MO 11: Poster – Chirality

Time: Tuesday 17:00–19:00 Location: Philo 1. OG

MO 11.1 Tue 17:00 Philo 1. OG

Towards CD-Spectroscopy of Single Chlorosomes — •Stefan Goppelt[1], Lisa Günther[1], Thomas Jansen[2], Jasper Knoester[3], and Jürgen Köhler[1] — [1]Spectroscopy of soft Matter, University of Bayreuth, Germany — [2]University of Groningen, The Netherlands — [3]University of Leiden, The Netherlands

As one of the most efficient light-harvesting systems in nature chlorosomes (the light-harvesting aggregates of green-(non)-sulfur bacteria) are considered as a template for novel solar cells [1]. Among other techniques linear-polarization resolved fluorescence-excitation spectroscopy revealed molecular aggregates of cylindrical symmetry as the dominating secondary structural elements within the chlorosomes [2]. Development of circular-dichroism spectroscopy will allow to elucidate further structural details such as the diameter and the length of the cylindrical structures.

[1] S. Sengupta et al, Angew. Chem. Int. Ed., 51: 6378-6382 (2012) [2] L. Günther et al, J. Phys. Chem. B, 122, 26, 6712*6723 (2018)

MO 11.2 Tue 17:00 Philo 1. OG

Towards the measurement of Photoelectron Circular Dichroism of (M)-[4] triangulane — •Tonio Rosen, Nicolas Ladda, Fabian Westmeier, Simon Ranecky, Sagnik Das, Sudheendran Vasudevan, Krishna Kant Singh, Hendrike Braun, Arne Senftleben, Jochen Mikosch, and Thomas Baumert — Universität Kassel

[n] Triangulanes are helically chiral molecules with structural helicity, providing a chiral scattering potential for electrons upon photoionization and a helical electron distribution in their highest occupied molecular orbital. Hence, these molecules are promising for investigating photoelectron circular dichroism (PECD) after resonance-enhanced multiphoton ionization in the gas phase. PECD is defined as a forward-backward asymmetry in photoelectron distribution with respect to the laser propagation direction in chiral molecules ionized with circularly polarized light. Using a velocity map imaging spectrometer, we aim to investigate the PECD of the smallest chiral triangulane, the [4] triangulane, in the 200- to 800 nm range. To this end, we want to employ gas chromatography, separating the enantiomers of a racemic mixture before their introduction into the experimental chamber. In this contribution, we will present the recent progress of this project.

MO 11.3 Tue 17:00 Philo 1. OG

Controlling the orientational degeneracy of rotational states in chiral molecules — •Elahe Abdiha, Shilpa Yadav, Sejun An, JuHyeon Lee, Boris G. Sartakov, Gerard Meijer, and Sandra Eibenberger-Arias — Fritz-Haber-Institut der Max-Planck-Gesellschaft; Berlin, 14195, Germany

We present recent experimental advances towards full enantiomer-specific control of the quantum states of chiral molecules using enantiomer-specific state transfer (ESST). Early studies on ESST reported only modest state-specific enantiomeric enrichment, limited to a few percent [1,2]. The main limitations are due to the thermal population of rotational states and their spatial degeneracy. Our group has overcome the limitation due to thermal population and achieved near-complete control of the enantiomers in a triad of rotational states containing the absolute ground state [3]. For this, we developed a new approach combining ultraviolet and microwave radiation to remove population from two out of three rotational states before applying ESST. In our recent work, we address the limitation due to spatial degeneracy when applying ESST to rotational states not including the absolute ground state. Here, M-state dependent Rabi frequencies impede the overall transfer efficiency when employing conventional pulse schemes. We incorporate theoretically tailored pulse schemes [4] and demonstrate enhanced control despite degeneracy. [1] Eibenberger et al. Phys. Rev. Lett. 118, 123002 (2017) [2] Pérez et al. Angew. Chem. Int. Ed. 56, 12512 (2017) [3] Lee et al. Nat. Commun. 15, 7441 (2024) [4] Leibscher et al. Commun. Phys. 5, 110 (2022).

