Ting Cao⁴, Guangyu Zhang³, Xijie Wang³, Aaron M. Lindenberg¹; ¹Stanford Univ., USA; ²SLAC National Accelerator Laboratory, USA; ³Inst. of Physics Chinese Academy of Sciences, China; ⁴Univ. of Washington, USA. The photophysics of MoS₂-graphene heterostructures at different twist angles has been investigated by ultrafast electron diffraction. The structural response of MoS₂ heterostructures show a twist-angle dependence and exhibit faster dynamics than pure monolayer MoS₂.
Tu1A.4 • 09:30
Quantum path interference of photoemissions from metal nanotips in two-color laser fields, Ang Li¹, Yiming Pan², Philip Dienstbier¹, Peter Hommelhoff²; ¹Dept. of Physics, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany; ²Dept. of Physics of Complex Systems, Weizmann Inst. of Science, Israel. We show that two-color quantum path interference from metal nanotips exhibits 90%+ visibility over an almost octave-spanning wavelength range (1180-2000 nm). Theoretical modeling explains this and other intricate features of two-color quantum path physics.

Tu1A.5 • 09:45
Ultrafast Magnetization Dynamics Revealed by Terahertz Magnetometry, Wentao Zhang¹,², Pablo Maldonado³, Zuanming Jin⁴, Tom Seifert⁴, Jacek Arabski⁶, Guy Schmerber⁶, Eric Beaurepaire⁶, Mischa Bonn², Tobias Kampfrath⁷, Peter Oppeneer³,⁷, Dmitry Turchinovich¹; ¹Bielefeld Univ., Germany; ²Max Planck Inst. for Polymer Research, Germany; ³Uppsala Univ., Sweden; ⁴Univ. of Shanghai for Science and Technology, China; ⁵ETH Zurich, Switzerland; ⁶Institut de Physique et Chimie des Matériaux de Strasbourg, France; ⁷Freie Universität Berlin, Germany. We investigate ultrafast magnetization dynamics in encapsulated iron films, benefiting from their laser-induced terahertz emission. Combined with first-principles theoretical modeling, the experimental results provide quantitative insights into the observed magnetization dynamics.

Room 1
10:30 -- 12:15
Tu2A • Charge Transfer
Presider: Amber Krummel; Colorado State Univ., USA

Tu2A.1 • 10:30 (Invited)
Title to be Announced, Naomi Ginsberg¹; ¹Univ. of California, Berkeley, USA. Abstract not available.

Tu2A.2 • 11:00
Implementation of Broadband near-UV Pump Pulses for Ultrafast 2D Electronic-Vibrational Spectroscopy, Jason W. Sandwisch¹, James D. Gaynor²,¹, Munira Khalil²; ¹Univ. of Washington, USA; ²College of Chemistry, Univ. of California, USA. We present the generation of efficient, tunable sub-20 fs broadband near UV pulses. The tunable pulses are used in two-dimensional electronic-vibrational spectroscopy and reveal additional vibronic states in an excited state intramolecular proton transfer process.

Tu2A.3 • 11:15
Vibronic Coherence Evolution in Ultrafast Charge Transfer, James D. Gaynor²,¹, Jason W. Sandwisch², Munira Khalil²; ¹College of Chemistry, Univ. of California, Berkeley, USA; ²Chemistry, Univ. of Washington, USA. The photoexcited charge transfer of the well-known dye molecule, “N3⁺”, is investigated using multidimensional (2D and 3D) EV spectroscopy. Vibronic coherences are shown to be central in its nonadiabatic photoexcited relaxation.

Tu2A.4 • 11:30
Hot Electron Transfer in Hybrid Semiconductor-Metal Nanorods Investigated with Two-Dimensional Electronic Spectroscopy, Franco Valduga de Almeida Camargo³, Tetsuhiko Nagahara³,², Yuval Ben-Shahar³, Yossef E. Panfil⁵, Mattia Russo¹, Uri Banin³, Giulio Cerullo¹; ¹Physics, Politecnico di Milano, Italy; ²Dept. of Chemistry and Materials Technology, Kyoto Inst. of Technology, Japan; ³Chemistry, The Hebrew Univ. of Jerusalem, Israel. Hybrid semiconductor-metal nanorods are very promising photocatalytic materials. We apply two-dimensional electronic spectroscopy to CdSe nanorods with gold tips, unravelling the mixing of electronic states, hot electron transfer and relaxation with sub-10 fs temporal resolution.
Tracking Structural Dynamics during Charge Separation Processes with Time-Resolved Impulsive Stimulated Raman Spectroscopy, Dongho Kim; Yonsei Univ., Korea (the Republic of). Structural dynamics during charge separation in donor-acceptor-type molecules were investigated by time-resolved impulsive stimulated Raman spectroscopy. Our results stress the time-domain Raman technique is a powerful method to observe structural changes in light-induced charge-separation reaction.

Deciphering Photoacidity by Following Electronic Charge Distribution Changes along the Photoacid Förster Cycle with Time-Resolved Nitrogen K-Edge X-Ray Absorption Spectroscopy, Sebastian Eckert, Marc-Oliver Winghart, Carlo Kleine, Ambar Banerjee, Maria Ekmova, Jan Ludwig, Jessica Harich, Rolf Mitzner, Daniel Aminov, Dina Pines, Ehud D. Pines, Philippe Wernet, Michael Odelius, Erik T.J. Nibbering; Max Born Inst., Germany; Dept. of Physics, Stockholm Univ., Sweden; Inst. for Nanostructure and Solid State Physics, Universität Hamburg, Germany; Dept. of Chemistry, Ben Gurion Univ. of the Negev, Israel; Inst. for Methods and Instrumentation for Synchrotron Radiation Research, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Germany; Dept. of Physics and Astronomy, Uppsala Univ., Sweden. We locally probe with picosecond N K-edge spectroscopy electronic structure changes along all stages of the Förster photocycle of a prototypical photoacid, and determine how photoacid behaviour is driven by the conjugate photobase side.

Multi-cycle terahertz driven ultrafast electron manipulation in dielectrically-lined waveguides, Dongfang Zhang, Moein Fakhari, Hüseyin Cankaya, Anne-laure Calendron, Nicholas Matlis, Franz X. Kärntner; Deutsches Elektronen Synchrotron, Germany. We report on multi-cycle THz driven electron manipulations (acceleration, compression, and focusing) in dielectrically-lined waveguides. Cascaded acceleration by re-cycling and re-phasing of THz pulses is demonstrated.

Vectorized coherent control for ultrafast magnetic pulses, Shawn M. Sederberg, Kamalesh Jana, Katherine Herperger, Fanqi Kong, Felix Hufnagel, Chunmei Zhang, Ebrahim Karimi, Paul Corkum; Joint Attosecond Science Laboratory, Canada; Physics, Univ. of Ottawa, Canada. We investigate coherent control of electrical currents in a semiconductor using vector laser beams and structured light. We demonstrate several schemes for exciting ring currents capable of turning on magnetic fields within a timescale of ~50 femtoseconds.

Elliptically polarized terahertz emission based on Pt-CoFeB-W Heterostructure, DE-YIN KONG, Bo Wang, Tianxiao Nie, Meng Xiao, Chandan Pandey, Yang Gao, Lianggong Wen, Weisheng Zhao, Junjun Ruan, Cunjun Ruan, Jungang Miao, Xiaojun Wu; School of Electronic and Information Engineering, Beihang Univ., China; School of Microelectronics, Beihang Univ., China; Inst. of Physics, Chinese Academy of Sciences, China; Qingdao Research Inst., Beihang Univ., China; School of Physical Sciences, Univ. of Chinese Academy of Sciences, China; Beijing Key Laboratory for Microwave Sensing and Security Applications, Beihang Univ., China. We demonstrate generation and manipulation of elliptically polarized terahertz radiation from Pt-CoFeB-W trilayer structures when being applied nonuniform magnetic field distribution.
Tu3A.4 • 14:30
Dynamic electron energy and momentum mapping for ultrafast intervalley relaxation in layered WSe₂, Hiroya Yamaguchi¹,², Keiko Kato², Hiroki Mashiko³, Yoshiaki Sekine³, Hiroki Hibino³,², Ikufumi Katayama¹, Jun Takeda¹, Katsuya Oguri²; ¹Yokohama National Univ., Japan; ²NTT Basic Research Laboratories, Japan; ³Kwansei Gakuin Univ., Japan. Dynamical energy and momentum mapping for intervalley electron transfer in WSe₂ was investigated with high-harmonic-based ultrafast ARPES. The measured ultrashort scattering time of 30 fs will provide a guide to lightwave control of valley pseudospin.

Tu3A.5 • 14:45
High-sensitivity time-resolved reflectivity in extreme ultraviolet region for probing carrier and phonon dynamics, Keiko Kato¹, Hiroki Mashiko¹, Yoji Kunihashi¹, Hideo Omi¹, Hideki Gotoh¹, Katsuya Oguri¹; ¹NTT Basic Research Laboratories, Japan. A highly sensitive method for measuring time-resolved reflection in extreme ultraviolet region was developed. We observed optical modulation ΔR/R~1×10^-4 by boxcar integration and lock-in detection, and the data acquisition takes four minutes.

Tu3A.6 • 15:00
Single-Shot Transient Absorption of Nascent Perovskite Nanocrystals, James C. Sadighian¹, Kelly S. Wilson¹, Michael L. Crawford¹, Cathy Y. Wong¹; ¹Univ. of Oregon, USA. Perovskite nanocrystals are measured with single-shot transient absorption during synthesis. The lineshape indicates that carriers in nascent nanocrystals become trapped at the surface, inducing internal electric fields. The evolving lineshape reports surface passivation during synthesis.

Tu3A.7 • 15:15
Deep-Learning CARS: Real-Time Removal of the Non-Resonant Background, Carlo M. Valensise¹, Alessandro Giuseppe², Federico Vernuccio¹, Alejandro De La Cadena Perez Gallardo¹, giulio Cerullo¹, Dario Polli³; ¹Politecnico di Milano, Italy; ²DIAG, Univ. of Rome "La Sapienza", Italy. We introduce a novel approach based on deep learning to remove non-resonant background from coherent anti-Stokes Raman scattering spectra in real time. The model is trained on synthetic spectra and successfully applied to experimental data.

Tu3A.8 • 15:30
Molecular quantum wakes for clearing fog, Malte C. Schroeder¹, Ilia Larkin², Thomas Produit¹, Eric W. Rosenthal³, Howard Milchberg¹, Jean-Pierre Wolf¹; ¹Deptartment of Applied Physics, Univ. of Geneva, Switzerland; ²Inst. for Research in Electronics and Applied Physics, Univ. of Maryland, USA; ³USA Naval Research Laboratory, USA. Fog is a major obstacle for free-space optical communication. Our work introduces a novel approach for clearing optically transparent paths through fog via the opto-mechanical displacement of droplets through molecular quantum wakes in air.

Tu3A.9 • 15:45
Bacterially Synthesized Tellurium Nanostructures for Broadband Ultrafast Nonlinear Optical Applications, Jun Wang¹, Werner Blau²; ¹Shanghai Inst of Optics and Fine Mech, China; ²School of Physics, CRANN and AMBER Research Centres, Trinity College Dublin, Ireland. We reported the ultrafast nonlinear optical properties of biological tellurium (Bio-Te) nanostructures, realized ultrafast pulse generation using Bio-Te as the saturable absorber, and demonstrated an all-optical switch based on the Bio-Te in optical fiber system.
The 22nd International Conference on Ultrafast Phenomena (UP 2020)
16-19 November 2020

Room 2
13:45 -- 15:15
Tu3B • Charge and Structural Dynamics
Presider: Phillip Keathley

Tu3B.1 • 13:45
Exerting Coherent Control over a Surface Structural Phase Transition via Amplitude Modes, Jan Gerrit Horstmann, Hannes Böckmann, Bareld Wit, Felix Kurtz, Gero Storeck; ¹Max Planck Inst. for Biophysical Chemistry, Germany; ²IV. Physical Inst., Univ. of Göttingen, Germany. We use ultrafast low-energy electron diffraction (ULEED) and multi-pulse optical excitation to demonstrate coherent control over the metal-insulator structural phase transition in atomic indium wires on the (111) surface of silicon.

Tu3B.2 • 14:00
Ultrafast Nonadiabatic Dynamics through an Intermolecular Conical Intersection, Antonietta De Sio, Ephraim Sommer, Lynn Gross, Xuan Trung Nguyen, Dusko Popovic, Elena Mena-Osteritz; ¹Institut für Physik, Universität Oldenburg, Germany; ²BCCMS, Universität Bremen, Germany; ³Institut für Organische Chemie II und Neue Materialien, Germany; ⁴Theoretical Division, Los Alamos National Laboratories, USA. Combining <10-fs two-dimensional electronic spectroscopy and atomistic nonadiabatic dynamics simulations, we track, for the first time, vibrational wavepacket motion through an intermolecular conical intersection governing the sub-100-fs energy transfer in photovoltaic molecular aggregates.

Tu3B.3 • 14:15
Blueshift of the TO Phonon Resonance in GaAs by Femtosecond Electron-Hole Excitation, Klaus Reimann, Ahmed Ghalgaoui, Michael Woerner, Thomas Elsaesser, Christoph Lienau; ¹Max-Born-Institut, Germany; ²Laboratoire de Physique, École Normale Supérieure, Université PSL, France; ³Paul-Drude-Institut, Germany. After electron-hole generation by femtosecond near-infrared pulses, the TO-phonon resonance in GaAs is blueshifted by 100~GHz as observed via a fourth-order nonlinear THz emission.

Tu3B.4 • 14:30
Light-induced manipulation of the charge density wave in 1T-TaSe2, Xun Shi, Wenjing You, Yingchao Zhang, Zhensheng Tao, Yigui Zhong, Peter Oppeneer, Xianxin Wu, Ronny Thomale, Kai Rossnagel, Michael Bauer; ¹JILA, Univ. of Colorado Boulder, USA; ²State Key Laboratory of Surface Physics and Dept. of Physics, Fudan Univ., China; ³Dept. of Physics and Astronomy, Uppsala Univ., Sweden; ⁴Inst. of Experimental and Applied Physics, Kiel Univ., Germany; ⁵Deutsches Elektronen-Synchrotron DESY, Germany; ⁶Ruprecht Haensel Laboratory, Kiel Univ. and DESY, Germany. Using trARPES, we observe that the CDW amplitude mode in 1T-TaSe2 can coherently modulate the electron temperature. Coherent electron-phonon coupling mechanisms are proposed to explain the electron temperature oscillations at different pump fluences.
Ultrafast charge transfer and interlayer exciton formation in WSe$_2$/WS$_2$ and WSe$_2$/graphene heterostructures, Guo-Hong Ma$^{1,2}$, Shanghai Univ., China; $^2$STU&SIOM Joint Laboratory for superintense lasers and the applications, China. The ultrafast charge transfer and dynamical interlayer excitons were investigated in the heterostructures comprising WSe$_2$/WS$_2$ and WSe$_2$/graphene bilayer. The results reveal the stacking order affect the charge transfer and therefore the formation of exciton in the heterostructure significantly.

