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An attosecond look at liquid water

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Attosecond spectroscopy is by now well established in the gas phase and first promising results have been obtained on solids. I will present an overview of the development of several new techniques that extend attosecond time-resolved spectroscopy to the liquid phase. First, the observation of coherent extreme-ultraviolet high-harmonic emission from water and several alcohols will be described. The comparison of the experimental results with a strongly-driven few-band model establishes the sensitivity of high-harmonic spectroscopy to the electronic structure of liquids. Second, the measurement of photoemission delays between the highest occupied valence band of liquid water and isolated water molecules in the gas phase will be described. These measurements provide detailed information on the scattering dynamics of electrons with the liquid environment. Third, the development of attosecond soft-X-ray absorption spectroscopy will be presented. Isolated attosecond pulses with a duration of 43 attoseconds have been measured. Time-resolved absorption measurements at the carbon K-edge have revealed ultrafast electronic and structural dynamics following ionization. First results from liquid-phase transient absorption will be presented.