MASS SPECTROMETER AND LEAK DETECTION

Ramon Rivera Varona
Research and Development Department
Plasma Laboratory Technician
Mechanical Engineering Department
PUPR

Mentor: Dr. Edbertho Leal
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.
The quadrupole mass analyzer was developed in parallel with the quadrupole ion trap by the third Nobel prize winning mass spectrometry pioneer, Wolfgang Paul.
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.
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 quadruple have a potential of \( +\left(U+V\cos(wt)\right) \) and the other two \( -(U+V\cos(wt)) \) where 'U' is the fixed potential and \( V\cos(wt) \) is the applied RF of amplitude 'V' and frequency 'w'.
Schematic of a quadruple 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.
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.
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
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