Organic Quantum Batteries, James Q. Quach$^1$, Kirsty McGhee$^3$, Lucia Ganzer$^2$, D. Rouse$^4$, B.W. Lovett$^4$, E.M. Gauger$^5$, J. Keeling$^4$, Giulio Cerullo$^2$, David G. Lidzey$^3$, Tesilla Virgili$^2$; $^1$Inst. for Photonics and Advanced Sensing and School of Chemistry and Physics, Univ. of Adelaide, Australia; $^2$Istituto di Fotonica e Nanotecnologia, CNR, IFN, Italy; $^3$Dept. of Physics and Astronomy, Univ. of Sheffield, UK; $^4$SUPA, School of Physics and Astronomy, Univ. of St Andrews, UK; $^5$SUPA, Inst. of Photonics and Quantum Sciences, Heriot-Watt Univ., UK. By ultrafast spectroscopy we provide experimental evidence of superextensive charging in organic quantum batteries constructed as microcavities based on a double dielectric-mirror structure containing a thin film of a Lumogen-F dye blended in a polystyrene matrix.

Femtosecond soft–X–Ray absorption spectroscopy of liquids with a water-window high-harmonic source, Tadas Balciunas$^1$, Adam Smith$^2$, Yi-Ping Chang$^1$, Cédric Schmidt$^1$, Kristina Zinchenko$^2$, Fernanda Nunes$^2$, Vit Svoboda$^2$, Emanuele Rossi$^2$, Zhong Yin$^2$, Jean-Pierre Wolf$^1$, Hans J. Woerner$^2$; $^1$GAP-Biophotonics, Univ. of Geneva, Switzerland; $^2$Laboratory for Physical Chemistry, ETH, Switzerland. We demonstrate femtosecond soft–X–ray absorption spectroscopy of liquid samples by combining a sub–micrometer–thin flat liquid jet with a high–harmonic source covering the entire water-window range. The time-resolved XAS measurements reveal valence-shell ionization dynamics of the liquid alcohols.

Field-resolved response of mid-infrared plasmonic antennas, Marco Fischer$^1$, Nicolo Maccaferri$^2$, Kevin Gallacher$^3$, Jacopo Frigerio$^4$, Giovanni Pellegrini$^6$, Giovanni Isella$^4$, Alfred Leitenstorfer$^4$, Douglas J. Paul$^3$, Paolo Biagioni$^4$, Daniele Brida$^{2,3}$; $^1$ Univ. of Konstanz, Germany; $^2$Univ. of Luxembourg, Luxembourg; $^3$Univ. of Glasgow, UK; $^4$Politecnico di Milano, Italy. We introduce a new experimental strategy to investigate the transient resonant behavior of plasmonic nanostructures. Our approach allows to access their full-time field-resolved response in amplitude and phase.

Coherently and Fluorescence-Detected Four- and Six-Wave-Mixing Two-Dimensional Electronic Spectroscopy: Measuring Multi-Exciton Dynamics and Delocalization, Pavel Malý$^1$, Stefan Müller$^2$, Julian Lüttig$^3$, Maximilian Schreck$^2$, Christoph Lambert$^2$, Tobias Briiner$^1$; $^1$Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Germany; $^2$Institut für Organische Chemie, Universität Würzburg, Germany. We directly compare nonlinear coherently and fluorescence-detected two-dimensional electronic spectra of electronically coupled squaraine heterodimers. By identifying signatures of multi-exciton nonequilibrium dynamics and delocalization, we establish grounds for interpretation of these nonlinear spectroscopy implementations.
Tu4A.5  
**Controlling the Dimensionality of Exciton-Exciton Annihilation in Atomically Thin Black Phosphorus**, Vivek Pareek¹, Julien Madeo¹, Keshav Dani¹; ¹OIST Graduate Univ., Japan. We use micro-transient absorption spectroscopy to show that the exciton-exciton annihilation process in bilayer black phosphorus can be tuned from 1D- to 2D-like in nature by controlling initial exciton density and temperature.

Tu4A.6  
**Studying the nature of the electron-hole bond in excitons in monolayer WSe₂ via time-resolved ARPES**, Michael Man¹, Julien Madeo¹, Chakradhar Sahoo¹-³, Marshall Campbell², Vivek Pareek¹, Elaine Wong², Abdullah Al Mahboob¹, Nicholas Chan¹, Arka Karmakar¹, Bala Murali Krishna Mariserla¹-³, Felipe d. Jornada⁴, Xiaqin Li², Tony Heinz²-⁶, Ting Cao⁵-⁷, Keshav Dani¹; ¹Okinawa Inst. of Science and Technology, Japan; ²Physics Dept., Univ. of Texas at Austin, USA; ³Dept. of Physics, Indian Inst. of Technology, India; ⁴Materials Science and Engineering, Stanford Univ., USA; ⁵Dept. of Applied Physics, Stanford Univ., USA; ⁶SLAC National Accelerator Laboratory, USA; ⁷Dept. of Materials Sciences and Engineering, Univ. of Washington, USA. Using time- and angle-resolved photoemission spectroscopy on a microscopic sample of a 2D semiconductor, we image the excitonic wavefunction in real- and momentum-space.

Tu4A.7  
**Solid-like Dynamics after XUV Photoionization of Large Molecules**, Marius Hervé¹, Victor Despré², Pablo Castellanos Nash³, Vincent Loriot¹, Alexie Boyer¹, Audrey Scognamiglio¹, Gabriel Karras¹, Richard Brédy¹, Eric Constant¹, Alexander G. Tielens¹, Alexander I. Kuleff², Franck Lépine¹; ¹ILM Univ Lyon1, France; ²PCI, Universität Heidelberg, Germany; ³Leiden Observatory, Leiden Univ., Netherlands. We used XUV pump-IR probe spectroscopy to probe the ultrafast dynamics in highly-excited large 2D molecules. Our results reveal the dominant role of correlation bands, general features of molecules due to electron correlation. Their relaxation is described following solid-like approaches.

Tu4A.8  
**Time delay in the coherent vibrational motion of H₂⁺ created by ionization of H₂**, Takanori Nishi¹, Erik Lötstedt¹, Kaoru Yamanouchi¹; ¹The Univ. of Tokyo, Japan. We show using reduced density matrices that a phase of the photoelectron created in the photoionization of H₂ induced by an attosecond pulse train introduces time delay in the coherent vibrational motion of H₂⁺.

Tu4A.9  
**High-order phase measurements of attosecond wave packets**, Jaco Fuchs¹, Nicolas Douguet², Stefan Donsa³, Fernando Martin⁴-⁶, Joachim Burgdörfer³, Luca Argenti⁵-⁷, Laura Cattaneo¹, Ursula Keller¹; ¹ETH Zurich, Switzerland; ²Dept. of Physics, Univ. of Central Florida, USA; ³Inst. of Theoretical Physics, Vienna Univ. of Technology, Austria; ⁴Departamento de Quimica Modulo 13, Universidad Autonoma de Madrid, Spain; ⁵CREOL, Univ. of Central Florida, USA; ⁶Condensed Matter Physics Center, Universidad Autonoma de Madrid, Spain. We demonstrate that the beating between 1- and 2-photon-transitions enables a sensitive detection of high-order phase terms of electron wave packets. This allows us to probe phase features well beyond the capabilities of existing attosecond spectroscopy.

Tu4A.10  
**Conditioned thermal states as nonclassical gates in subcycle sampling of quantum fields**, Patrick Cusson¹, Stephane Virally¹, Denis Seletskiy¹; ¹Polytechnique Montreal, Canada. Time-domain quantum electrodynamics is coming of age with recent demonstrations of direct probing of femtosecond quantum fields. Here, we propose to harness nonclassical light from bright entangled sources to dramatically enhance field-resolved measurements.
Large-Scale Ab Initio Calculation of Ultrafast Dynamics in Thin-Film Dielectrics, Kazuhiro Yabana¹, Yuta Hirokawa³, Atsushi Yamada¹, Shunsuke Yamada¹, Masashi Noda¹, Mitsuharu Uemoto², Taisuke Boku¹; ¹Univ. of Tsukuba, Japan; ²Kobe Univ., Japan. We have achieved a large-scale ab initio simulation of light-matter interaction over 10,000 atoms. Nonlinear optical phenomena in glass thin film including high harmonic generation and light-matter energy transfer are described with unprecedented details.

Pointing Characteristics of X-rays Generated by Relativistic Electron Acceleration via 45 TW fs Laser-He Plasma, Georgia Andrianaki¹,³, Anastasios Grigoriadis¹,², Emmanouil Benis², Nektarios Papadogiannis¹,⁴; ¹Inst. of Plasma Physics and Lasers, Greece; ²Physics, Univ. of Ioannina, Greece; ³School of Production Engineering & Management, Technical Univ. of Crete, Greece; ⁴Dept. of Music Technology and Acoustics, Hellenic Mediterranean Univ., Greece. We present measurements on the pointing characteristics of the x-ray sources driven by 45 TW, 25 fs laser pulses interacting with variable pressure He-jet. Betatron-type radiation along with 100 MeV directional quasi-monoenergetic electrons are observed.

Phase-Modulated Rapid-Scanning Fluorescence-Detected Two-Dimensional Electronic Spectroscopy, Damianos Agathangelou¹, Ariba Javed¹,², Manuel Joffre³, Jennifer Ogilvie¹; ¹Dept. of Physics and Biophysics, Univ. of Michigan, USA; ²Dept. of Materials Science and Engineering, Univ. of Michigan, USA; ³Laboratoire d’Optique et Biosciences, Ecole Polytechnique, France. We demonstrate a rapid-scanning approach for fluorescence-detected two-dimensional electronic spectroscopy based on phase modulation and digital lock-in detection. The complex linear and non-linear signals of interest are retrieved simultaneously within several seconds of acquisition time.

Disentangling genuine dynamics from cross phase modulation artefacts in Femtosecond Stimulated Raman Spectroscopy, Giovanni Batignani¹, Carino Ferrante¹, Giuseppe Fumero¹,³, Tullio Scopigno¹,²; ¹Sapienza Università di Roma, Italy; ²Istituto Italiano di Tecnologia, Center for Life Nano Science @Sapienza, Italy; ³Dipartimento di Scienze di Base e Applicate per l’Ingeg, Università La Sapienza, Italy. Coherent artefact is a well-known nonlinear process plaguing ultrafast time-resolved experiments. Here, a Femtosecond-Stimulated-Raman-Scattering based approach, able to disentangle genuine dynamics from coherent artefacts, is introduced for demonstrating optically-driven femtosecond enhancement of the exchange interaction.

Laser-induced inner-shell excitations through electron re-collision, Gilad Marcus¹, Yunpei Deng², Zihua Zeng³, Pavel Komi⁴, Yinghui Zheng⁵, Wolfram Helm⁶, Xinhua Xie⁷, Zoltan Filus⁸, Mathieu Dumergue⁹, Roland Flender⁴, Máté Kurucz⁹, Ludovit Haizer⁹, Balint Kiss⁹, Subhendu Kahaly⁹, Ruxin Li¹; ¹The Hebrew Univ., Jerusalem, Israel; ²PSI, Swaziland; ³SIOM, China; ⁴Technische Universität Dortmund, Germany; ⁵ELI-Alps, Hungary. Laser induced x-ray fluorescence were observed against laser polarization ellipticity. While emission from krypton peaks at linear polarization, a signature of recollision, emission from neon shows opposite trend. We attribute it to two competing processes.

Effects of the Pump Wavelength on Laser-Induced Ultrafast Demagnetization, Katherine Légaré¹, Vincent Cardin¹, Tadas Baliunas², Andrius Baltuska², Heide Ibrahim³, Emmanuelle Jal³, Boris Vodungbo³, Nicolas Jaouen⁴, Charles Varin⁵, Jan Lüssing⁶, François Légaré⁷; ¹INRS-EMT, Canada; ²TU WIEN, Austria; ³UPMC, France; ⁴Synchrotron SOLEIL, France; ⁵Cégep de l’Outaouais, Canada. A high harmonics source is used to perform x-ray resonant magnetic scattering on magnetic samples. The dynamics of laser-induced ultrafast demagnetization are probed and longer pump wavelengths are found to increase the initial quenching levels.
**Tu4A.17**

*Observation of Laser-Assisted (e,2e) in Ultrashort Intense Laser Fields*, Takashi Hiroi¹, Yuya Morimoto², Reika Kanya¹, Kaoru Yamanouchi¹; ¹The Univ. of Tokyo, Japan; ²Friedrich-Alexander Universität Erlangen-Nürnberg, Germany. We observed one-photon energy exchange process of laser-assisted electron impact ionization of argon in intense laser fields, and the increase of the signal intensity due to light-dressing effect was revealed.

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**Tu4A.18**

*Electron Correlation in Double Ionization of H$_2$S by Near Circular Laser Fields*, Sarayoo Kangaparambil¹, Vaclav Hanus¹, Martin Dorner-Kirchner¹, Seyedreza Larimian¹, Andrius Baltuska¹, Markus Kitzler-Zeiler¹, Xinhuaxie¹; ¹Technische Universität Wien, Austria; ²Paul Scherrer Inst., Switzerland. We report an experimental study of electron correlation in strong field double ionization of H$_2$S by near circular laser fields. Three types of electron correlation were observed from the kinetic-energy-released-resolved measurements.

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**Tu4A.19**

*Front and rear surface ablation within gold films with variable film thickness induced by ultrafast laser radiation*, Markus Olbrich², Theo Pflug², Alexander Horn²; ¹Institut für Physik, Technische Universität Chemnitz, Germany; ²Laserinstitut Hochschule Mittweida, Hochschule Mittweida, Germany. The interplay of front and rear surface ablation is discussed by performing two-temperature hydrodynamic (TTMHD) modeling to explain the experimentally obtained ablation structures on gold films, whereby the modeling is further validated by ultrafast metrology.

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**Tu4A.20**

*Towards Real-Time Monitoring of Interfacial Chemical Dynamics with Time-Resolved X-ray Photoelectron Spectroscopy*, Matthew Fraund¹, Mario Borgwardt¹, Johannes Mahl¹, Felix Brausse¹, Friedrich Roth², Monika Blum³, Oliver Gessner¹; ¹Chemical Sciences Division, Lawrence Berkeley National Laboratories, USA; ²Inst. of Experimental Physics, TU Bergakademie Freiberg, Germany; ³Physics Dept., Universität Hamburg, Germany; ²Advanced Light Source, Lawrence Berkeley National Laboratory, USA. Picosecond time-resolved ambient-pressure X-ray photoelectron spectroscopy of gold nanoparticle-sensitized titanium dioxide indicates similar charge injection yields but significantly different recombination dynamics after photoexcitation in dry and water-coated conditions.

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**Tu4A.21**

*Rescattering of low energy photoelectrons by extremely long wavelengths*, Martin Ranke¹, Sophie Walter¹, Anastasios Dimitriou¹, Markus Pfau¹, Malte Sumfleth¹, Mark J. Prandolini¹, Thomas Gebert¹, Andrey Kazansky¹, Nikolay Kabachnik¹, Ulrike Frühling¹; ¹Universität Hamburg, Germany; ²DESY, Germany; ³Max-Planck-Institut, Germany; ²ikerbasque, Spain. Angle resolved spectra of photoelectrons generated by multiphoton ionization in the presence of THz-light fields were measured. We observed a strong electron modulation for different THz phases, which we attribute to momentum transfers caused by rescattering at the ionic core.

