

# SEMINAR: Advancing attosecond science to liquids and chiral molecules

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16:00 to 17:00

Seminar Room

Attosecond science is maturing into a transformative tool for measuring and understanding electronic dynamics on their fundamental time scales, but its extension to complex systems is hampered by several challenges. To date, spectroscopy with attosecond pulses has been missing the ability to distinguish chiral molecules, because of a lack of circularly polarized attosecond pulses. We have developed attosecond metrology in circular polarization<sup>1</sup> and applied it to the study of continuum-continuum transitions in electron vortices, establishing a general framework for attosecond circular-dichroism chronoscopy<sup>2</sup>. Application to photoionizations of s orbitals enables the first experimental separation of photoionization and measurement-induced delays<sup>3</sup>. The first application of circularly polarized attosecond pulses to chiral-sensitive experiments enabled us to observe and control photoelectron circular dichroism (PECD) on the attosecond timescale and to directly measure chiral photoionization delays of up to ~240 attoseconds<sup>4</sup>, which contain a ~60 as contribution from the chirality of continuum-continuum transitions.

In parallel, soft-X-ray absorption spectroscopy with attosecond pulses has been developed, first in gases<sup>5,6</sup> and then in liquids<sup>7</sup>, enabling element-specific studies of solvated molecules in liquid water. This novel technique has been used to reveal the electronic and structural dynamics underlying ultrafast proton transfer in solvated urea<sup>8</sup> and the dephasing of conical-intersection-driven electronic dynamics in solvated pyrazine<sup>9</sup>.

These advances chart a promising path for attosecond-resolved studies of molecular function in aqueous environments, opening exciting opportunities for understanding radiation damage, solvation dynamics, and chiral interactions at their fundamental electronic timescale<sup>10</sup>.

References:

1 Han, M. et al., *Optica* 10, 1044-1052 (2023)

2 Han, M. et al., *Nature Phys.* 19, 230-236 (2023)

3 Han, M. et al., *Science Advances* 10, eadj2629 (2024)

4 Han, M. et al., *Nature* 645, 95-100 (2025)

5 Pertot, Y. et al., *Science* 355, 264-267 (2017)

6 Zinchenko, K. et al., *Science* 371, 489 (2021)

7 Smith, A. et al., J. Phys. Chem. Lett. 11, 1981-1988 (2020)

8 Yin, Z. et al., Nature 619, 749-754 (2023)

9 Chang, Z. et al., Nature Phys. 21, 137-145 (2024)

10 Worner H. J. and Wolf J.P., Nat. Rev. Chem. 9, 185 (2025)

**Hosted by:** Prof. Dr. Jens Biegert