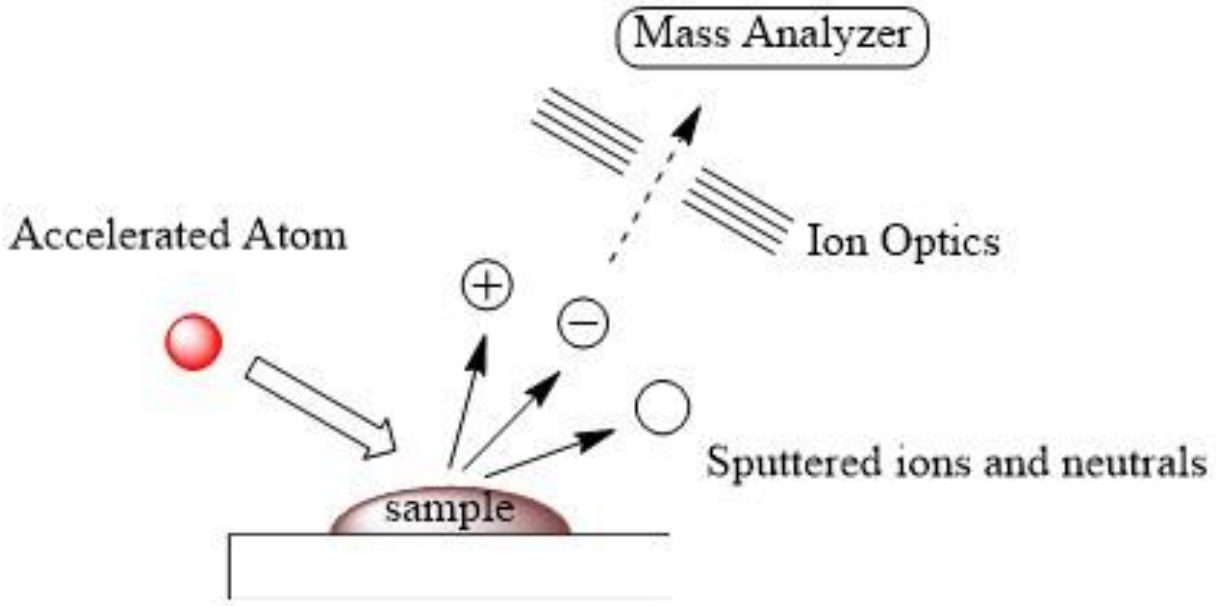
Instrumental technique

Fast atom bombardment mass spectrometry (FAB MS)