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**Tu4A.22**

*Ultrafast Probing of the Dielectric Response of Nanoplasmonic Systems*, Zsuzsanna Pápa¹,², Janos Csontos²,³, Peter Dombi², Judit Budai²,³; ¹Wigner Research Inst. for Physics, Hungary; ²ELI-HU Nonprofit Ltd., Hungary; ³Optics and Quantum Electronics, Univ. of Szeged, Hungary. We demonstrate results of plasmon-associated probing of the dielectric properties of metallic surface nanostructures utilizing ultrafast ellipsometry. Monitoring changes in the dielectric function allows for tracking plasmon related transitions and decay mechanisms.
Tu4A.23
Terahertz-Induced Electron Emission from a Gold Surface, Ashutosh Sharma1, Fulop Jozsef1; 2ELI-ALPS Research Inst., Hungary. Electron emission from a gold surface was observed at THz peak field strengths above 40 kV/cm. Flipping the polarity of the THz pulses resulted in a significantly different current signal. The electron signal, also measured as function of the THz polarization angle, showed double maxima.

Tu4A.24
Second harmonic generation driven by petahertz non-linear current in a centrosymmetric organic superconductor, Yohei Kawakami1, Tatsuya Amano1, Hirozumi Ohashi1, Hirotake Itoh1, Takahiko Sasaki1, Kenji Yonemitsu2, Shinichiro Iwai1; 1Tohoku Univ., Japan; 2Physics, Chuo Univ., Japan. In a centrosymmetric organic superconductor, a non-linear petahertz current driven by a single-cycle 6 femtosecond field shows up as SHG. The SHG represents a CEP sensitive nature and an enhancement near the superconducting temperature.

Tu4A.25
Role of band structure on solid-state high-order harmonic generation, Long Lin1, Peng-Cheng Li1, Shih-I Chu2; 1Shantou Univ., China; 2Univ. of Kansas, USA. We adopt a derivative-free unconstrained optimization algorithm to optimize the band structure for the SHHG, and investigate the sensitivity of the SHHG to the band structure of the solid. We find that the band structure play an important role in SHHG.

Tu4A.26
Ultrafast spectroscopy of transparent dye-sensitized solar cells designed for the near-infrared, Ilias Nikolinakos1, Naim Waad2, Vittoria Novelli3, Nadia Barbero3, Iva Dzeba2, Fionnuala Grifoni3, Claudia Barolo3, Frédéric Sauvage3, Stefan Haacke1; 1IPCMS-Univ. of Strasbourg, France; 2Laboratoire de Réactivité et Chimie des Solides, Université de Picardie Jules Verne, France; 3NIS InterDept.al and INST M Reference Centre, Univ. of Torino, Italy. We report here femtosecond transient absorption studies of a novel cyanine derivative near-IR absorbing dye incorporated in transparent solar cell devices of record efficiency, revealing dye-aggregation as the main injection yield limiting factor.

Tu4A.27
Atto-FTH - Fourier Transform Holography Beyond the Temporal Coherence Limit, Sici Wang1, Wilhelm Eschen1, Chang Liu1, Michael Steinert1, Thomas Pertsch1, Jens Limpert1, Jan Rothhardt1; 1Inst. of Applied Physics, Germany. We present a lensless imaging method which allows combining high temporal and high spatial resolution. We demonstrate a spatial resolution of 38nm with an XUV bandwidth supporting 320as pulse duration.

• 16:00
Observation of Dynamical Bloch Oscillations in Dielectrics, Jan Reislöhner1, Doyeong Kim1, Adrian N. Pfeiffer1; 1Friedrich Schiller Univ. Jena, Germany. The effect that the current alternates direction when the electrons leave the first Brillouin zone is observed with noncollinear spectroscopy. The onset of Bloch oscillations is mapped into an interference trace.

Tu4A.28
Raman effect in the spectral broadening of ultrashort laser pulses in hydrocarbon molecules, Reza Safaei1, Ojoon Kwon1, Guangyu Fan1, Philippe Lassonde1, Bruno E. Schmidt1, Heide Ibrahim1, François Légaré1; 1INRS-EMT, Canada. A conventional hollow-core fiber (HCF) scheme is implemented to investigate the effect of group velocity dispersion (GVD) and Raman scattering in spectral broadening in molecular gases for low energy pulse compression application.
Tu4A.29
Strain effect on the orientation-dependent harmonic spectrum of monolayer aluminum nitride, Ziwen Wang¹, Chao Yu¹, Ruifeng Lu¹, ²Dept. of Applied Physics, Nanjing Univ. of Science and Technology, China; ²State Key Laboratory of Molecular Reaction Dynamics, Dalian Inst. of Chemical Physics, Chinese Academy of Sciences, China.
The theoretical investigation of the strain effect on the orientation-dependent high-order harmonic generation (HHG) of monolayer aluminum nitride (AlN) by solving the multiband semiconductor Bloch equations in strong laser fields.

Tu4A.30
Ultrafast Dynamics of Singlet Excitons in Perylene Derivative Nanoparticles, Chris Rehhagen², Shanawaz Rafiq¹, Gregory D. Scholes¹, Stefan Lochbrunner¹; ¹Frick Chemistry Laboratory, Princeton Univ., USA; ²Inst. of Physics, Univ. of Rostock, Germany.
The ultrafast exciton dynamics of Perylene Red nanoparticles is investigated by transient absorption spectroscopy. The singlet exciton moves incoherently in the nanoparticle with a diffusion constant of 0.22nm²/ps till it decays into a dark state within 85 ps.

Tu4A.31
Angle-resolved Photoelectron Spectroscopy of large Water Clusters ionized by an XUV Comb, Lorenzo Colaizzi¹,², Loren Ban³, Vincent Wanie¹,², Krishna Saraswathula¹, Erik P. Månsson¹, Philipp Rupp⁵,⁶, Qingcao Liu⁵,⁶, Lennart Seifert¹, Elisabeth A. Herzig⁷, Andrea Cartella¹,³, Bruce L. Yoder³, Andrea Trabattoni¹, Matthias F. Kling⁵,⁶, Thomas Fennel⁷, Ruth Signorell³, Francesca Calegari¹,³, ¹Center for Free-Electron Laser Science, DESY, Germany; ²Physics Dept., Univ. of Hamburg, Germany; ³Dept. of Chemistry and Applied Biosciences, ETH Zürich, Switzerland; ⁴Institut National de la Recherche Scientifique, Canada; ⁵Max Planck Inst. of Quantum Optics, Germany; ⁶Dept. of Physics, Ludwig-Maximilians-Universität München, Germany; ⁷Inst. of Physics, Univ. of Rostock, Germany; ⁸The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Germany.
We performed angle-resolved photoelectron spectroscopy of water clusters ionized by an extreme-ultraviolet attosecond pulse train. A clean signature of the clusters was isolated from the water monomer contribution, to be used for time-resolved attosecond spectroscopy.

Tu4A.32
Ultrafast Dynamics of Photosensitizers based on Fe(II), Ayla Päpcke¹, Jakob Steube², Yannik Vukadinovic², Matthias Bauer², Stefan Lochbrunner¹; ¹Universität Rostock, Germany; ²Univ. of Paderborn, Germany.
The increase in lifetime of the potentially photocatalytic active ³MLCT state of Fe(II) complexes upon ligand design is characterized by ultrafast absorption spectroscopy to guide the development of Fe based photosensitizers.

Tu4A.33
Ultrafast formation dynamics of excited neutral nitrogen molecules inside femtosecond laser filaments, Xiang Zhang¹, Rostyslav Danylo¹, Zhengquan Fan¹, Dongjie Zhou¹, Qi Li¹, Bin Zhou¹, Qingqing Liang¹, Songlin Zhuang¹, Aurelien Houard¹, Andre Mysyrowicz¹, Eduardo Oliva³, Yiu Liu¹; ¹Univ. of Shanghai for Sci. and Tech., China; ²Laboratoire d’Optique Appliquee, France; ³Universidad Politécnica de Madrid, Spain.
We examined the formation dynamics of excited neutral nitrogen molecules inside femtosecond filaments, with a laser-induced fluorescence depletion technique. Our results suggest that the excitation of neutral N₂ occurs via collisions with energetic free electrons.

Tu4A.34
Study of Molecular Ionization and Dissociation with a Strong Field Autocorrelator, Hongtao Hu¹, Sarayoo Kangaparambil¹, Vaclav Hanus³, Martin Dorner-Kirchner¹, Andrius Baltuska¹, Markus Kitzler-Zeiler¹, Xinhua Xie¹,²; ¹Technische Universität Wien, Austria; ²Paul Scherrer Inst., Switzerland.
We present strong field autocorrelation measurements of molecular ionization and dissociation with a reaction microscope. Time-frequency analysis of the time-domain signals was performed to obtain electron and nuclear dynamics during molecular ionization and dissociation.
**Oscillatory Dynamics of the Spin-Boson Model with Ultrastrong Interactions with the Environment**, Nirmalendu Acharyya¹, Martin Richter¹,², Benjamin Fingerhut¹; ¹Max-Born-Institut, Germany; ²Friedrich-Schiller-Universität Jena, Germany. We numerically investigate the impact of non-diagonal system-bath interaction on real-time dissipative dynamics of the Spin-Boson model. For Ohmic environments, a novel class of coherences emerges that induce longtime entanglement between system and environment.

**Femtosecond Energy Transfer Between Coupled Localized Surface Plasmon Resonances**, Uri Arieli¹, Haim Suchowski¹; ¹Tel-Aviv Univ., Israel. We present an ultra-broadband interference microscope for measuring ultrafast response of broadband femtosecond pulses. We use this setup to unravel the ultrafast linear dynamics of coupled Localized Surface Plasmon Resonances.

**Breather soliton in mode-locked laser**, Tianhao Xian¹, Li Zhan¹; ¹Shanghai Jiao Tong Univ., China. We generate breather solitons in a mode-locked laser. Using fast detection, we observe the spectral and roundtrip time evolution of the breathers. A total 7.13 fs roundtrip time jitter is observed for the first time.

**Giant AC Stark Effect in a Strongly-Coupled Light-Matter System**, Dmitry Panna¹, Nadav Landau¹, Liron Gantz¹, Leonid Rybak¹, Shai Tsesses¹, Guy Adler¹, Sebastian Brodbeck², Christian Schneider², Sven Höfling², Alex Hayat¹; ¹Technion, Israel; ²Universität Würzburg, Germany. We demonstrate experimentally non-perturbative modulation of a strongly coupled light-matter system – stronger than the Rabi energy, allowing for a wide range of applications, such as ultrafast all-optical polaritonic switches and phase imprinting on polariton condensates.

**Symmetry aspects of attosecond transient absorption spectroscopy in a dielectric crystal**, Shunsuke Yamada¹, Kazuhiro Yabana¹; ¹Univ. of Tsukuba, Japan. A relation between the crystalline symmetry and the transient modulation of optical properties of dielectric crystal in attosecond transient absorption spectroscopy is presented. Taking 4H-SiC as an example, first-principles calculations confirm the symmetry relation.

**On the absence of phonon bottleneck in lead selenide quantum dot**, Luye Yue¹, Lele Yang¹, Jingjun Li¹, Dong Liu¹, Yingpeng Qi², Xuan Wang², Jianming Cao¹; ¹Center for Ultrafast Science and Technology, Key Laboratory for Laser Plasmas (Ministry of Education) and School of Physics and Astronomy, Shanghai Jiaotong Univ., China; ²Beijing National Laboratory for Condensed Matter Physics, Inst. of Physics, Chinese Academy of Sciences, China; ³Physics Dept. and National High Magnetic Field Laboratory, Florida State Univ., USA; ⁴Songshan Lake Materials Laboratory, China; ⁵School of Science, Shandong Jiaotong Univ., China. We observed the ultrafast lattice dynamic in lead selenide (PbSe) quantum dots using ultrafast electron diffraction. The electron-phonon coupling time constant is about 10 ps, showing no sign of phonon bottleneck.

**Role of the bound states in below-threshold harmonic generation of Cs atom**, Zhi-Bin Wang¹, Chun-Xiang Guo¹, Zhi-Hong Jiao¹, Peng-Cheng Li¹, Shih-I Chu³; ¹Northwest Normal Univ., China; ²Shantou Univ., China; ³Univ. of Kansas, USA. We present an ab initio investigation of below-threshold harmonic generation (BTHG) of Cs atom in intense mid-infrared laser fields by solving the time-dependent Schrödinger equation. We find that the bound states play an important role in the channel selection process for BTHG.
Tu4A.42
Forward and Backward Emission of Two-Photon Laser Induced Fluorescence, Kai Wang, Yejun Wang, Jizhou Wang, Zhenhua Yi, Yujie Shen, Waruna Kulatilaka, Alexei Sokolov, Marlan Scully; Texas AM Univ., USA. Two-photon laser induced fluorescence (TPLIF) in Kr is studied using femtosecond pump-probe technique. Forward and backward radiations have shown different behaviors, which implicate the different physical process for TPLIF in forward and backward direction.

Tu4A.43
Multielectron trace of back reaction in high-harmonic generation, Alba de las Heras, CARLOS HERNÁNDEZ GARCÍA, Luis Plaja; Universidad de Salamanca, Spain. We describe back-reaction as a novel correlation mechanism in the two-electron dynamics of helium atoms exposed to intense laser fields. The electron-electron correlation information is encoded as a high-energy secondary plateau in high-harmonic spectroscopy.

Tu4A.44
Laser-Enabled Control of Interatomic-Coulomb-Decay Dynamics, Predrag Ranitovic, Craig W. Hogle, Leigh Martin, Xiao-Min Tong, Kiyoshi Ueda, Tsventa Miteva, Lorenz S. Cederbaum, Henry C. Kapteyn, Margaret Murnane; Univ. of Colorado at Boulder JILA, USA; Center for Computational Sciences, Univ. of Tsukuba, Japan; Inst. of Multidisciplinary Research for Advanced Materials, Tohoku Univ., Japan; Laboratoire de Chimie Physique, Sorbonne Université, France; Theoretical Chemistry, PCI, Universität Heidelberg, Germany. Interatomic-Coulomb-Decay (ICD) processes play an important role in the interaction of X-rays with biological systems. Here, we present the first successful experimental demonstration that enables and precisely times the outcome of an ICD process in an argon dimer, utilizing ultrafast XUV and IR radiation.

Tu4A.45
Nonlinear plasmonic response in GaAs/InGaAs core/shell nanowires, Rakesh Rana, Leila Balaghi, Ivan Fotev, Harald Schneider, Manfred Helm, Emmanouil Dimakis, Alexej Pashkin; Helmholtz-Zentrum Dresden-Rossendorf, Germany; Inst. of Ion Beam Physics and Materials Research, Helmholtz Zentrum Dresden Rossendorf, Germany; Center for advancing electronics Dresden (cfaed), Technische Universität Dresden, Germany. We show nonlinear plasmonic response in GaAs/InGaAs nanowires using high field terahertz pulses. With increasing THz field, plasmon resonance is redshifted, and spectral weight decreases indicating an inhomogeneous intervalley electron scattering across the nanowire.

