Bio-Molecule Characterization Using a Novel Ion Mobility Orbitrap Mass Spectrometer

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Introduction

Drift time - ion mobility spectrometry (DT-IMS) can offer improved resolving power compared to other classes of mobility separation systems. When coupled with mass spectrometry, IMS provides structural characterization with an added dimension of ion separation. Orbitrap mass spectrometers offer high mass resolution and accuracy that are widely used in biochemical studies. We have bridged the gap between DT-IMS (capable of operating >100H) and orbitrap (operating at around 1-10 H) capabilities and reported on a novel analytical system. We have expanded its applicability to intact proteins and a novel ionization method, surface acoustic wave nebulization (SAWN) been successfully coupled with IMS orbitrap.

All experiments were performed with a bespoke IMS instrument (Spectroglyph, Kennewick, WA) coupled to a QExactive orbitrap mass spectrometer (ThermoFisher, San Jose, CA) using nanoESI and/or surface acoustic wave nebulization (SAWN). The IMS incorporates an interface for orthogonal ion injection, followed by an ion funnel trap, a drift tube and an IMS Exit Gate. In each IMS experiment, 21st ion packets are injected based on a pseudo-random sequence of N-bits. The same waveform is applied to the IMS Exit Gate but shifted sequentially in time. At each delay step, orbitrap mass spectra are acquired and the acquired multiplexed spectra are then inverse-transformed to reconstruct the original data vector.

Instrument Layout & Control Software

A) Ion Mobility Spectrometer (IMS) layout as shown in Graphical User Interface (GUI) of the instrument control software. B) Experimental sequences used for encoding raw data with Ion Mobility Spectrometer (IMS) coupled to Q Exactive mass spectrometer.

Results

Polyalanine IMS

Polyalanine IMS, Native, 200mM Ammonium Acetate

Polyalanine Drift Time vs. CCS Simulation

Simulated values are from Bush et al., Anal. Chem. 2012, 84, 7124-7130.

Limit of Detection

Angiotensin II, 1nM

Ubiquitin IMS

Native, 200mM Ammonium Acetate

Derivatized, H2O-MoCF3-Al2O5 50.0.1

Conclusions

• High performance Ion Mobility Spectrometer has been designed, integrated with a Q Exactive
• IMS-QE validated with a variety of biochemical samples
• IMS-QE offers additional dimension
• SAWN could be coupled IMS-QE

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