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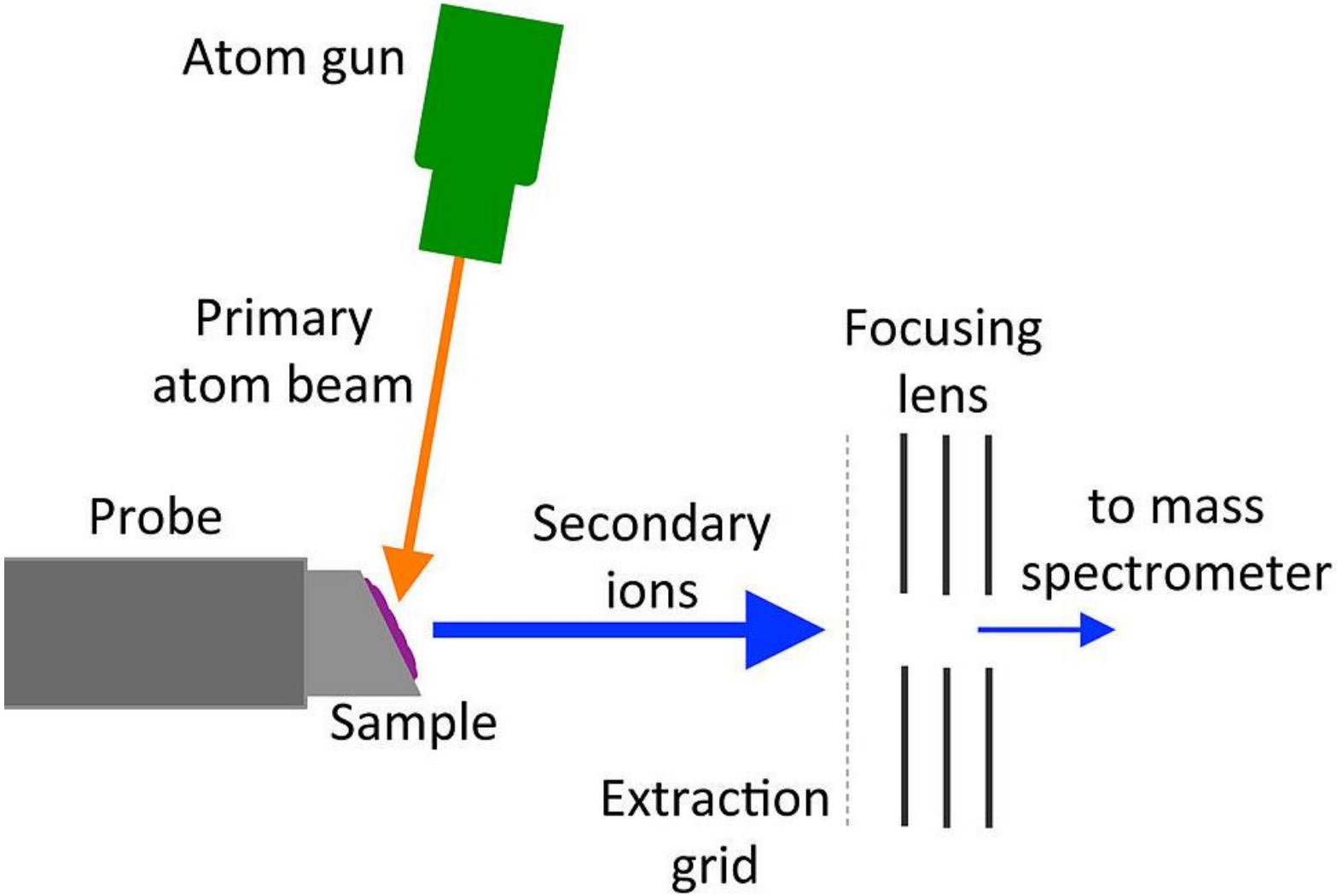
Introduction

- Fast atom bombardment (FAB) is an ionization technique used in mass spectrometry in which a beam of high energy atoms strikes a surface to create ions.
- When a beam of high energy ions is used instead of atoms, the method is known as fast ion bombardment (FIB).
- In FAB and FIB, the material to be analysed is mixed with a non-volatile chemical protection environment, called a matrix, and is bombarded under vacuum with a high energy (4000 to 10,000 electron volts) beam of atoms/ions.
- It was developed by Michael Barber at the University of Manchester in 1980.