Tu4A.46
Optics-Free Focusing and Application to Spectral Filtering of XUV Beam, Constance Valentin, Kevin Veyrinas, Jan Vabek, Dominique Descamps, Clement Pejot, Frederic Burgy, Fabrice Catoire, Eric Constant, Eric Mevel; CNRS - CELIA, France; ELI Beamline, Czechia; CNRS - ILM, France; Université Bordeaux CELIA, France. We experimentally characterize XUV intensity profiles and wavefronts, and demonstrate XUV beams focusing without resorting any optics. We use this coherent effect to spectrally filter group of harmonics. Simulations show possible control of attosecond temporal structure.

Tu4A.47
Ultrafast Dynamics of Excitons in 2D Nanobubbles, Zachary H. Withers, Sharad Ambardar, Rana Kamb, Dmitri Voronine; Univ. of South Florida, USA. Nanobubbles in monolayer transition metal dichalcogenides (TMDs) exhibit strong excitonic properties controlled by strain, with promising applications in nanoeengineering. We simulate ultrafast exciton dynamics in coupled nanobubbles in TMD heterostructures, motivating novel tip-enhanced experimental techniques.
Tu4B.1
Characterization of Attosecond Pulse Train and Nonlinear Fourier Transform Spectroscopy in Dissociative Ionization of Acetylene, Takuya Matsubara\textsuperscript{1,2}, Shinichi Fukahori\textsuperscript{1,2}, Yasuo Nabekawa\textsuperscript{1}, Kaoru Yamanouchi\textsuperscript{2}, Katsumi Midorikawa\textsuperscript{1}; \textsuperscript{1}RIKEN Center for Advanced Photonics, Japan; \textsuperscript{2}Dept. of Chemistry, The Univ. of Tokyo, Japan. An attosecond pulse train consisting of \textasciitilde 210 as pulses is characterized by interferometric autocorrelation measurements of dissociative ionization of C\textsubscript{2}H\textsubscript{2}. The selective C-C bond breaking of C\textsubscript{2}H\textsubscript{2}\textsuperscript{+} by the 7th harmonic is identified.

Tu4B.2
Multicolor Concentric Annular Ultrafast Vector Beams, Shunlin Huang\textsuperscript{1,2}, Peng Wang\textsuperscript{2}, Xiong Shen\textsuperscript{2}, Jun Liu\textsuperscript{2,3}; \textsuperscript{1}School of Physics Science and Engineering, Tongji Univ., China; \textsuperscript{2}Shanghai Inst. of Optics and Fine Mechanics, China; \textsuperscript{3}Univ. Center of Materials Science and Optoelectronics Engineering, Univ. of Chinese Academy of Sciences, China. We demonstrate generation of novel multicolor concentric annular ultrafast vector beams by using cascaded four-wave mixing in a glass plate pumped by two intense vector femtosecond pulses.

Tu4B.3
Ultrafast laser spectral reshaping and carrier-frequency control by intense terahertz fields in electro-optic materials, Flavio Giorgianni\textsuperscript{1}, Uros Puc\textsuperscript{2}, Mojca Jazbinsek\textsuperscript{2}, Min-Jeong Koo\textsuperscript{3}, Jae-Hyun Han\textsuperscript{3}, O-Pil Kwon\textsuperscript{3}, Carlo Vicario\textsuperscript{1}; \textsuperscript{1}Paul Scherrer Institut, Switzerland; \textsuperscript{2}Univ. of Applied Sciences, Switzerland; \textsuperscript{3}Ajou Univ., Korea (the Republic of). Intense terahertz fields induce a time-varying phase modulation by Pockels and Kerr effects, which causes spectacular spectral modifications of a co-propagating near-infrared laser. The results open new prospects for light modulation at terahertz frequency.

Tu4B.4
High-power OPCPAs at 1.45 – 2.4 µm and up to 100 W power scalability, Jan Heye Buss\textsuperscript{1}, Michael Schulz\textsuperscript{1}, Ivanka Grgruras\textsuperscript{1}, Torsten Golz\textsuperscript{1}, Mark Prandolini\textsuperscript{1,2}, Robert Riedel\textsuperscript{1}; \textsuperscript{1}Class 5 Photonics GmbH, Germany; \textsuperscript{2}Inst. for Experimental Physics, Univ. Hamburg, Germany. A high-power optical parametric chirped-pulse amplifier (OPCPA) at 1.45 – 2.40 µm wavelength, pumped by Yb-based solid-state lasers with average power scalability up to 100 W and pulse durations in the few-cycle regime is presented.

Tu4B.5
Generation of CEP-stable half-cycle 10 μm pulses through two-color laser-induced filamentation, Wei-Hong Huang\textsuperscript{1,2}, Fumitoshi Kumaki\textsuperscript{1}, Chih-Wei Luo\textsuperscript{2}, Takao Fuji\textsuperscript{1}; \textsuperscript{1}Toyota Technological Inst., Japan; \textsuperscript{2}National Chiao Tung Univ., Taiwan. We have experimentally demonstrated the generation of half-cycle pulses with the center wavelength of 10 μm through two-color filamentation in nitrogen with the duration of 12 fs, which corresponds to 0.36 cycles.

Tu4B.6
Supercontinuum spectral phase interferometry with isolated attosecond pulse, Hiroki Mashiko\textsuperscript{1}, Akihiro Oshima\textsuperscript{2,1}, Ming Chen\textsuperscript{3}, Koji Asaga\textsuperscript{4,1}, Ikufumi Katayama\textsuperscript{2}, Jun Takeda\textsuperscript{2}, Tadashi Nishikawa\textsuperscript{4}, Katsuya Oguri\textsuperscript{1}; \textsuperscript{1}NTT Basic Research Laboratories, Japan; \textsuperscript{2}Dept. of Physics, Yokohama National Univ., Japan; \textsuperscript{3}Inst. of Photonics Technologies, National Tsing Hua Univ., Taiwan; \textsuperscript{4}Dept. of Electronic Engineering, Tokyo Denki Univ., Japan. We demonstrate supercontinuum spectral phase interferometry with an isolated attosecond pulse (IAP). The interferogram indicates a high degree of temporal coherence over the full IAP continuous spectrum, which will contribute to exploring dispersive electron dynamics.
Tu4B.7
Two-Photon Excitation of an Exciton-Polariton Condensate, Nadav Landau¹, Dmitry Panna¹, Sarit Feldman¹, Sebastian Brodbeck², Christian Schneider², Sven Höfling², Alex Hayat¹; ¹Technion, Israel; ²Universität Würzburg, Germany. We observe two-photon excited condensation of microcavity exciton-polaritons using angle- and time-resolved photoluminescence spectroscopy. Our results pave the way towards high-intensity THz source via stimulated transition from two-photon excited 2p excitons to the lower-polariton condensate.

Tu4B.8
Double the efficiency with flat-top beam shaping in a multi-mJ MIR OPCPA at 10 kHz repetition rate, xiao zou³, Wenkai Li³, Shizhen Qu³, Kun Liu³, Hao Li², Qijie Wang³, Ying Zhang³, Houkun Liang²,¹; ¹Sichuan Univ., China; ²Singapore Inst. of Manufacturing Technology, Singapore; ³Nanyang Technological Univ., Singapore. We report a flat-top pumped MIR OPCPA through engineering the pump profile via diffractive optical elements, that doubles the efficiency and produces 3 µm pulses with 2.7 mJ pulse energy at 10 kHz repetition rate.

Tu4B.9
Efficient multi-cycle terahertz generation via difference frequency generation of a multiple-lines source, Wenlong Tian²,¹, Halil Olgun², Lu Wang²,³, Giovanni Cirmi²,⁴, Yi Hua²,⁴, Damian Schimpf², Hüseyin Çankaya²,³, Mikhail Pergament², Michael Hemmer², Nicholas Matlis², Franz Kärtner²,⁴; ¹Xidian Univ., China; ²DESY, Germany; ³Physics Dept., Univ. of Hamburg, Germany; ⁴Hamburg Centre for Ultrafast Imaging, Germany. We demonstrated the efficient multi-cycle 0.5 THz generation within a periodically poled lithium niobate via difference frequency generation of a multiple-lines source. With 130 mJ/cm² pump fluence, the internal optical-THz efficiency is up to 0.3%.

Tu4B.10
Near-Fully Efficient, Back-Conversion Suppressed OPA and Efficient Upconversion of Fractional Harmonics, Noah Flemens¹, Nick Swenson¹, Jeffrey Moses¹; ¹Cornell Univ., USA. We show simultaneous phase matching of OPA and idler SHG suppresses back-conversion in OPA. Spatiotemporal analysis of LNB-based devices demonstrates femtosecond pulse amplification with 45% signal energy efficiency and efficient fractional-harmonic upconversion of the pump.

Tu4B.11
Tunable Third Harmonic Vacuum Ultraviolet Coherent Light Generation Using Dielectric Nanomembranes, Kuniaki Konishi¹,², Daisuke Akai³, Yoshio Mita⁴, Makoto Ishida³, Junji Yumoto¹,³, Makoto Kuwata-Gonokami⁵; ¹Inst. for Photon Science and Technology, The Univ. of Tokyo, Japan; ²PRESTO, Japan Science and Technology Agency, Japan; ³Electronics-Inspired Interdisciplinary Research Inst., Toyohashi Univ. of Technology, Japan; ⁴Dept. of Electrical and Electronic Engineering, The Univ. of Tokyo, Japan; ⁵Dept. of Physics, The Univ. of Tokyo, Japan. We demonstrate a simple and practical method for generating tunable coherent vacuum ultraviolet light with an adequate intensity for spectroscopic application such as ARPES based on third harmonic generation in dielectric free-standing nanomembranes.

Tu4B.12
Generation of Continuously-Tunable, Narrowband THz Pulses from Phase-Locked Femtosecond Pulse Bursts, Vinzenz Stummer¹, Tobias Flöry¹, Edgar Kaksis¹, Audrius Pugžlys¹,², Andrius Baltuska¹,², Gergo Krizsan³, Gyula Polyóni³, Jozsef Fülöp³; ¹TU Wien, Austria; ²Center for Physical Sciences & Technology, Lithuania; ³Univ. of Pecs, Hungary; ⁴ELI Alps, Hungary. We demonstrate generation of continuously-tunable, narrowband THz pulses from phase-locked multi-millijoule femtosecond pulse bursts by optical rectification in a tilted-pulse-front setup. Experimental results indicate advances in both femtosecond pulse burst and high-energy THz source technology.
Tu4B.13
Generation of a Femtosecond Optical Vortex at 2 µm, Yongguang Zhao¹,², Li Wang³, Weidong Chen¹, Xiaodong Xu², Pavel Loiko⁴, Xavier Mateos⁵, Zhengping Wang⁵, Xinguang Xu⁵, Uwe Griebner¹, Valentin Petrov¹; ¹Max-Born Inst., Germany; ²Jiangsu NORMAL Univ., China; ³Université de Caen, France; ⁴Universitat Rovira i Virgili (URV), Spain; ⁵Shandong Univ., China. A mode-locked solid-state laser in combination with a single-cylindrical-lens mode-converter is employed to produce a femtosecond optical vortex. The bandwidth-limited 112-fs pulses represent the shortest duration for a vortex laser in the 2-µm spectral range.

Tu4B.14
Simultaneous Measurement of Two Femtosecond Pulses and Interpulse Delay for Two-colour Pump-probe Experiments, Miguel Miranda², Allan Pettipher³, Miguel Canhota¹, Rosa Romero², Helder M. Crespo²,¹, John Tisch¹; ¹Universidade do Porto, Portugal; ²Sphere Ultrafast Photonics, Portugal; ³Blackett Laboratory, Imperial College, UK. We numerically demonstrate the simultaneous measurement of the complete temporal profile and interpulse delay of two few-cycle 10-fs laser pulses with different wavelengths using a single dispersion scan measurement.

Tu4B.15
Stabilization of Mach Zehnder Interferometer in a sub-cycle shortwave-infrared OPA system, Y. C. Lin¹, Yasuo Nabekawa¹, Katsumi Midorikawa¹; ¹RIKEN, Japan. We stabilize a Mach-Zehnder-Interferometer including an AOPDF in each arm for compensating for dispersion of an over-octave shortwave-infrared spectrum, 0.9-2.4 µm. The phase jitter is estimated to be 130 mrad. This scheme was adopted in the OPA system to generate 4.4 fs (0.73 cycles) pulses at 1.8 µm.

Tu4B.16
Post-Compression of Picosecond Pulses to Four Optical Cycles via Multi-Pass Spectral Broadening, Prannay Balla¹,², Ammar Bin Wahid¹, Ivan Sytcevich³, Chen Guo¹, Anne-Lise Viotti¹, Laura Sillitti¹, Andrea Cartella⁴, Skirmantas Alisauskas¹, Hamed Tavakoli¹, Uwe Grosse-Wortmann¹, Arthur Schönberg¹,², Marcus Seidel¹, Bastian Manschwetus¹, Tino Lang¹, Andrea Trabattoni¹, Francesca Calegari¹,², Arnaud Couairon¹,², Cord L. Arnold³, Ingmar Hartl¹, Christoph M. Heyl¹,²; ¹Deutsches Elektronen-Synchrotron DESY, Germany; ²Helmoltz-Inst. Jena, Germany; ³Dept. of Physics, Lund Univ., Sweden; ⁴The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Germany; ⁵Centre de Physique Théorique, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, Germany. We demonstrate post-compression of 1.2 ps pulses to the few-cycle regime via multi-pass spectral broadening. We achieve compression factors of 40 via single and >90 via dual stage compression employing mJ pulses.

Tu4B.17
Influence of pulse separation caused by dual-wavelength wave plate on terahertz generation in two-color laser filaments, Jianxin Wang¹, Zhiqiang Yu¹, Weiwei Liu¹; ¹Nankai Univ., China. A femtosecond laser pulse is separated into two pulses with a certain time delay when pulse is incident on a dual-wavelength wave plate. This paper verifies the influence of pulse separation on terahertz generation in two-color laser filaments experimentally and theoretically.

Tu4B.18
Fast Pulse Reconstruction from FROG Traces Using Only Three Time-Shift Steps, Anjun Mao¹,², Chengpu Liu¹; ¹Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China; ²Univ. of Chinese Academy of Sciences, China. The fast reconstruction of an ultrashort laser pulse can be realized from flexibly shaped cross-phase-modulated frequency-resolved optical gating (FROG) traces via ptychography algorithm, which are composed of only three time-shift steps.
Tu4B.19
Experimental quantification of pulse train instabilities using dispersion scan, Benjamín Alonso\textsuperscript{1,2}, Salvador Torres-Peiró\textsuperscript{3}, Rosa Romero\textsuperscript{2}, Paulo T. Guerreiro\textsuperscript{2}, Azahara Almagro-Ruiz\textsuperscript{3}, Pere Pérez-Millán\textsuperscript{4}, Helder M. Crespo\textsuperscript{4,2}; \textsuperscript{1}Univ. of Salamanca, Spain; \textsuperscript{2}Sphere Ultrafast Photonics, Portugal; \textsuperscript{3}FYLA Laser SL, Spain; \textsuperscript{4}Univ. of Porto, Portugal. We apply the self-calibrating d-scan technique to quantify the pulse train instabilities in a fiber laser with supercontinuum generation in a photonic crystal fiber (PCF). Using an all-normal dispersion PCF, stable 15-fs pulses are measured.

