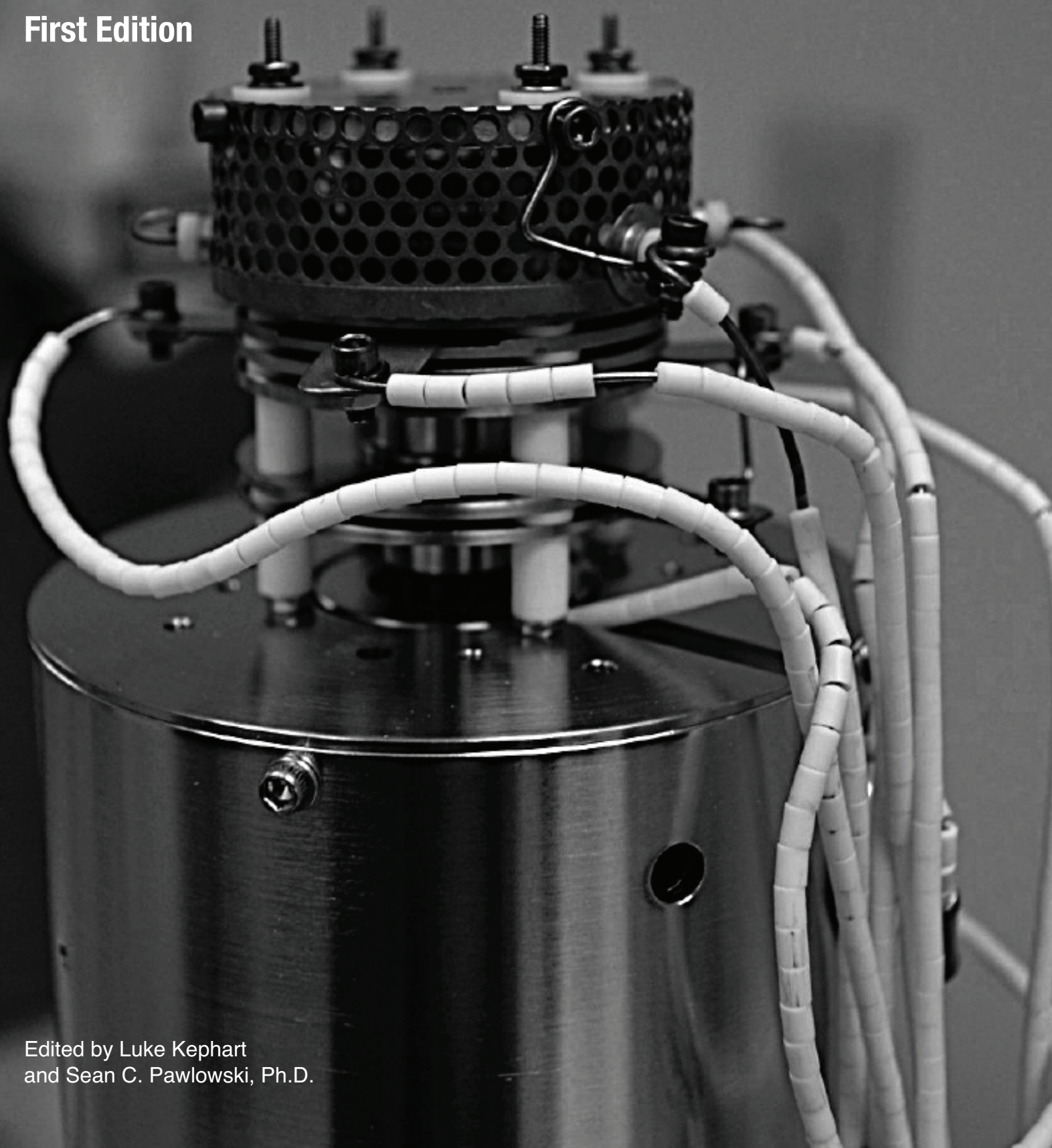


# Mass Spectrometry

First Edition



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# What Is Mass Spectrometry?

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## Chapter 1

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### Purpose

In the study of scientific theory and the natural world, one aspect has always held prominence: the investigation and analysis of the identity of materials. From the ancient concepts of Phlogiston and the Ether, to the careful liquors of the alchemists, to the Bosons, Quarks, and other sub-atomic particles of today's scientists, identifying what something is and what it is made up of has yielded many incredible discoveries. This text aims to make mass spectrometry, one of the most powerful modern techniques for characterizing materials, accessible to today's young scientists in a variety of different majors and fields to advance their knowledge and understanding of the natural world. The discussion begins with a working definition of this valuable analytical tool, and continues with an explanation of how it works and where it is used.

### Definition of Mass Spectrometry

Mass spectrometry is a powerful analytical technique that uses a compound's unique molecular structure, specifically its mass-to-charge ratio ( $m/z$ ) of ions, to determine the type and amount of components present.

### Ions

An ion is an atom, molecule, or fragment of a molecule that has an unequal number of protons and electrons, giving it an overall non-zero charge. Ions can be either positively or negatively charged. Until the molecule of interest has a charge, it cannot be directed by the electric and magnetic fields of the mass spectrometers. In mass spectrometry, an ion can be created in several ways (Refer to Chapter 2). The most common, known as Electron Ionization, or EI, uses a stream of energetic electrons to knock an electron off of a molecule, creating a positive ion. This stream of electrons is often of sufficient energy to actually break apart most molecules, resulting in "mass fragments." These fragments can be used to identify a molecule's make-up.

### Free Ions in Gas Phase

In the analysis of samples by mass spectrometry, the analyte, or substance being measured or identified, must be transported to the detector. Ionization is the means by which scientists put a figurative handle on the molecule in order to steer it through the mass spectrometer. The driving of these ions is managed by using electrostatic voltages throughout the system, keeping the ion packets focused and on target. A fuller explanation of ion optics and their usage is included in Chapter 2 of this text.

Table 1.1 shows the many ways, including EI, in which a molecule can be ionized. "A" is the analyte being ionized (whether an atom or a molecule), and the reactant, if present, is labeled as "M". The \* indicates an excited state.