MO 11.4 Tue 17:00 Philo 1. OG

Towards Circular Dichroism in Ion Yield and Electron Kinetic Energy on 3-Methylcyclopentanone — •Liliana M. Ramos Moreno[1], Deepak K. Pandey[1], Sagnik Das[1], Claus-Peter Schulz[2], Hendrike Braun-Knie[1], and Jochen Mikosch[1] — [1]Institut für Physik, Universität Kassel, Heinrich Plett Str. 40, 34132 Kassel, Germany — [2]Max Born Institute, Max-Born-Straße 2A, 12489 Berlin, Germany

The cyclic ketone 3-methyl cyclopentanone (3-MCP) is well-known for a strong Circular Dichroism in Ion Yield (CDIY) effect in resonance enhanced multiphoton ionization via the $\pi^* \leftarrow$ n transition. Coherent control of CDIY in 3-MCP using tailored femtosecond laser pulses has recently been demonstrated [1]. We now aim to build on this study to resolve the CDIY effect into different photoelectron kinetic energy bands. To this end we extend the twin focus approach [2], with two spatially separated foci of opposite and alternating circular polarization in an ion time-of-flight mass spectrometer, to Photoelectron Photoion Coincidence (PEPICO) spectroscopy [3]. Moreover, our temperature-variable molecular beam cluster source allows tuning the 3-MCP conformer composition within limits and, in the future, to explore effects oof micro-solvation via clustering individual water molecules to the chiral molecule.

[1] Das et al., Phys. Chem. Chem. Phys., 27, 8043-8051 (2025) [2] Ring et al., Rev. Sci. Instrum. 92, 033001 (2021) [3] Müller et al., JPCA 118, 8517 (2014)

MO 11.5 Tue 17:00 Philo 1. OG

Coherent Control of a chirality-modifying vibrational wave packet — •Nicolas Ladda, Fabian Westmeier, Tonio Rosen, Sudheendran Vasudevan, Simon Ranecky, Sagnik Das, Krishna Singh, Hendrike Braun, Jochen Mikosch, Thomas Baumert, and Arne Senftleben — Institute of Physics and CINSaT, University of Kassel, 34132 Kassel, Germany

Converting an enantiomer into the other configuration via an electronically excited state has recently been observed on the femtosecond timescale. Here, we want to present a coherent control scheme of the vibrational wave packet that is causing this transformation. A so-called pump-dump scheme is achieved by splitting the pump pulse into two parts and delaying one of them with a Mach-Zehnder interferometer. This allows for stopping the motion of the created wave packet by the pump pulse with the dump pulse at the desired delay. This results in the conversion of the enantiomer into its mirror configuration via the excited state [1] and subsequent fixation by deexcitation to the ground state. The process is studied by time-resolved photoelectron circular dichroism in the gas phase, providing an interaction-free environment and a large chiral observable [2].

[1] W. Sun, I. Kleiner, A. Senftleben, M. Schnell, J. Chem. Phys. 2022, 156, 15, 154304.

[2] N. Böwering, T. Lischke, B. Schmidtke, N. Müller, T. Khalil, U. Heinzmann, Phys. Rev. Lett. 2001, 86, 1187

MO 11.6 Tue 17:00 Philo 1. OG

Towards measuring the circular dichroism in the ion yield of selenofenchone via tailored femtosecond laser pulses — •Krishna Kant Singh, Sagnik Das, Nicolas Ladda, Sudheendran Vasudevan, Tonio Rosen, Fabian Westmeier, Arne Senftleben, Jochen Mikosch, Thomas Baumert, and Hendrike Braun — Institut für Physik, Universität Kassel, Heinrich-Plett-Strasse 40, 34132 Kassel, Germany

Circular Dichroism (CD) is a powerful method for distinguishing enantiomers through their differential absorption of left- and right-circularly polarized light. This asymmetry can also manifest in their ionization yields, known as CD in ion yield (CDIY). We investigate this using our home-built Time-of-Flight mass spectrometer in a twin-peak measurement setup [1] to study how linear chirp influences the anisotropy [2]. The π^* * n transition in selenofenchone is red-shifted into the visible region (550*600 nm) and liquid-phase measurements indicate a pronounced CD effect. This makes the molecule particularly appealing for investigating CDIY, as technological controlling CDIY processes via tailored light fields is more readily achieved in the infrared or visible range. [1] T. Ring, et. al. Rev. Sci. Instrum., 2021, 92, 033001 [2] S. Das et. al., Phys. Chem. Chem. Phys., 2025, 27, 8043-8051