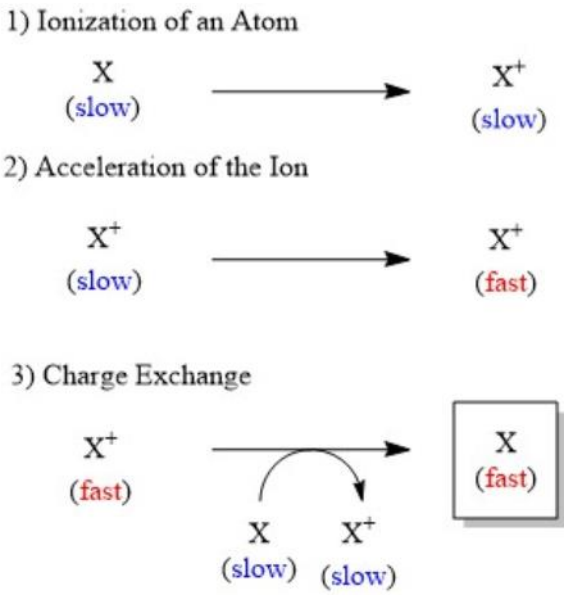
FAB MS

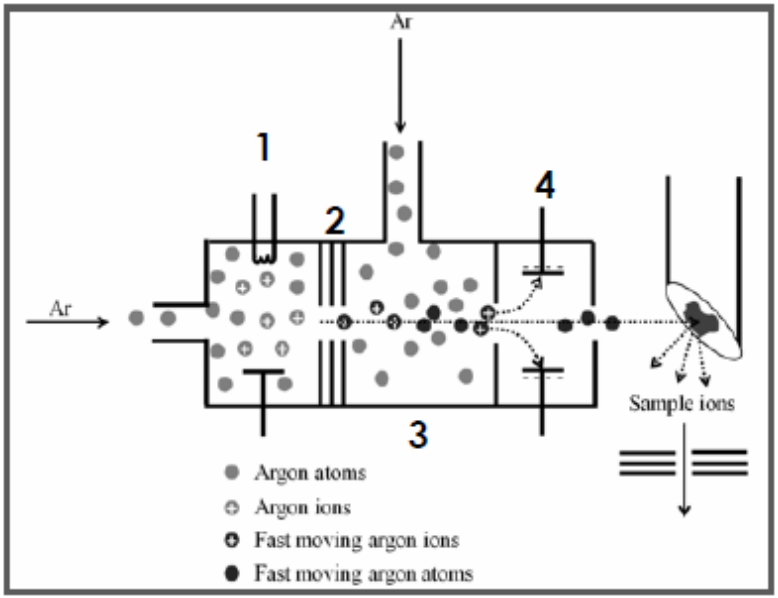

Atom gun
Primary
atom beam
Probe
Sample
Secondary
ions
Focusing
lens
to mass
spectrometer
Extraction
grid

Atom Gun

The Ar or Xe beam required in FAB is generated within an appropriate atom gun:

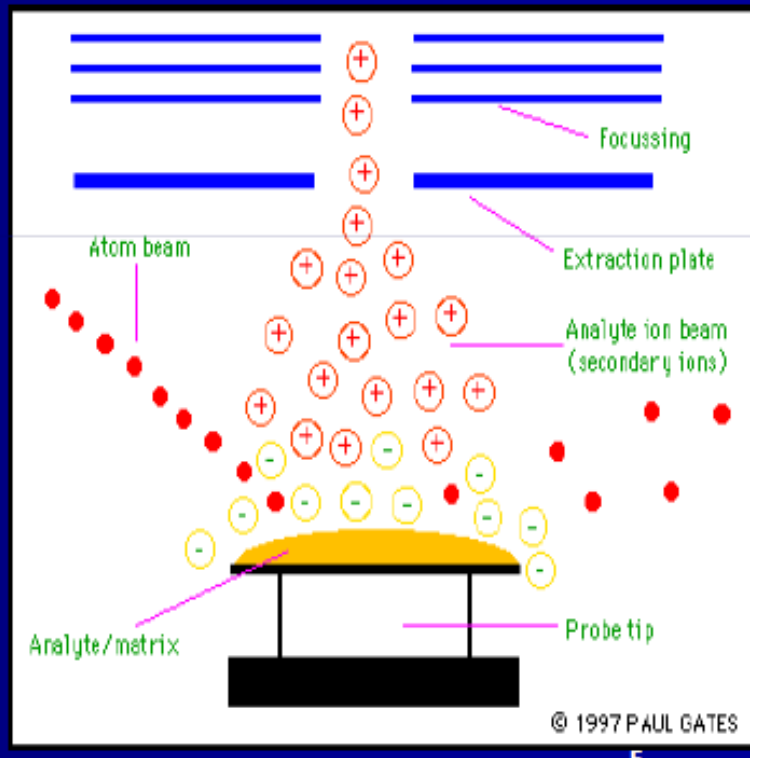
- ❖ Ar (or Xe) atoms are ionised by electron ionization within chamber 1
- ❖ The resulting ions are then focused and accelerated by lenses 2
- ❖ When arriving in chamber 3, Ar ions exchange charge and energy with Ar neutral atoms
- ❖ Ar ions are separated from accelerated neutral atoms, outgoing from chamber 3, by electrostatic deflectors 4: fast Ar atoms are finally directed outside, towards the sample stage.
- ❖ The processes occurring in the different stages of the atom gun are:





How Does FAB Work?

