

12.2 Fundamentals and general terms

Accelerator mass spectrometry

An ultra-sensitive technique using tandem accelerators employed mainly for the study of long-lived radioisotopes, and stable isotopes at very low abundances (10^{-12} - 10^{-15}).

Atomic mass unit (u)

This unit is based on the standard that the mass of ^{12}C is exactly 12 u. The older symbol, amu, using the standard based on the mass of ^{16}O is no longer recommended. In biochemistry the term dalton, symbol Da, is sometimes used but is not here recommended.

Charge number (z)

This is the total charge on an ion divided by the elementary charge (e).

Crossed electric and magnetic fields

Electric and magnetic fields with the electric field direction at right angles to the magnetic field direction.

Double-focusing mass spectrograph

An instrument that uses both direction and velocity focusing so that an ion beam initially diverging and containing ions of different energies is separated into beams according to the mass/charge ratio which are thus focused on to a photographic plate or film.

Double-focusing mass spectrometer

An instrument that uses both direction and velocity focusing so that an ion beam initially diverging and containing ions of different energies is separated into beams according to the mass/charge ratio. The ion beam is measured electrically.

Dynamic fields mass spectrometer

A mass spectrometer in which the separation of a selected ion beam depends essentially on the use of fields, or a field, (generally electric) varying with time.

Electric sector

An arrangement of two conducting sheets forming a capacitor and producing a radial electrostatic field used to deflect and focus ion beams of different energies.

Fourier transform ion cyclotron (FT-ICR) mass spectrometer

A high-frequency mass spectrometer in which the cyclotron motion of ions, having different mass/charge ratios, in a constant magnetic field, is excited essentially simultaneously and coherently by a pulse of a radio-frequency electric field applied perpendicularly to the magnetic field. The excited cyclotron motion of the ions is subsequently detected on receiver plates as a time domain signal that contains all the cyclotron frequencies excited. Fourier transformation of the time domain signal results in the frequency domain FT-ICR signal which, on the basis of the inverse proportionality between frequency and mass/charge ratio, can be converted to a mass spectrum. See also *ion cyclotron resonance (ICR) mass spectrometer*.

Hybrid mass spectrometer

A mass spectrometer which combines analysers of different types, *e.g.* a magnetic plus electric sector combined with a quadrupole. See also *tandem mass spectrometer*.

Ion cyclotron resonance (ICR) mass spectrometer

A high-frequency mass spectrometer in which the ions to be detected, with a selected mass/charge ratio, absorb maximum energy through the effect of a high-frequency field and a constant magnetic field perpendicular to it. Maximum energy is gained by ions that satisfy the cyclotron resonance condition and as a result these are separated from ions of different mass/charge. See also *Fourier transform ion cyclotron mass spectrometer* and *ion trap*.

Ion trap

A device that permits the ejection of ions with a m/z ratio less than a prescribed value and retention of those with higher mass. It depends on the application of radio frequency voltages between a ring electrode and two end-cap electrodes to confine the ions in a circular path. The choice of these voltages determines the m/z ratio below which ions are ejected. Unlike the ion cyclotron resonance spectrometer no magnetic field is required for the operation of the ion trap.

Mass/charge ratio

(m/z) ratio.

Magnetic deflection

The deflection of an ion beam as a result of the motion of the ions in a magnetic field (the magnetic sector). Motion is generally at right angles to the direction of the magnetic field.

Magnetic field

See *magnetic deflection*.

Magnetic sector

See magnetic deflection, and also in 12.3.3.2 Magnetic sector instruments.

Mass analysis

The process by which a mixture of ionic or neutral species is identified according to their mass/charge ratios (ions) or their aggregate atomic masses (neutrals). The analysis may be quantitative or qualitative.

Mass number (m)

The sum of the total number of protons and neutrons in an atom, ion or molecule.

Mass spectrograph

An instrument in which the beams of ions are separated (analysed) according to the mass/charge ratio and the mass spectrum is recorded on a photographic plate or film.

Mass spectrometer

An instrument in which the beams of ions are separated (analysed) according to the mass/charge ratio and the ions are measured electrically.

Mass spectrometer operating on the linear accelerator principle

A mass spectrometer in which the ions to be separated absorb maximum energy through the effect of alternating electric fields parallel to the direction of ion motion. These ions are then separated from other ions of different mass/charge by an additional electric field.

Mass spectrometry

The branch of science that deals with all aspects of mass spectroscopes and the results obtained with these instruments.

Mass spectrometry/mass spectrometry MS/MS

See *tandem mass spectrometer*.

Mass spectroscope

A term (now obsolete) which may refer to either a mass spectrometer or a mass spectrograph.

Mass spectroscopy

The study of systems by a process of forming gaseous ions, with or without fragmentation, which are then characterized by their mass/charge ratios and their relative abundances.

Mattauch-Herzog geometry

An arrangement for a double-focusing mass spectrograph in which a deflection of $\pi/4$ radians in a radial electrostatic field is followed by a magnetic deflection of $\pi/2$ radians.

Nier-Johnson geometry

An arrangement for a double-focusing mass spectrometer in which a deflection of $\pi/2$ radians in a radial electrostatic field analyser is followed by a magnetic deflection of $\pi/3$ radians. The electrostatic analyser uses a symmetrical object-image arrangement and the magnetic analyser is used asymmetrically.

π/n radian ($180^\circ/n$) magnetic sector

An arrangement in which an ion beam is deflected magnetically through π/n radians, where $n > 1$.

Prolate trochoidal mass spectrometer

A mass spectrometer in which the ions of different mass/charge ratios are separated by means of crossed electric and magnetic fields in such a way that the selected ions follow a prolate trochoidal path. The commonly used term “cycloidal” is incorrect and should not be used as the path is not cycloidal. (A cycloid is a special case of a trochoid). See *crossed electric and magnetic fields*.

Quadrupole ion storage trap (Quistor)

An arrangement in which ions with a desired range of mass/charge ratios are trapped by making them describe stable paths under the influence of a static and a high frequency, electric, quadrupole field. See *ion trap*.

Quadrupole mass analyser

An arrangement in which ions with a prescribed mass/charge ratio are made to describe a stable path under the influence of a static and a high frequency electric field and are then detected. Ions with different mass/charge ratios are separated from the detected ions because of their unstable paths.

Single-focusing mass spectrometer

An instrument in which an initially divergent ion beam with a given value of mass/charge ratio is brought to focus.

Static fields mass spectrometer

An instrument that can separate selected ion beams by means of fields that do not vary with time. The fields are generally both electric and magnetic.

Tandem mass spectrometer

An instrumental arrangement in which ions are subjected to two or more sequential stages (which may be separated spatially or temporally) of analysis according to the mass/charge ratio. The study of ions by means of two stages of mass analysis is termed *mass spectrometry/mass spectrometry MS/MS*.

Time-of-flight mass spectrometer

An instrument making use of the fact that ions of different mass/charge ratio, and all with the same initial translational energy, require different times to traverse a given distance in a field-free region.

Transmission

The ratio of the number of ions leaving a region of a mass spectrometer to the number entering that region.