MO 11.7 Tue 17:00 Philo 1. OG

In Situ Circular Dichroism Spectroscopy and Spatial Separation of Chiral Molecules — •Sejun An, Gerard Meijer, and Sandra Eibenberger-Arias — Fritz-Haber-Institut der Max-

Planck-Gesellschaft, Berlin, Germany

Chirality is a fundamental symmetry property, yet enantiomers remain difficult to distinguish or control. Enantiomer-Specific State Transfer (ESST) provides a powerful route for enantioselective population control by driving a sequence of microwave transitions [1]. Recent advances in 2024 increased the ESST efficiency to 92%, enabling near-complete state-specific enantiomeric enrichment [2].

Here, ESST is extended toward in situ circular dichroism (CD) spectroscopy. Since the population of a quantum state can be enantioselectively controlled, CD measurements can be performed directly on a racemic mixture without switching laser polarization. This enables CD spectroscopy for chiral molecules that cannot be separated into pure enantiomers by conventional methods, and reduces systematic errors associated with polarization switching, thereby improving reproducibility and sensitivity.

Furthermore, ESST will be further advanced by rotational-state-selective ionization, enabling spatial separation of enantiomers. In this approach, the enantioselectively prepared rotational state is ionized, and the resulting ions can be separated by an external electric field.

[1] S. Eibenberger et al. Phys. Rev. Lett. 118, 123002 (2017)
[2] J. H. Lee et al. Nat. Commun. 15, 7441 (2024)

MO 11.8 Tue 17:00 Philo 1. OG

Towards Photoelectron Circular Dichroism in the photodetachment from fenchone derived anions — •Viktoria Katharina Brandt, Kun Duan, André Fielicke, and Gerard Meijer — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

Photoelectron Circular Dichroism (PECD) is a chiral optical effect that manifests in the angle-dependent photoemission of an electron upon irradiation of a chiral molecule by circularly polarized light. The use of anions in PECD studies allows for pre-photodetachment mass selectivity and eliminates the need for X-ray based ionization sources or multiphoton ionization schemes. The use of anions also enables studies of PECD under conditions of photodetachment, a photoemission regime that has historically been understudied. Fenchone and its derivates have been extensively investigated using PECD, due to its rigid bicyclic structure, which limits the presence of additional isomers, as well as its non-toxicity and high availability. We present first steps in the study of PECD of fenchone derived anions. These anions are created in a plasma entrainment source where fenchone (FenH) reacts with hydride and hydroxide to form anions of three different masses, fenchone $-H^+$ (Fen^-), fenchone $+H^-$ ($FenHH^-$) as well as fenchone $+OH^-$ ($FenHOH^-$). The PECD and potential structures of these anions are presented.

MO 11.9 Tue 17:00 Philo 1. OG

A molecular source for probing ultrafast dynamics in chiral systems — •Akhila Jose[1], Juliette Leroux[1,2], Niclas Wieland[1], Sara Savio[1], Gunnar Petersen[1], Lasse Wülfing[4], Moritz Zander[1,3], Parth Patil[1,3], Filippa Dudda[1], Marius Thiem[1], Leonie Ashenbrenner[1], and Markus Ilchen[1,3] — [1]Department of Physics, Universität Hamburg, 22607 Hamburg, Germany — [2]The Hamburg Centre for Ultrafast Imaging, 22761 Hamburg, Germany — [3]Deutsches Elektronen-Synchrotron DESY, 22607 Hamburg, Germany — [4]Fakultät Physik, Technische Universität Dortmund, 44227 Dortmund, Germany

Chiral molecules are fundamental to life. They exhibit different interactions with other chiral systems, even though they share identical properties in achiral environment. Probing these differences requires measuring the photoelectrons and fragment ions produced after photo-dissociation. A double-sided velocity map imaging spectrometer enables simultaneous 4π detection of electrons and ions, providing correlated information on electron angular distributions and molecular fragmentation. To study intrinsic chiral behavior under realistic conditions, molecules must be examined in both isolated and liquid environments. This requires a molecular source that delivers high axial density for efficient ionization and high-quality imaging signals. Combining the newly developed molecular jet with a double-sided imaging spectrometer and tabletop laser or synchrotron radiation, we can resolve chiral effects, from photoelectron patterns to enantiomer-specific and phase-dependent behavior.