Tu4B.20
Efficient THz generation by optical rectification of intense mid-infrared pulses in organic crystals, Claudia Gollner\textsuperscript{1}, Mostafa Shalaby\textsuperscript{2}, Ignas Astrauskas\textsuperscript{1}, Corinne Brodeur\textsuperscript{2}, Andrius Baltuska\textsuperscript{1,3}, Audrius Pugzlys\textsuperscript{1,3}; \textsuperscript{1}TU Wien, Austria; \textsuperscript{2}Swiss Terahertz-Research, Switzerland; \textsuperscript{3}Center for Physical Sciences & Technology, Lithuania. We report on efficient THz generation in DAST, driven by mid-infrared pump sources. Due to the suppression of multi-photon absorption, high pump fluences can be applied and outstanding optical to THz conversion efficiencies of more than 4\% can be reached.

Tu4B.21
Proposed Approach Based on Optical Parametric Amplification at Critical Wavelength Degeneracy for the Development of 100-PW Class Femtosecond Lasers, Razvan Dabu\textsuperscript{1}; \textsuperscript{1}Inst. Nuclear Physics & Engineering, Romania. At signal critical wavelength, super-broad parametric gain bandwidths can be obtained in nonlinear crystals pumped at degeneracy. Large-size partially deuterated KDP crystals, pumped by green lasers, can amplify \textasciitilde1.1-\textmu m central wavelength, sub-10 femtosecond laser pulses.

Tu4B.22
Carrier to Envelope Phase (CEP) Stable, Few cycle Cr:ZnSe Laser Amplifier., Pavel Komm\textsuperscript{1}, Uzziel Sheintop\textsuperscript{1,2}, Salman Noach\textsuperscript{2}, Gilad Marcus\textsuperscript{1}; \textsuperscript{1}The Hebrew Univ., Jerusalem, Israel; \textsuperscript{2}Jerusalem College of Technology, Israel. Cr:ZnSe laser amplifier resulted more than 40 \textmu J, 72fs pulses, at \lambda 0 \approx 2375nm. The CEP stability of the parametrically generated seed stands firm through 6 orders of magnitude of amplification.

Tu4B.23
Multi-wavelength annular optical pulses generated by double interferent femtosecond Bessel laser beams in silica glass, Zhiqiang Yu\textsuperscript{1}, Nan Zhang\textsuperscript{1}, Dan Lu\textsuperscript{1}, Weiwei Liu\textsuperscript{1}; \textsuperscript{1}Nankai Univ., China. The resonance-enhanced four-wave mixing is the reason for focusing Bessel beams on UV-visible fused silica to generate multi-wavelength ultrashort optical pulses. The interference of two beams of light can enhance the signal output.

Tu4B.24
Proposal for Generating Pairs of Synchronized Ultrafast Electron Bunches, Shanny Pelchat-Voyer\textsuperscript{1,2}, Michel Piché\textsuperscript{1,2}; \textsuperscript{1}Université Laval, Canada; \textsuperscript{2}Centre d’Optique, Photonique et Laser, Canada. We show using test-particle simulations that the method of direct-field acceleration could be used to generate pairs of synchronized electron bunches from low-density gases or micrometric targets.

Tu4B.25
Towards high repetition rate ultra-intense lasers, latest developments at Amplitude Technologies, Olivier Zabiolle\textsuperscript{1}; \textsuperscript{1}Amplitude Shanghai Laser, China. We will present our latest results on ELI-ALPS 2 PW at 10Hz laser with 17 fs pulse duration and its pump laser who deliver 50 J at 10 Hz in one single beam.
Study of Temporal, Spectral and Energy Fluctuations of SASE FEL Pulses, Ivette Jazmin Bermudez Macias¹, Rosen Ivanov¹, Guenter Brenner¹, Jia Liu², Mikhail Yurkov¹, Stefan Duesterer¹; ¹Deutsches Elektronen-Synchrotron, Germany; ²European XFEL, Germany. We present an investigation into the fluctuations of pulse duration, spectral distribution and pulse energy of SASE XUV pulses at FLASH on a shot-to-shot basis, and corroborate the experimental findings with simulations.

Elliptical terahertz generation by two-color lineally polarized strong laser pulses, Guoli Wang¹, Wentao Zhang¹, Lei Zhang²; ¹Northwest Normal Univ., China; ²School of Mathematics and Physics, Lanzhou Jiaotong Univ., China. We theoretically investigate the polarization characteristics of terahertz radiations generated by two-color nonparallel linearly polarized $\omega$ and $2\omega$ pulses. Some new findings are worthy of confirmation with more investigations.

The Loss of Coherence Between Rotational States of N$_2^{+}$, Yuxuan Zhang¹, Yulan Wu¹, Rao Chen¹, Shaohua Sun¹, Zuoye Liu¹; ¹Lanzhou Univ., China. The N$_2^{+}$ lasing spectra with varying time delays are measured with two different polarizations of pump pulse. The inhibited time-dependent oscillation indicates that the polarization-modulated pump pulse can reduce the coherence between different rotational states.

Attosecond time delay in multiphoton ionization, Weifeng Yang¹, Xiaohon g Song¹, Xiwang Liu¹; ¹Shantou Univ., China. We uncover the time information about ionization and scattering encoded in the recent phase measurements of ATI electrons in multiphoton ionization regime with generalized quantum trajectory Monte Carlo method.

Ultrafast Charge Transfer in a Charged Dipeptide Induced by Absorption of UV Light, Alexie Boyer¹, Marius Hervé¹, Richard Brédy¹, Isabelle Compagnon¹, Abdul Rahman Allouche¹, Franck Lépine¹; ¹ILM Univ Lyon1, France. Combination of controlled ion molecular beam and ultrafast laser technology has been used to probe ultrafast dynamics in a dipeptide. Our results show evidence of charge transfer, of a few tens of picoseconds, induced by UV absorption.

Relaxation of Complex Electronic Resonances in Molecules Controlled by Shaped Laser Pulses, Camilo Granados¹, Nicola Mayer¹, Evgenii Ikonnikov¹, Oleg Kornilov¹; ¹Max-Born Inst., Germany; ²Max Born Inst., Germany. Relaxation of complex resonances studied in our recent work on XUV-NIR pump-probe spectroscopy of N$_2$ and naphthalene is affected by quantum interferences. Here we explore control of the relaxation by shaped NIR pulses.

Enhancing Linear Accelerator and X-ray Free Electron Laser Brightness with Tailored Laser-Electron Interactions, Sergio Carbajo¹; ¹SLAC National Accelerator Laboratory, USA. we will review spatio-temporally tailored laser-electron interactions that enhance linear accelerator and free electron laser brightness to advance ultrafast X-ray spectroscopies
Tu4B.33
Integral Representation of Weak-Field Asymptotic Theory Using Density Functional Orbitals and Potentials for an Efficient and Qualitatively Accurate Calculation of Angle Dependent Ionization Rate, Imam Wahyutama¹, Kenneth Lopata²,³, Mette B. Gaarde¹, Kenneth J. Schafer¹; ¹Physics and Astronomy, Louisiana State Univ., USA; ²Chemistry, Louisiana State Univ., USA; ³Center for Computation and Technology, Louisiana State Univ., USA. We explore the implementation of weak-field asymptotic theory using orbitals and potentials calculated via Density Functional Theory. This provides a way to calculate strong field ionization rates by assuming that the field is constant.

Tu4B.34
Generation of Ultrashort Bias-Free Photocurrent Pulses by Intra-Band Free-Carrier Oscillations Driven by Intense Few-Cycle Laser Pulses in Wide-Band-Gap Crystals, Vitaly Gruzdev¹, Olga Sergaeva²; ¹Univ. of New Mexico, USA; ²Dept. of Physics and Engineering, ITMO Univ., Russia. Analysis of free-carrier oscillations driven by an intense few-cycle laser pulse suggests generation of femtosecond pulse of photocurrent in dielectric and semiconductor crystals at zero external bias. Parametric scaling of peak photocurrent magnitude is reported.

Tu4B.35
Theoretical Proposal for Spatially Tuning EIT by Using Structured Coupling Light in Ultracold ⁸⁷Rb Atomic, Vikas S. Chauhan¹, Rohit Kumar¹, Dixith Manchaiah¹, Raghavan K. Easwaran¹; ¹Physics, Indian Inst. of Technology, India. Lambda type scheme of ⁸⁷Rb atomic medium in a two-dimensional magneto-optical trap (2D MOT) is assumed for the study. The spatial location of the EIT signal is tuned by using the different 'l' values of the structured light.

Tu4B.36
The Critical Opalescence under the Focusing of Shock Waves in Water, Stepan Andreev¹, Konstantin Artemiev², Sergey Kazantsev¹,³; ¹Moscow Polytechnic Univ., Russia; ²Prokhorov General Physics Inst. of the Russian Academy of Sciences, Russia; ³Moscow Technical Univ. of Communications and Informatics, Russia. We show that appearance of a bright luminous area at a certain distance from the water vessel walls, irradiated by powerful pulse of a non-chain HF laser is due to the effect of critical opalescence.

Tu4B.37
Unipolar half-cycle pulses and their applications for efficient excitation and selective ultrafast control of atomic systems, Rostislav Arkhipov¹,², Mikhail Arkhipov¹,², Anton Pakhomov¹, Ihar Babushkin³, Ayhan Demircan³, Uwe Morgner³, Nikolay Rosanov²,⁵; ¹St. Petersburg State Univ., Russia; ²ITMO Univ., Russia; ³Inst. of Quantum Optics, Leibniz Univ. Hannover, Germany; ⁴Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering—Innovation across Disciplines), Germany; ⁵Ioffe Inst., Russia. We discuss recently developed methods of unipolar half-cycle pulse generation in optical and terahertz frequency ranges. We demonstrate their application for effective and selective excitation of atomic level populations in spite of non-resonant interaction.

Tu4B.38
Investigation of joint electron-nuclear dynamics in H₂ using time-dependent multiconfiguration method, Yang Li¹, Takeshi Sato¹,², Kenichi Ishikawa¹,²; ¹Dept. of Nuclear Engineering and Management, Graduate School of Engineering, The Univ. of Tokyo, Japan; ²Research Inst. for Photon Science and Laser Technology, The Univ. of Tokyo, Japan. We developed and numerical implemented a time-dependent multiconfiguration method which is well suitable for the study of coupled electronic and nuclear motion in molecules. Here we apply it to strong-field laser-driven H₂.
Electron-phonon coupling in few layer WS\textsubscript{2} measured by pump-degenerate four-wave mixing, Joseph P. Avenoso\textsuperscript{1}, Daniela Zahn\textsuperscript{2}, Lars Gundlach\textsuperscript{1}; \textsuperscript{1}Univ. of Delaware, USA; \textsuperscript{2}Fritz-Haber-Institut der Max-Planck-Gesellschaft, Germany. Femtosecond pump-degenerate four-wave mixing is employed to measure the ultrafast phonon response triggered by electronic excitation in few layer WS\textsubscript{2}. 2LA(M) and low wavenumber modes facilitate electron-phonon coupling on the picosecond time-scale after excitation.

Angular Dependence of Electron Rescattering in Molecules, Hongtao Hu\textsuperscript{1}, Sarayoo Kangaparambil\textsuperscript{1}, Vaclav Hanus\textsuperscript{1}, Martin Dorner-Kirchner\textsuperscript{1}, Seyedreza Larimian\textsuperscript{1}, Andrius Baltuska\textsuperscript{1}, Martin Dorner-Kirchner\textsuperscript{1}, Seyedreza Larimian\textsuperscript{1}, Andrius Baltuska\textsuperscript{1}, Xinhua Xie\textsuperscript{1,2}; \textsuperscript{1}Technische Universität Wien, Austria; \textsuperscript{2}Paul Scherrer Inst., Switzerland. We report an experimental study of the dependence of strong field ionization and dissociation on molecular alignment. The dependence of electron rescattering probability on molecular alignment can be obtained from the measured non-sequential double ionization yield.

Out-of-Equilibrium Two-Phonon Absorption Processes in Gallium Arsenide, Eugenio L. Cinquanta\textsuperscript{1}, Lorenzo Gatto\textsuperscript{3,2}, Michele Devetta\textsuperscript{1}, Gabriele Crippa\textsuperscript{2}, Salvatore Stagira\textsuperscript{2}, Caterina Vozzi\textsuperscript{1}; \textsuperscript{1}CNR-IFN, Italy; \textsuperscript{2}Dipartimento di Fisica, Politecnico di Milano, Italy; \textsuperscript{3}Dipartimento di Fisica, Università degli Studi di Milano, Italy. Although Gallium Arsenide (GaAs) is one of the most studied semiconductors, its hot carrier and hot phonon dynamics are still debated. Here, we report two-phonon out-of-equilibrium absorption processes in the transient THz response of GaAs.

NBOHCs' photocycle revealed in synthetic silica by transient absorption measurements, Vincenzo De Michele\textsuperscript{1,2}, Alice Sciortino\textsuperscript{2}, Fabrizio Messina\textsuperscript{2}, Marco cannas\textsuperscript{2}, Aziz Boukenter\textsuperscript{1}, Emmanuel Marin\textsuperscript{1}, Sylvain Girard\textsuperscript{1}, Youcef Ouerdane\textsuperscript{1}; \textsuperscript{1}Laboratoire Hubert Curien, France; \textsuperscript{2}Physics and Chemistry, Univ. of Palermo, Italy. We report a set of femtosecond transient absorption experiments with variable UV excitations, which allow clarifying the photocycle of the non-bridging-oxygen-hole-center, one of the key point defects controlling the optical response of amorphous silica.

Photoelectron emission delay in graphene: anisotropic effects of atomic potential, jaedong Lee\textsuperscript{1}, Hyosub Park\textsuperscript{3}, Youngjae Kim\textsuperscript{1}; \textsuperscript{1}DGIST, Korea (the Republic of). We theoretically investigate the effects of the anisotropic potential on EWS delay in graphene. The results show that Eienbud-Wigner-Smith delay is strongly affected by the anisotropy induced by the photo-hole screening in the 2D structure.

All-Optical Ultrafast Valley Current in Graphene, Youngjae Kim\textsuperscript{3}, Jaedong Lee\textsuperscript{1}; \textsuperscript{1}DGIST, Korea (the Republic of). We theoretically suggest that the monolayer graphene has an intrinsic functionality for generation of polarized valley spin currents or valley diodes under the electromagnetic wave even though the graphene is non-Berry curvature system.

