Session 5b) Novel Methodology 2: Technical Development

2D-LC-IRMS – A journey to more possibilities

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Compound specific stable isotope analysis (CSIA) can be applied in numerous fields, including the evaluation of sources and transformation processes of micropollutants and the verification of food authenticity. Coupling liquid chromatography (LC) to an isotope ratio mass spectrometer (IRMS), stable carbon isotope signatures of analytes in aqueous samples can be assessed. Limitations arise due to the wet chemical oxidation of carbon in the LC-IRMS interface, where all oxidisable carbon is transformed to carbon dioxide (CO_2). The use of organic substances as eluents, buffers, or modifiers can lead to falsified carbon isotope signatures and must be avoided. This restriction limits the use of established chromatographic separations that rely on organic eluents, which make up over 90% of applied LC methods. Only inorganic buffers and temperature can be used for method development, making the process challenging and time-consuming, especially for more complex samples.

For the first time, this study establishes the coupling of two-dimensional liquid chromatography (2D-LC) with LC-IRMS to overcome these limitations. This coupling allows existing LC methods using organic additives in the first dimension to be employed without further method development. The analyte of interest is transferred via heart-cut modulation to the second dimension, where the organic solvents are separated from the analyte before oxidation.

We will present the development and implementation of the 2D-LC-IRMS system and demonstrate how it overcomes the traditional limitations of aqueous LC-IRMS methods. The presentation will highlight how this advanced coupling addresses challenges such as complex sample matrices and analyte coelution, which have been difficult to manage with conventional LC-IRMS techniques. Attendees will gain insights into the enhanced capabilities of the 2D-LC-IRMS system and its potential to broaden the scope of CSIA, offering a preview of its future applications.