ADLERSHOFER KOLLOQUIUM Analytik

Topic: **Acoustic Ion Manipulation: Electric-field-free Approach to Gate, Focus, and Separate Ions at Atmospheric Pressure**

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Chair: Dr. Jens Riedel, BAM – 1.3

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Summary: Approaches to control the motion and direction of ionized particles and molecules are an essential aspect of ion-based spectrometries, such as mass spectrometry (MS) and ion mobility spectrometry (IMS). A wide variety of ion optics exist to reflect, focus, separate, gate, and filter ions based on physical properties. Notably all rely on electric and magnetic fields to alter the trajectory of ionized atoms and molecules. While these optics are quite efficient at low pressures due to the large mean free path, diffusion and electrostatic repulsion between ions dominate at higher pressures. Conventional ion optics, that use electric or magnetic fields, can guide ions at atmospheric pressure (AP), but require high field strengths to overcome the dominating aerodynamic effects.

Here, we describe a remarkable phenomenon whereby low-power acoustic fields are used to move, shape, gate, and separate beams of gaseous ions at atmospheric pressure. We refer to this approach as Acoustic Ion Manipulation (AIM). Gaseous ions at AP are directed towards and separated by the presence of the acoustic field. To better understand the phenomenon, an ion-detector array provided a measure of bulk ion movement, while mass spectrometry (MS) offered chemical-specific information. As one example of an AIM setup, a standing acoustic wave was formed with two ultrasonic speakers and placed between an ionization source and ion detector. Ion beams preferentially travel through regions of stable pressure gradients (i.e. nodes) and deflect from unstable regions (i.e. antinodes). Shadowgraphy revealed that the ions are separated from a neutral gas stream. Specific examples of ion focusing, gating, and separation (based on ion size) will be shown. In addition, experimental findings will be used to postulate a theory to develop a better understand of the behavior of gas-phase ions in acoustic fields. This discovery could have profound impacts in IMS/MS instrumentation as well as materials processing and characterization.

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