Control of signal coherence in an incoherently pumped fiber optical parametric oscillator, Josephine Yi Qiu\textsuperscript{1}, Shuxin Du\textsuperscript{1}, Yiqing Xu\textsuperscript{2,3}; \textsuperscript{1}Huzhou Univ., China; \textsuperscript{2}Physics Dept., University of Auckland, New Zealand; \textsuperscript{3}The Dodd-Walls Centre for Photonic and Quantum Technologies, New Zealand. We report a numerical study of an incoherently pumped fiber optical parametric oscillator. Following the convection-induced phase-locking mechanism, we show that the oscillating sideband can be grown into a higher degree coherence.
Tu4B.46
Probing spectral and temporal fine structures of high-order harmonic generation in laser-driven electron-rescattering, Lin Han, Zhi-Hong Jiao, Peng-Cheng Li, Shi-H-I Chu; ¹Northwest Normal Univ., China; ²Shantou Univ., China; ³Univ. of Kansas, USA. We present an ab initio precision investigation of the subtle details of the spectral and temporal fine structures of high-order harmonic generation in laser-driven electron-rescattering by using a new synchrosqueezing transform method.

Tu4B.47
Gauge-Invariant Time-Dependent Configuration Interaction Singles Method for Molecular Strong Field Physics, Takuma Teramura, Takeshi Sato, Kenichi Ishikawa; ¹The Univ. of Tokyo, Japan. We present a numerical implementation of the gauge-invariant time-dependent configuration interaction singles method for high-order harmonic generation in molecules. We demonstrate successful simulations for propane of low symmetry.

Tu4B.48
The ellipticity of the incident beam can influence the filaments distribution formed by the quarter circle phase plate in air, Jinpei Liu; ¹Nankai Univ., China. In the previous simulations, the initial beam is only modulated by the quarter circle phase plate. However, the results of this paper reveal that the ellipticity of the incident beam can affect multi-filamentation distribution.

Room 1
08:30 -- 10:00
W1A • Attosecond Science
Presider: Kyung Taec Kim; Inst. for Basic Science

W1A.1 • 08:30 (Invited)
Attosecond Dynamical Franz-Keldysh Effect In Core Excitons, Matteo Lucchini, Shunsuke A. Sato, Giacinto D. Lucarelli, Bruno Moio, Giacomo Inzani, Rocío Borrego-Varillas, Fabio Frassetto, Luca Poletto, Hannes Huebener, Umberto De Giovannini, Angel Rubio, Mauro Nisoli; ¹Politecnico di Milano, Italy; ²IFN, CNR, Italy; ³Max Planck Inst. for the Structure and Dynamics of Matter, Germany; ⁴Center for Computational Sciences, Univ. of Tsukuba, Japan; ⁵IFN, CNR, Italy. Sub-cycle MgF₂ core-exciton dynamics was studied by attosecond reflection spectroscopy. We found that the interplay between the crystal and the core-exciton strongly alters the ultrafast material response, introducing a delay as big as 1 femtosecond.

W1A.2 • 09:00
Attosecond Vacuum-Ultraviolet Photoconductive Switching in Dielectrics, Keyhan Golyari, Marcus Osiander, Kevin Scharl, Lukas Lehnert, Florian Siegrist, Dmitry Zimin, Matthew Weidman, Isabella Floss, Valerie Smejkal, Christoph Lemell, Joachim Burgdörfer, Martin Schultze, Ferenc Krausz; ¹Max-Planck-Institut für Quantenoptik, Germany; ²Fakultät für Physik, Ludwig-Maximilians-Universität München, Germany; ³Inst. for Theoretical Physics, Vienna Univ. of Technology, Austria; ⁴Inst. of Experimental Physics, Graz Univ. of Technology, Austria. We demonstrate a petahertz bandwidth single-photon photoconductive switch by populating the conduction band in dielectrics with attosecond vacuum-ultraviolet (VUV) light pulses. Femtosecond pulse-driven currents reveal intra- and inter-band conduction band carrier dynamics.

W1A.3 • 09:15
Attosecond spectroscopy of size-resolved water clusters, Xiaochun Gong, Saijoscha Heck, Denis Jelovina, Hans J. Woerner; ¹Laboratory of Physical Chemistry, ETH Zürich, Switzerland. Ultrafast delocalized hole electron dynamics on attosecond temporal scale, which correlates to different cluster size, is observed in water clusters by a new developed attosecond coincidence metrology.
Attosecond resolution from free running interferometric measurements, Jaco Fuchs¹, Constantin Krüger¹, Laura Cattaneo¹, Ursula Keller¹; ²ETH Zurich, Switzerland. On the attosecond time scale even the smallest portion of timing jitter crucially affects the experimental time resolution. Here, we present a novel analysis technique of attosecond interferometric measurements, which overcomes the effects of jitter.

Theory of Subcycle Linear Momentum Transfer in Strong-Field Tunneling Ionization, Hongcheng Ni¹,², Simon Brennecke³, Xiang Gao³, Pei-Lun He³, Stefan Donsa³, Iva Brezina³, Feng He³, Jian Wu³, Manfred Lein³, Xiao-Min Tong³, Joachim Burgdörfer³; ¹State Key Laboratory of Precision Spectroscopy, East China Normal Univ., China; ²Inst. for Theoretical Physics, Vienna Univ. of Technology, Austria; ³Institut für Theoretische Physik, Leibniz Universität Hannover, Germany; ⁴Key Laboratory for Laser Plasmas (Ministry of Education) and School of Physics and Astronomy, Collaborative Innovation Center for IFS (CICIFSA), Shanghai Jiao Tong Univ., China; ⁵Center for Computational Sciences, Univ. of Tsukuba, Japan. We study the subcycle phase (or time) resolved linear momentum transfer to an atom accessible by an attoclock protocol. We demonstrate an interplay between nonadiabatic and nondipole effects in strong-field tunneling ionization.

High-energy Mid-infrared Femtosecond Pulses for Attosecond Science, Eiji J. Takahashi¹; ¹Extreme Photonics Research Group, RIKEN, Japan. Abstract not available.

Ultrafast Thin-Disk based CPA System with >1kW Output Power and <500fs Pulse Duration, Christoph Wandt¹, Clemens Herkommer¹, Robert Jung¹, Sandro Klingebiel¹, Peter Krötz¹, Michael Rampp¹, Catherine Teisset¹, Knut Michel¹, Thomas Metzger¹; ¹TRUMPF Laser GmbH + Co KG, Germany. A thin-disk based CPA system with a maximum compressed pulse energy of 260mJ at a repetition rate of 1kHz and output powers close to 2kW at 20kHz is presented. Spectral amplitude shaping led to pulse durations of < 500fs at 206mJ.

The ELI-ALPS HR2 Laser System: CEP-Stable Few-Cycle Pulses at 500W of Average Power, Steffen Hädrich¹, Nico Walther¹, Peter Simon², Tamas Nagy³, Andreas Blumenstein³, Evgeny Shestaev¹, Peter Jojart², Zoltan Varallyay⁵, Imre Seres⁵, Adam Bőrzsönyi⁵, Tino Eidam¹, Jens Limpert³,⁴; ¹Active Fiber Systems GmbH, Germany; ²Laser-Laboratorium Göttingen e.V., Germany; ³Max-Born-Institut, Germany; ⁴Inst. of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Germany; ⁵ELI-ALPS, ELI-HU Non-Profit Ltd., Hungary. We present the latest development of the ELI-ALPS HR2 laser towards a 5mJ, 6fs CEP stable output, which will be enabled by post-compression of >1kW, >10mJ fiber CPA system in an 8m long stretched hollow-core fiber.
The 22nd International Conference on Ultrafast Phenomena (UP 2020)
16-19 November 2020

W2A.4 • 11:30
Red-shifted and enhanced spectral broadening by molecular alignment for the multi-TW regime, Guangyu Fan2, reza safaei2, Ojoon Kwon3, Vittoria Schuster4, Katherine Légaré5, Philippe Lassonde2, Alborz Ehteshami2, Loïc Arias4, Antoine Laramée2, Julien Beaudoin-Bertrand4, Jens Limpert3, Zhensheng Tao5, Michael Spanner6, Bruno E Schmidt7, Heide Ibrah im2, Andrius Baltuska1, François Légaré2; 1Technische Universität Wien, Austria; 2INRS-EMT, Canada; 3Friedrich Schiller Univ. Jena, Germany; 4Universtes Laval, Canada; 5Fudan Univ., China; 6National Research Council Canada, Canada; 7Few-cycle Inc., Canada.

We demonstrate an approach for scaling the redshifted spectral-broadening efficiency using the intrinsic temporal properties of molecular alignment. Dramatically enhanced spectra are obtained in Nitrogen filled HCF, spanning from 700 nm to above 1200 nm.

W2A.6 • 12:00
Long-term-stable Thulium-doped Fiber CPA with >100W average power and >1GW peak power, Christian Gaida1, Fabian Stutzki1, Martin Gebhardt1, Tobias Heuermann1, Sven Breitkopf1, Tino Eidam1, Jan Rothhardt1,4, Jens Limpert1,2, 1Active Fiber Systems GmbH, Germany; 2Institut für Angewandte Physik, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Germany; 3Friedrich-Schiller-Universität Jena, Germany; 4Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.

We present the first thulium-doped fiber CPA delivering >100 W average-power and simultaneously >1 GW of peak-power with >228 µJ energy and <120 fs duration at 1940 nm center wavelength. It shows an excellent long-term power stability <0.5% RMS over >48 hours.

W2B • Ultrafast Microscopy
Presider: Aaron Lindenberg; Stanford Univ., USA

W2B.1 • 10:30
Coherent Control of a Single-Molecule Switch with Sub-Cycle Atomic Forces, Lukas Kastner1, Dominik Peller1, Thomas Buchner1, Carmen Roelcke1, Florian Albrecht1,2, Nikolaj Moll2, Jascha Repp1, Rupert Huber1; 1Univ. of Regensburg, Germany; 2IBM Research-Zürich, Switzerland. We introduce sub-cycle atomic-scale forces provided by near fields of a lightwave-driven scanning probe tip. Exerting these ultrafast forces to key atoms of a single-molecule switch allows us to coherently steer a select structural rotation that modulates the switching statistics by up to 39%.
Femtosecond nanoscopy with high harmonics, Sergey Zayko, Ofer Kfir, Michael Heigl, Michael Lohmann, Murat Sivis, Manfred Albrecht, Claus Ropers; 1Univ. of Göttingen, Germany; 2Experimental Physics IV, Inst. of Physics, Germany; 3International Center for Advanced Studies of Energy Conversion (ICASEC), Germany. We present the first nanoscale imaging of femtosecond phenomena using high-harmonic radiation that combines these extreme scales. Capturing the ultrafast spin dynamics in real-space reveals simultaneously local demagnetization and nonlocal phenomena at the domain boundaries.

Ultrafast Optical Dynamics of a Nonlinearly Coupled Au Plasmon-ZnO Exciton Nanostructure, Jinhui Zhong, Jue-Min Yi, Dong Wang, Anke Korte, Abbas Chimeh, Peter Schauf, Erich Runge, Christoph Lienau; 1Carl von Ossietzky Universität Oldenburg, Germany; 2Technische Univ. Ilmenau, Germany. By using interferometric frequency-resolved autocorrelation spectroscopy, we spectrally and temporally probe the coherent second-order nonlinear emission from hybrid Au (plasmon)/ZnO (exciton) nanosponges. The femtosecond coherence dynamics and quantum pathways of plasmon-enhanced nonlinear excitonic emission are revealed.

Persistent intraband quantum beats and femtosecond hole relaxation in a single charged CdSe/ZnSe quantum dot, Philipp Henzler, Marcel Erbe, Christian Traum, Matthias Holtkemper, Doris E. Reiter, Tilmann Kuhn, Denis V. Seletskiy, Alfred Leitenstorfer; 1Dept. of Physics and Center for Applied Photonics, Univ. of Konstanz, Germany; 2Inst. of Solid State Theory, Univ. of Münster, Germany; 3Dept. of Engineering Physics, Polytechnique Montreal, Canada. Quantum beats between excited electron states in a quantum dot are detected by femtosecond induced absorption into biexcitonic levels and manipulated by pump-probe polarizations. Hot intraband coherence persists for 100 ps despite femtosecond hole relaxation.

Femtosecond nano-imaging of the few-femtosecond coherent dynamics of two-dimensional materials, Tao Jiang, Wenjin Luo, Vasily Kravtsov, Mikhail Tokman, Alexey Belyanin, Markus B. Raschke; 1Dept. of Physics, Dept. of Chemistry, and JILA, Univ. of Colorado Boulder, USA; 2MOE Key Laboratory of Advanced Micro-Structured Materials, and Inst. of Precision Optical Engineering, Tongji Univ., China; 3ITMO Univ., Russia; 4Inst. of Applied Physics, Russian Academy of Sciences, Russia; 5Dept. of Physics and Astronomy, Texas A&M Univ., USA. Using plasmonic nanofocusing coupled with ultrafast femtosecond pulses, we perform spatio-temporal nonlinear optical imaging of graphene and MoSe2. We resolve for the first time the nanoscale heterogeneity in the few-femtosecond coherent dynamics in two-dimensional materials.

Imaging the Dynamics of Charge Transfer and Frenkel Excitons in Molecular Thin Films, Benjamin Stadtmüller, Ralf Hemm, Florian Haag, Martin Mitkov, Sebastian Emmerich, Sebastian Hedwig, Martin Aeschlimann; 1Technische Universität Kaiserslautern, Germany. Using time- and momentum-resolved photoemission, we investigated the formation and ultrafast relaxation process of excitons in molecular materials. We uncovered stepwise transitions between charge transfer and Frenkel excitons with different charge character and spatial distributions.

Controlling Free Electrons with Optical Whispering-Gallery Modes, Ofer Kfir, Hugo Lourenço-Martins, Gero Storeck, Murat Sivis, Tyler Harvey, Tobias Kippenberg, Armin Feist, Claus Ropers; 2Univ. of Göttingen, Germany; 2École Polytechnique Fédérale de Lausanne (EPFL), Switzerland. We show that whispering-galley modes can drive strong coherent modulations in co-propagating free-electron beams, sufficient for generating 17-attosecond-long electron pulses. We use electron spectroscopy to resolve cavity modes and trace the cavity ringdown.
Controlled Attosecond Pulse Generation with Tailored Optical Waveform, Yudong Yang\textsuperscript{1,2}, Giulio Maria Rossi\textsuperscript{1}, Roland E. Mainz\textsuperscript{1}, Fabian Scheiba\textsuperscript{1,2}, Miguel A. Silva-Toledo\textsuperscript{1,2}, Giovanni Cirmi\textsuperscript{1,2}, Franz X. Kärtner\textsuperscript{1,2}; \textsuperscript{1}Deutsches Elektronen-Synchrotron DESY, Germany; \textsuperscript{2}Dept. of Physics, Univ. of Hamburg, Germany. We present the control of spectral-temporal characteristics of attosecond pulses by tailoring the HHG-driving optical waveform attained via parametric waveform synthesis. Attosecond streaking measurements are performed for full characterization of XUV pulses and synthesized field.