- Fast moving beam is directed towards the sample
- Sample is dissolved in a matrix and placed on target
- Beam collides producing +ve and –ve ions from matrix, analyte etc



Proton transfer by any organic ion (FH^+) arising from the matrix

$$FH^+ + M \rightarrow MH^+ + F$$

Cation/anion attachment from salts dissolved into the sample

$$Na^+ + M \rightarrow MNa^+$$
$$Cl^- + M \rightarrow MCl^-$$

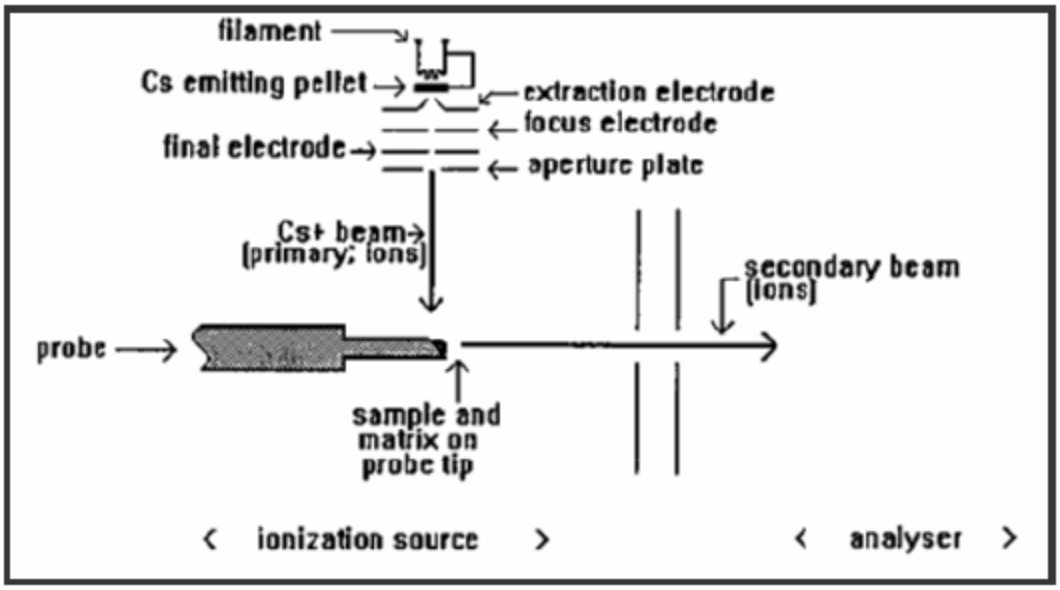
If the analyte is anionic, partial charge recombination with counterions in the sample or proton abstraction from the matrix (e.g. glycerol, G) may occur:

$$M^{2-} + Na^+ \rightarrow MNa^-$$
$$G + M^{2-} \rightarrow [G - H]^- + HM^-$$

Fast Ion Bombardment (FIB)-MS

Fast ion bombardment was introduced soon after FAB-MS when it was clear that the latter could not ionize (bio)molecules with MW higher than 10000 u.

The principle of FIB is using a Cs^+ beam instead of a Xe or Ar one, to hit the sample:



Cs^+ ions are generated by a pellet heated by a filament and then accelerated towards the probe tip by very high potentials, up to 35 kV.

Limitations of FAB MS

- High background below 200 m/z units;
- Upper MW limit at 10000 u;
- Difficulty in achieving a precise and accurate quantification.
- Sample preparation

Limitations of FIB MS

- Steer the ion at high voltage.
- High background below 250 m/z units
- Sample preparation

Thank You