

# MASS SPECTROMETER AND LEAK DETECTION

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# MASS SPECTROMETER

- **Mass spectrometers** are used in both quantitative and qualitative analysis, including high-resolution accurate mass measurements for the determination of elemental compositions.
- **Mass spectrometry** (MS) is an analytical spectroscopic tool primarily concerned with the separation of molecular (and atomic) species according to their mass.
- MS can be used in the analysis of many types of samples, from elemental to large proteins and polymers.

# HISTORY

- The quadrupole mass analyzer was developed in parallel with the quadrupole ion trap by the third Nobel prize winning mass spectrometry pioneer, **Wolfgang Paul**

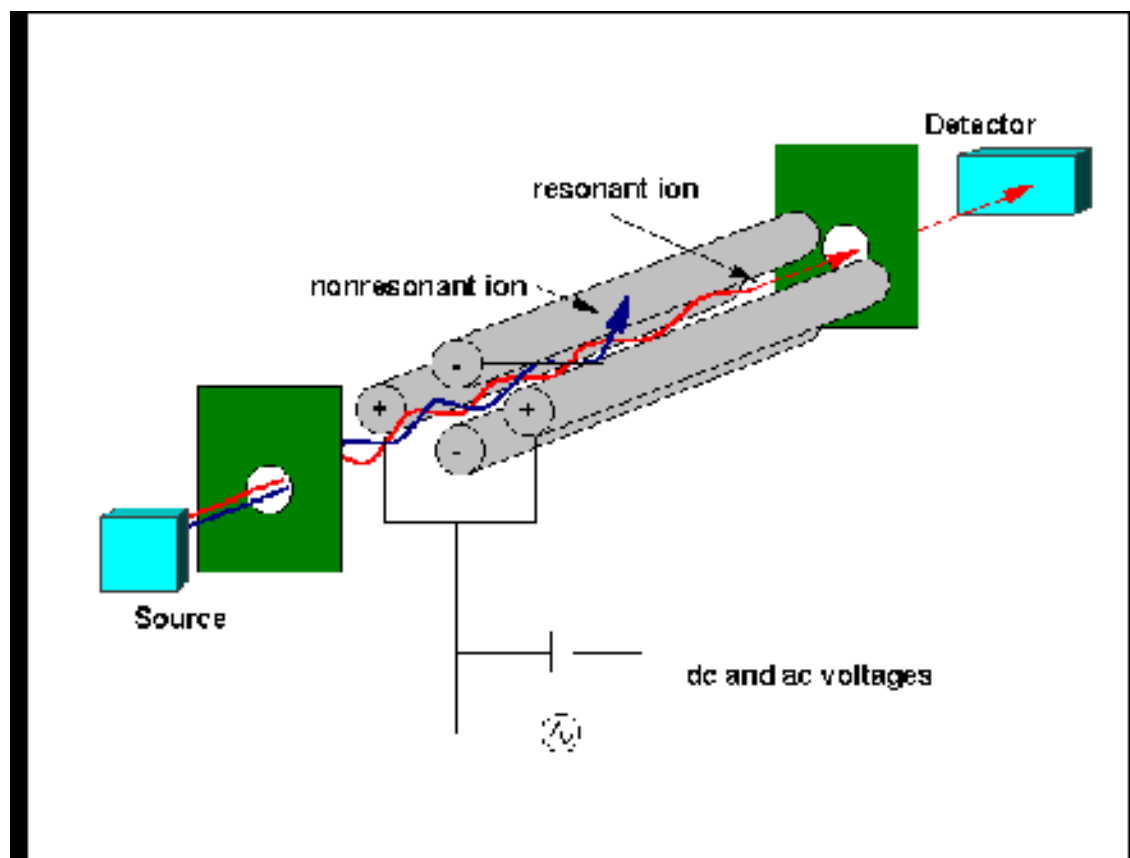
# MASS ANALYZER

- *A quadrupole mass analyzer* consists of four parallel rods that have fixed DC and alternating RF potentials applied to them.
- Ions produced in the source of the instrument are then focused and passed along the middle of the quadrupoles.

# MASS ANALYZER

- Their motion will depend on the electric fields so that only ions of a particular  $m/z$  will be in resonance and thus pass through to the detector.
- The two opposite rods in the quadrupole have a potential of  $+(U+V\cos(\omega t))$  and the other two  $-(U+V\cos(\omega t))$  where 'U' is the fixed potential and  $V\cos(\omega t)$  is the applied RF of amplitude 'V' and frequency ' $\omega$ '.

# Schematic of a quadrupole mass analyzer



# QUADRUPOLE MASS ANALYZER

- This results in ions being able to traverse the field free region along the central axis of the rods but with oscillations among the poles themselves.
- These oscillations result in complex ion trajectories dependent on the  $m/z$  of the ions.

# QUADRUPOLE MASS ANALYZER

- Specific combinations of the potentials 'U' and 'V' and frequency 'w' will result in specific ions being in resonance creating a stable trajectory through the quadrupole to the detector.
- All other  $m/z$  values will be non-resonant and will hit the quadrupoles and not be detected.

# QUADRUPOLE MASS ANALIZER

- The mass range and resolution of the instrument is determined by the length and diameter of the rods.
- Quadrupole mass spectrometers generally have two configurations in the modern laboratory

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■ Quadrupole mass spectrometers generally have three configurations in the modern laboratory:

✦ gas-chromatography

✦ liquid-chromatography

✦ can also be placed in tandem to enable them to perform fragmentation studies



# MASS SPECTROMETERS COMPONENTS

- Quadrupole mass spectrometers consist of:
  - ✦ An ion source
  - ✦ Ion optics to accelerate and focus the ions through an aperture into the quadrupole filter
  - ✦ the quadrupole filter itself with control voltage supplies
  - ✦ an exit aperture
  - ✦ an ion detector and electronics
  - ✦ a high-vacuum system

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