High-Harmonic Dipole Response Characterized by Ellipsometry, Kuang-Yu Chang\textsuperscript{1}, Long-Cheng Huang\textsuperscript{1}, Koji Asaga\textsuperscript{2,3}, Pei-Chi Huang\textsuperscript{1}, Ming-Shian Tsai\textsuperscript{1}, Laura Rego\textsuperscript{4}, Luis Plaja\textsuperscript{4}, Hiroki Mashiko\textsuperscript{2}, Katsuyuki Oguri\textsuperscript{2}, Carlos Hernandez Garcia\textsuperscript{4}, Ming-Chang Chen\textsuperscript{1,5}; \textsuperscript{1}Inst. of Photonics Technologies, National Tsing Hua Univ., Taiwan; \textsuperscript{2}NTT Basic Research Laboratories, Japan; \textsuperscript{3}Dept. of Electronic Engineering, Tokyo Denki Univ., Japan; \textsuperscript{4}Grupo de Investigación en Aplicaciones del Láser y Fotónica, Departamento de Física Aplicada, Univ. of Salamanca, Spain; \textsuperscript{5}Dept. of Physics, National Tsing Hua Univ., Taiwan. We demonstrate that polarization control and characterization of high-harmonic generation in non-collinear geometry performs as an excellent ellipsometry that can fully retrieve the amplitude and phase of ultrafast dipole response, advancing attosecond metrology.

Integrated Attosecond Time-Domain Spectroscopy, Feliz Ritzkosky\textsuperscript{2}, Mina Bionta\textsuperscript{1}, Marco Turchetti\textsuperscript{1}, Yujia Yang\textsuperscript{1}, William Putnam\textsuperscript{3}, Karl Berggren\textsuperscript{1}, Franz X. Kärtner\textsuperscript{2}, Phillip Keathley\textsuperscript{1}; \textsuperscript{1}MIT, USA; \textsuperscript{2}DESY, Germany; \textsuperscript{3}UC Davis, USA. Optical-field emission from nanostructures is used to sample few-fJ, broadband electric field transients in the time domain. The measured field transients reveal the plasmonic dynamics of the nanoantenna in situ.

Radio frequency controlled electron pulses for time-resolved LEED, Dennis Epp\textsuperscript{1}, Marcel Möller\textsuperscript{1}, Claus Ropers\textsuperscript{1,2}; \textsuperscript{1}IV. Physikalisches Institut, Georg-August-Universität Göttingen, Germany; \textsuperscript{2}Max Planck Inst. for Biophysical Chemistry, Germany. We demonstrate radio-frequency compression and streaking of low-energy electron pulses for ultrafast diffraction from surfaces with few-ps time resolution.

Topographic Control of Light at the Quantum Level, Sergio Carbajo\textsuperscript{1}; \textsuperscript{1}SLAC National Accelerator Laboratory, USA. We present the synthesis of ultrashort laser bullets with real-time adaptive and programmable field topology, including field amplitude, and linear, spin angular, and orbital angular momenta.
Extreme Raman Spectral Broadening in Hollow-Core Fibers, Giulio Coccia, Riccardo Piccoli, Paolo Carpeggiani, Guangyu Fan, Edgar Kaksis, Audrius Pugzlys, Young-Gyun Jeong, Andrea Rovere, Roberto Moranotti, Luca Razzari, Bruno E. Schmidt, Aleksandr Aleksandrovich Voronin, Aleksei Zheltikov, Andrius Baltuska; 1TU Wien, Austria; 2Centre Énergie, Matériaux et Télécômmunications (EMT), Institut National de la Recherche Scientifique (INRS), Canada; 3Center for Physical Sciences and Technology, Lithuania; 4Inst. of Fundamental and Frontier Sciences, Univ. of Electronic Science and Technology of China, China; 5few-cycle Inc, Canada; 6Physics Dept., International Laser Center, M. V. Lomonosov Moscow State Univ., Russia; 7Russian Quantum Center, Russia. Stimulated Raman Scattering over ~6-m-long nitrogen-filled hollow-core fibers enables the efficient generation of high-energy (mJ), few-cycle (~20-fs), shortwave-IR (1-1.73 µm) pulses. Full three-dimensional model is also required to predict the observed extremely asymmetric spectral broadening.

Sub 5-cycle pulse generation from mode-locked Cr:ZnS laser using mid-IR resonant SWCNTs, Daiki Okazaki, Ikki Morichika, Esko Kauppinen, Zhang Qiang, Anton Anisimov, Varjos Ilkka, Shohei Chiashi, Shigeo Maruyama, Satoshi Ashihara; 1IIS, The University of Tokyo, Japan; 2Applied Physics, Aalto Univ., Finland; 3Canatu Ltd, Finland; 4Mechanical Engineering, The Univ. of Tokyo, Japan. We demonstrate the excellent saturable absorption of single-walled carbon nanotubes with resonance around 2.4 μm, realizing 36-fs oscillation in a Cr:ZnS oscillator. Introducing a two-stage single pass amplifier, the output exceeds 100 nJ.

Sustainable cascading of the femtosecond supercontinuum generation in multi-plate media, Zongyuan Fu, Sheng Zhang, Bingbing Zhu, Guangyu Fan, Shunjia Wang, Andrius Baltuska, Chuanshan Tian, Zhensheng Tao; 1State Key Laboratory of Surface Physics and Dept. of Physics, Fudan Univ., China; 2Inst. of Photonics, TU Wien, Gusshausstrasse 27/387, Austria. We investigate the femtosecond supercontinuum generation and compression in layered Kerr media. The condition for extending the setup in a sustainable way is revealed, with characteristic spectral and temporal features. We demonstrate tenfold pulse compression in a single-stage multiplate setup by including 14 layers of the thin medium.

Light-wave Driven Charge- and spin Dynamics, Martin Schultze; 1IEP, TU Graz, Austria. Attosecond spectroscopy is used to track solid-state carrier and spin dynamics and to study ultrafast light-field driven modifications of optical, electronic and magnetic material properties that might allow future ultrafast optoelectronic and spintronic applications.

Extremely Non-Adiabatic Switching of Deep-Strong Light-Matter Coupling, Joshua Mornhinweg, Maike Halbhuber, Viola Zeller, Cristiano Ciuti, Dominique Bougeard, Rupert Huber, Christoph Lange; 1Univ. of Regensburg, Germany; 2Laboratoire Matériaux et Phénomènes Quantiques, CNRS, Université de Paris, France. We observe a non-adiabatic switch-off of deep-strong light-matter coupling characterized by pronounced subcycle polarization oscillations. A quantum model verifies that light-matter decoupling occurs more than an order of magnitude faster than the optical cycle duration.
Time delays from one-photon transitions in the continuum, Jaco Fuchs, Nicolas Douguet, Stefan Donsa, Fernando Martin, Joachim Burgdörfer, Luca Argenti, Laura Cattaneo, Ursula Keller; ETH Zurich, Switzerland; Dept. of Physics, Univ. of Central Florida, USA; Inst. of Theoretical Physics, Vienna Univ. of Technology, Austria; Departamento de Quimica Modulo 13, Universidad Autonoma de Madrid, Spain; Condensed Matter Physics Center, Universidad Autonoma de Madrid, Spain; CREOL, Univ. of Central Florida, USA. We retrieve time delays from one-photon transitions in the electronic continuum. This enables a quantification of the angular momentum contribution to the photoionization time delay.

Dephasing and revival of an attosecond electron wave packet in silane caused by coupled electron-nuclear dynamics, Danylo Matselyukh, Victor Despré, Nikolay Golubev, Vit Svoboda, Alexander I. Kuleff, Hans Jakob Woerner; ETH Zurich, Switzerland; Universität Heidelberg, Germany; EPFL, Switzerland. Soft-X-ray attosecond transient absorption spectroscopy has been performed on silane (SiH₄), capturing dephasing and revival of Rydberg-valence electronic wavepackets with periods of 1.32-1.39 fs. The experimental results are confirmed with fully quantum dynamics simulations.

Controlled optical waveforms for efficient chiral discrimination on ultrafast time scales, David Ayuso, Andres Ordonez, Misha Ivanov, Olga Smirnova; Max-Born-Institut, Germany; Technische Universität Berlin, Germany; Humboldt-Universität zu Berlin, Germany. We demonstrate the ultimate efficiency in chiral discrimination using focused pulses of linearly polarized light. Sub-cycle control of the incident light wave enables full control over the enantio-sensitive response of chiral matter, exposing molecule-specific fingerprints.

Structuring Light’s Chirality: LR≠RL, Andres Ordonez, David Ayuso, Piero Decleva, Misha Ivanov, Olga Smirnova; Max-Born-Institut, Germany; Technische Universität Berlin, Germany; Humboldt-Universität zu Berlin, Germany; Università degli studi di Trieste, Italy. We introduce structured light with zero net chirality displaying a charge-polarized-like pattern of chirality. It allows perfect enantiomeric discrimination within the dipole approximation on ultrafast time scales, with opposite enantiomers emitting harmonics in opposite directions [arXiv:2004.05191].

Ultrafast Broadband Dichroism by Transient Optical Symmetry Breaking in Plasmonic Metasurfaces, Margherita Maiuri, Andrea Schirato, Andrea Toma, Remo Proietti, Paolo Laporta, Peter Nordlander, Giulio Cerullo, Alessandro Alabastri, Giuseppe Della Valle; Politecnico di Milano, Italy; Istituto Italiano di Tecnologia, Italy; Electrical and Computer Engineering, Rice Univ., USA. We theoretically predict and experimentally demonstrate by polarization-resolved ultrafast transient absorption that the inhomogeneous space-time distribution of photogenerated hot carriers induces a sub-picosecond symmetry breaking in a plasmonic metasurface made of highly symmetric metaatoms.

Room 1
08:30 -- 10:00
Th1A • XFEL Science
Presider: Junko Yano; Lawrence Berkeley National Laboratory, USA

Title to be Announced, Ilme Schlichting; Max Planck Inst. for Med. Research, Max-Planck-Institut, Germany. Abstract not available.
The 22nd International Conference on Ultrafast Phenomena (UP 2020)
16-19 November 2020

Th1A.2 • 09:00
Heme Doming in Ferric Cytochrome c: Femtosecond X-ray Absorption and X-ray Emission Studies, Camila Bacellar1, Dominik Kinschel1, Giulia F. Mancini1, rebecca ingle1, Jérémy Rouxel2, Oliviero Cannelli3, Claudio Cirelli4, Gregor Knopp5, Jakub Szlachetko2, Frederico Lima3, Samuel Menzi3, Georgios Pamfilidis1, Katharina Kubicek1, Dmitry Khakhulin3, Wojciech Gawelda3, Angel Rodriguez- Fernandez4, Mykola Biednov5, Christian Bressler3, Christopher Arrell6, Philip Johnson7, Christopher J. Milne8, Majed Chergui9; 1Inst. of Nuclear Physics, Poland; 2European XFEL, Germany; 3EPFL, Switzerland. The photoinduced dynamics of ferric Cytochrome c was investigated by ultrafast non-resonant X-ray emission (XES) and X-Ray Absorption (XAS) spectroscopies, and a cascade through high spin states accompanied by heme dynamics is observed for the first time. © 2020 The Author(s)

Th1A.3 • 09:15
Megahertz-Rate Pump–Probe Jitter and Drift Characterization at a Hard X-ray Free-Electron Laser, Romain Letrun1, Tokushi Sato1, Henry J. Kirkwood1, Jia Liu1, Jan Grünert1, Adrian P. Mancuso1,2; 1European XFEL, Germany; 2Dept. of Chemistry and Physics, La Trobe Inst. for Molecular Science, La Trobe Univ., Australia. We report on the development and implementation of single-shot hard X-ray/optical cross-correlation at the European X-ray free-electron laser for characterization of timing jitter and drift at megahertz rate.

Th1A.4 • 09:30
Ultrafast Charge Transfer and Electron Delocalization in a Cyanide-Bridged Ru-Ru Dimer Investigated with Femtosecond Transient X-ray and IR Spectroscopies, Benjamin I. Poulter1, Elisa Biasin2, Chelsea Liekhus-Schmaltz3, Christopher Arrell3, Sven Augustin3, Claudio Cirelli3, Amy Cordones-Hahn4, Philip Johnson5, Gregor Knopp6, Christopher J. Milne7, Roberto Alonso Mori8, Dmitry Ozerov9, Marco Reinhard10, Jason W. Sandwisch11, Dimosthenis Sokaras12,13, Ivan Usov5, Robert B. Weakly14, Niranjan Govind15, Robert Schoenlein16, Munira Khalil17; 1Chemistry, Univ. of Washington, USA; 2Stanford Pulse Inst., SLAC National Accelerator Laboratory, USA; 3SwissFEL, Paul Scherrer Inst., Switzerland; 4Linac Coherent Light Source, SLAC National Accelerator Laboratory, USA; 5Stanford Synchrotron Radiation Lightsource, SLAC National Accelerator Laboratory, USA; 6Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory, USA. Transient IR and X-Ray spectroscopies were used to investigate excited state delocalization of a mixed valence Ru based donor-bridge-acceptor complex on a femtosecond timescale revealing the role of the electron density on the Ru-CN-Ru fragment.

Th1A.5 • 09:45
Femtosecond Molecular Flattening in [Cu(dmp)2]⁺ Probed by X-ray Emission Spectroscopy and Solution Scattering, Tae-Kyu Choi1, Dmitry Khakhulin2, György Vankó3, Zoltán Németh3, Jakub Szlachetko1, Makina Yabashi1, Thomas Penfold1, Wojciech Gawelda1,6, Tetsuo Katayama7,8, 1European XFEL, Germany; 2Wigner Research Centre for Physics, Hungarian Academy of Sciences, Hungary; 3Inst. of Nuclear Physics, Polish Academy of Sciences, Poland; 4RIKEN SPring-8 Center, Japan; 5Chemistry-School of Natural and Environmental Sciences, Newcastle Univ., UK; 6Faculty of Physics, Adam Mickiewicz Univ., Poland; 7Japan Synchrotron Radiation Research Inst., Japan. Femtosecond electronic and nuclear dynamics in [Cu(dmp)2]⁺ complex upon 550 nm photoexcitation are studied with X-ray emission spectroscopy and X-ray solution scattering, revealing pseudo Jahn-Teller distortion (~410 fs) coupled with coherent vibrational motion.

Room 1
10:30 -- 12:30

Th2A • Excitons
Presider: Dongho Kim; Yonsei Univ., Korea (the Republic of)

Th2A.1 • 10:30 (Invited)
Coherent Two-dimensional Electronic Spectroscopy with Dual Mode-locked Lasers, Minhaeng Cho1; 1Dept. of Chemistry, Korea Univ., Korea (the Republic of). Abstract not available.
The 22nd International Conference on Ultrafast Phenomena (UP 2020)
16-19 November 2020

Th2A.2 • 11:00
Molecular annihilation dynamics measured in the perturbative regime of excitation, Pavel Malevich\textsuperscript{1}, Constantin Heshmatpour\textsuperscript{1,2}, Harald Ceymann\textsuperscript{3}, Maximilian Schreck\textsuperscript{3}, Juergen Hauer\textsuperscript{1,4}; \textsuperscript{1}Technische Universität München, Germany; \textsuperscript{2}Charles Univ., Czechia; \textsuperscript{3}Universität Wuerzburg, Germany; \textsuperscript{4}Vienna Univ. of Technology, Austria. We present a fully non-collinear 50 kHz shot-to-shot detected two-dimensional electronic spectroscopy setup for directly studying bi-exciton relaxation dynamics via 5\textsuperscript{th} order signals. The measurements report on annihilation timescales at a single, perturbative excitation energy.

Th2A.3 • 11:15
Probing Exciton Transport in Squaraine Polymers Using Fifth-Order Two-Dimensional Spectroscopy, Julian Lüttig\textsuperscript{1}, Pavel Malý\textsuperscript{1}, Arthur Turkin\textsuperscript{2}, Katja Mayershoffer\textsuperscript{1}, Simon Büttner\textsuperscript{1}, Christoph Lambert\textsuperscript{2}, Tobias Brixner\textsuperscript{1}; \textsuperscript{1}Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Germany; \textsuperscript{2}Institut für Organische Chemie, Universität Würzburg, Germany. We use the technique of exciton–exciton-interaction two-dimensional spectroscopy to investigate exciton transport in squaraine copolymers. We reveal the influence of the polymer chain conformation by comparing the exciton dynamics in H- and J-type polymers.

Th2A.4 • 11:30
Packing Morphology-Dependent Singlet Fission in Single Crystal Anthradithiophene Derivatives, Gina Mayonado\textsuperscript{1}, Kyle Vogt\textsuperscript{1}, Jonathan Van Schenck\textsuperscript{1}, Oksana Ostroverkhova\textsuperscript{1}, Matthew W. Graham\textsuperscript{1}; \textsuperscript{1}Oregon State Univ., USA. Single crystal excited state dynamics in functionalized anthradithiophene (ADT) derivatives were compared across four distinct packing morphologies. Using polarization-dependent transient absorption microscopy, morphology-dependent singlet fission was observed in only three of the four ADT derivatives.

Th2A.5 • 11:45
Probing atomic motions accompanying singlet exciton fission in pentacene, Hélène Seiler\textsuperscript{1}, Marcin Kryński\textsuperscript{2}, Daniela Zahn\textsuperscript{1}, Yoav William Windsor\textsuperscript{1}, Thomas Vasileiadis\textsuperscript{1}, Sebastian Hammer\textsuperscript{2}, Jens Pflaum\textsuperscript{2}, Mariana Rossi\textsuperscript{3,1}, Ralph Ernstorfer\textsuperscript{1}, Heinrich Schwoerer\textsuperscript{3}; \textsuperscript{1}Fritz Haber Inst., Germany; \textsuperscript{2}Julius-Maximilians-Universität, Experimental Physics VI, Univ. of Würzburg, Germany; \textsuperscript{3}MPI for Structure and Dynamics of Matter, Germany. We investigate the structural dynamics accompanying singlet fission in pentacene single crystals with femtosecond electron diffraction. The data reveal incoherent and coherent contributions to the structural dynamics. We discuss the implications for singlet fission properties.

Th2A.6 • 12:00
Ultrafast Spectroscopy Reveals Structural Heterogeneity of Artificial Light-Harvesters, Maxim S. Pshenichnikov\textsuperscript{1}, Björn Kriete\textsuperscript{1}; \textsuperscript{1}Zernike Inst. for Advanced Materials, Univ. of Groningen, Netherlands. Ultrafast 2D spectroscopy is combined with single-object spectroscopy to disentangle the structural heterogeneity of an artificial light-harvester. The dynamically (~50 fs timescale) fluctuating environment governs the system’s properties, but not structural variations among different harvesters.

Th2A.7 • 12:15
Charge generation mediated by bound polaron pairs and delocalized charge transfer states in non-fullerene organic photovoltaics, Yin Song\textsuperscript{2}, Xiao Liu\textsuperscript{1}, Yongxi Li\textsuperscript{1}, Hoang Nguyen\textsuperscript{1}, Rong Duan\textsuperscript{1}, Kevin J. Kubarych\textsuperscript{1}, Stephen Forrest\textsuperscript{3}, Jennifer Ogilvie\textsuperscript{1}; \textsuperscript{1}Univ. of Michigan, USA. Using two-dimensional electronic and electronic-vibrational spectroscopies, we find that charge generation via both electron and hole transfer pathways are mediated by bound polaron pairs and delocalized charge-transfer states in non-fullerene organic photovoltaics.
The 22nd International Conference on Ultrafast Phenomena (UP 2020)
16-19 November 2020

Room 1
14:00 -- 16:15
Th3A • Chemical Reactions
Presider: Tobias Brixner; Universität Würzburg, Germany

Th3A.1 • 14:00 (Invited)
Ultrafast Dynamics of Molecular Motors Driven by Near-Infrared Light, Nong V. Hoang1, Lukas Pfeifer2, Ben L. Feringa2, Maxim S. Pshenichnikov1; 1Zernike Inst. for Advanced Materials, Univ. of Groningen, Netherlands; 2Stratingh Inst. for Chemistry, Univ. of Groningen, Netherlands. Dye-sensitization of a molecular motor allowed its functioning under two-photon near-infrared excitation. Ultrafast transient absorption spectroscopy was used to verify energy transfer from the sensitizer to the motor and motor’s subsequent rotation.

Th3A.2 • 14:30
Probing Ultrafast Photochemical Reaction at Water Surface by Heterodyne-Detected Vibrational Sum Frequency Generation, Ryoji Kusaka1, Satoshi Nihonyanagi2, Tahei Tahara3; 1RIKEN, Japan. Heterodyne-detected vibrational sum frequency generation (HD-VSFG) is a powerful probe to reveal structure and dynamics at interfaces. We present femtosecond time-resolved vibrational tracking of a photochemical reaction at water surface realized for the first time.

Th3A.3 • 14:45
Vibrational relaxation of water at the air/H2O interface revealed by time-resolved heterodyne-detected vibrational sum-frequency generation in the OH stretch hot-band region, Woongmo Sung1, Ken-ichi Inoue1, Satoshi Nihonyanagi1,2, Tahei Tahara1,2; 1Molecular Spectroscopy Laboratory, RIKEN, Japan; 2RIKEN Center for Advanced Photonics (RAP), RIKEN, Japan. Vibrational relaxation ($T_1$) time of hydrogen-bonded OH of interfacial water was determined by TR-HD-VSFG spectroscopy to be 250 - 400 fs contrary to the previous report, while free-OH stretch shows noticeably slow (~1 ps) $T_1$.

Th3A.4 • 15:00
Manipulating Ultrafast Conical Intersection Dynamics by Optical Cavities, Bing Gu1, Shaul Mukamel1; 1Chemistry, Physics and Astronomy, Univ. of California, Irvine, USA. Optical cavities provide a novel means to manipulate photochemical processes. Real-time dynamical/spectroscopic simulations of pyrazine molecules strongly coupled to a cavity mode show that the polariton effects can influence significantly the conical intersection dynamics.

Th3A.5 • 15:15
Probing Delayed C–I Bond Fission in the UV Photochemistry of 2-Iodothiophene with Core-to-Valence Transient Absorption Spectroscopy, Benjamin W. Toulson1, Mario Borgwardt1, Davide Faccialà2, Daniel M Neumark3,1, Stephen R Leone3,1, Oliver Gessner1; 1Lawrence Berkeley National Laboratory, USA; 2Istituto di Fotonica e Nanotecnologie—CNR, Italy; 3Univ. of California, Berkeley, USA. The UV photodissociation dynamics of 2-iodothiophene are monitored by an XUV probe pulse that promotes iodine 4d core-to-valence transitions. Absorption changes from molecular iodine species conclusively show that dissociation requires up to ~1 picosecond. © 2020 The Authors

Th3A.7 • 15:30
Ultrafast Conical Intersection Dynamics Monitored Through Electronic Coherences by Stimulated X-Ray Raman Signals, Shaul Mukamel1, Thomas Schnappinger2, Regina de Vivie-Riedle2, Daniel Keefer1; 1Chemistry and Physics and Astronomy, Univ. of California, Irvine, USA; 2Chemie, Ludwig-Maximilians-Universität München, Germany. Coherences at conical intersections are probed by X-Ray stimulated Raman signals. Contrary to the common picture of short femtosecond and precisely timed non-adiabatic passages, the distinctly visible coherence signature survives for a much longer time.
Th3A.6 • 15:45
Extreme-ultraviolet time-resolved photoelectron spectroscopy of the photoisomerisation dynamics of cis-stilbene in the gas and liquid phases, Chuncheng Wang1, Max Waters1, pengju zhang1, Tran Trung Luu1, Vit Svoboda1, Conail Perry1, Zhong Yin1, Hans Jakob Woerner1; 1ETH Zurich, Switzerland. Measuring time-resolved photoelectron spectra of liquids, and achieving photon energies to probe electronic ground states is challenging. We present gas- and liquid-phase XUV-TRPES of cis-stilbene, providing new insight into this prototype of molecular photoisomerisation dynamics.

Th3B • High-Harmonic Generation and Applications
Presider: Katsumi Midorikawa; RIKEN, Japan

Th3B.1 • 14:00
Attosecond spectral singularities in solid-state high-harmonic generation, Ayelet J. Uzan1, Gal Orenstein1, Barry D. Bruner1, Álvaro Jiménez-Galán2, Chris McDonald3, Rui E.F. Silva4, Nikolai Klimkin5,6, Valerie Blanchet7, Talya Arusi-Parpar1,9, Michael Krüger1,9, Alexey Rubtsov5,6, Olga Smirnova2,10, Misha Ivanov2,11, Thomas Brabec1, Nirit Dudovich1; 1Dept. of Physics of Complex Systems, Weizmann Inst. of Science, Israel; 2Max-Born-Institut, Germany; 3Dept. of Physics, Univ. of Ottawa, Canada; 4Departamento de Fisica Teórica de la Materia Condensada, Universidad Autónoma de Madrid, Spain; 5Russian Quantum Center, Russia; 6Dept. of Physics, Lomonosov Moscow State Univ., Russia; 7CNRS, CEA, CELIA, Universite de Bordeaux, France; 8Applied Physics Dept., NRC Soreq, Israel; 9Dept. of Physics and Solid State Inst., Technion, Israel; 10Technische Universität Berlin, Germany; 11Imperial College London, UK; 12Dept. of Condensed Matter Physics, Weizmann Inst. of Science, Israel. Using high-harmonic generation spectroscopy, we reveal the underlying attosecond dynamics in multi-band solid-state systems. We identify the mapping of spectral caustics into the high-harmonic spectrum, and probe the structure of multiple unpopulated high conduction bands.

Th3B.2 • 14:15
Electron-vibrational coupling dynamics in SF₆, Patrick D. Rupprecht1, Lennart Aufleger1, Alexander Magunia1, Simon Heinze2, Thomas Ding1, Marc Rebholz1, Stefano Amberg1, Nikola Mollov1, Felix Henrich1, Mauritus W. Haverkort1, Christian Ott1, Thomas Pfeifer2; 1Max Planck Inst. for Nuclear Physics, Germany; 2Inst. for theoretical physics, Heidelberg Univ., Germany. We report on soft x-ray transient absorption spectroscopy in SF₆. The influences of strong SWIR fields and of impulsive stimulated Raman scattering initiated vibrational breathing mode dynamics on the 6a¹g(52p1/2, 3/2)¹ resonance are investigated.

Th3B.3 • 14:30
Detecting electronic coherences by the multidimensional HHG spectroscopy, Shicheng Jiang1, Markus Kowalewski2, Konstantin Dorfman1; 1East China Normal Univ., China; 2Dept. of physics, Univ. of Stockholm, Sweden. We propose an all-optical method based on pump-probe HHG to detect electronic coherence. Based on a new developed semi-perturbative approach, coherence between bound states is observed in Fourier transformed harmonic spectra using noncollinear geometry setup.
Th3B.4 • 14:45
Symmetry of Molecular Rydberg States Revealed by XUV Transient Absorption Spectroscopy, Peng Peng1, Claude Marceau1, Marius Hervé1, Paul Corkum1, Andrei Naumov1; 1National Research Council of Canada, Canada. We studied Rydberg states of N2 and O2 by XUV transient absorption spectroscopy. We were able to determine the polarization direction of the electronic transitions, and hence identify the symmetry of the final states.

Th3B.5 • 15:00
High-order Harmonic Generation in Femtosecond Laser Micromachined Devices for Ultrafast X-ray Spectroscopy, Anna Gabriella Ciriolo1, Rebeca Martínez Vázquez1, Valer Tosa2, Aldo Frezzotti3, Eugenio L. Cinquanta1, Gabriele Crippa4, Davide Faccialà1, Michele Devetta1, Roberto Osellame4, Caterina Vozzi1, Salvatore Stagira4; 1CNR - Istituto di Fotonica e Nanotecnologie, Italy; 2National Inst. for R&D of Isotopic and Molecular Technologies, Romania; 3Dept. of Aerospace Science and Technology, Politecnico di Milano, Italy; 4Dept. of Physics, Politecnico di Milano, Italy. We demonstrate efficient high-order harmonic generation in fused-silica chips fabricated by femtosecond laser micromachining. This work provides a route toward the miniaturization of HHG beamlines and the implementation of X-ray spectroscopy with attosecond temporal resolution.

Th3B.6 • 15:15
Role of intraband dynamics on circularly polarized high-harmonic generation from solids, Nicolai Klemke1,2, Nicolas Tancogne-Dejean1,3, Angel Rubio1,3, Franz Kärntner1,2, Oliver D. Mücke1,4; 1DESY, Germany; 2Physics Dept., Univ. of Hamburg, Germany; 3Max Planck Inst. for the Structure and Dynamics of Matter, Germany; 4The Hamburg Centre for Ultrafast Imaging, Germany. We perform single-particle intraband-only calculations to study the origin of circularly polarized higher-order harmonics from solids. The simulation results are compared to new experimental data on high-harmonic generation in zinc sulfide.

Th3B.7 • 15:30
Tracking Ultrafast Solid-State Dynamics in VO2 Using High Harmonic Spectroscopy, Mina Bionta1, Elissa Haddad1, Adrien Leblanc1, Vincent Gruson1,2, Philippe Lassonde1, Heide Ibrahim1, Jérémie Chaillou1, Nicolas Émond1, Martin R. Otto3, Bradley J. Siwick3, Mohamed Chaker1, François Légaré1; 1INRS-EMT, Canada; 2The Ohio State Univ., USA; 3McGill Univ., Canada. We extend time-resolved high harmonic spectroscopy to solid-state systems by investigating the dynamics of the insulator-to-metal phase transition in the strongly correlated material, VO2, revealing all electronic states involved.

Th3B.8 • 15:45
Phase matched high-harmonic generation in macroscopic single-layer graphene, Roberto Boyero-Garcia1, Óscar Zurrón-Cifuentes1, Luis Plaja1, Carlos Hernandez Garcia1; 1Universidad de Salamanca, Spain. We study the macroscopic build-up of the high-harmonic signal in single-layer graphene. Our results show that the emission is dominated by a phase-matched ring.