# LITTLE FLOWER COLLEGE
# DEPARTMENT OF CHEMISTRY

## AUGER ELECTRON SPECTROSCOPY (AES)

PRESENTED BY

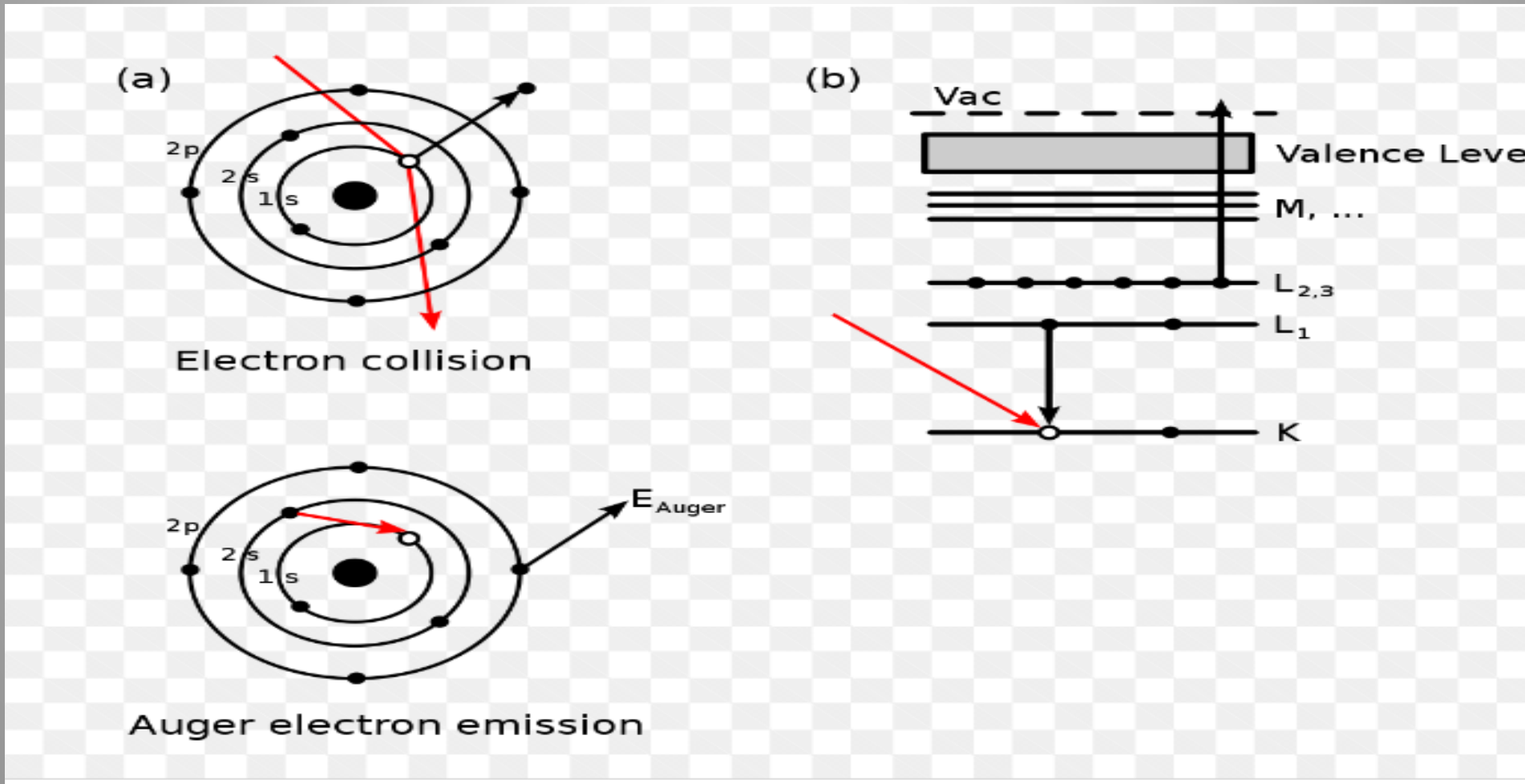
ROSE THERESA

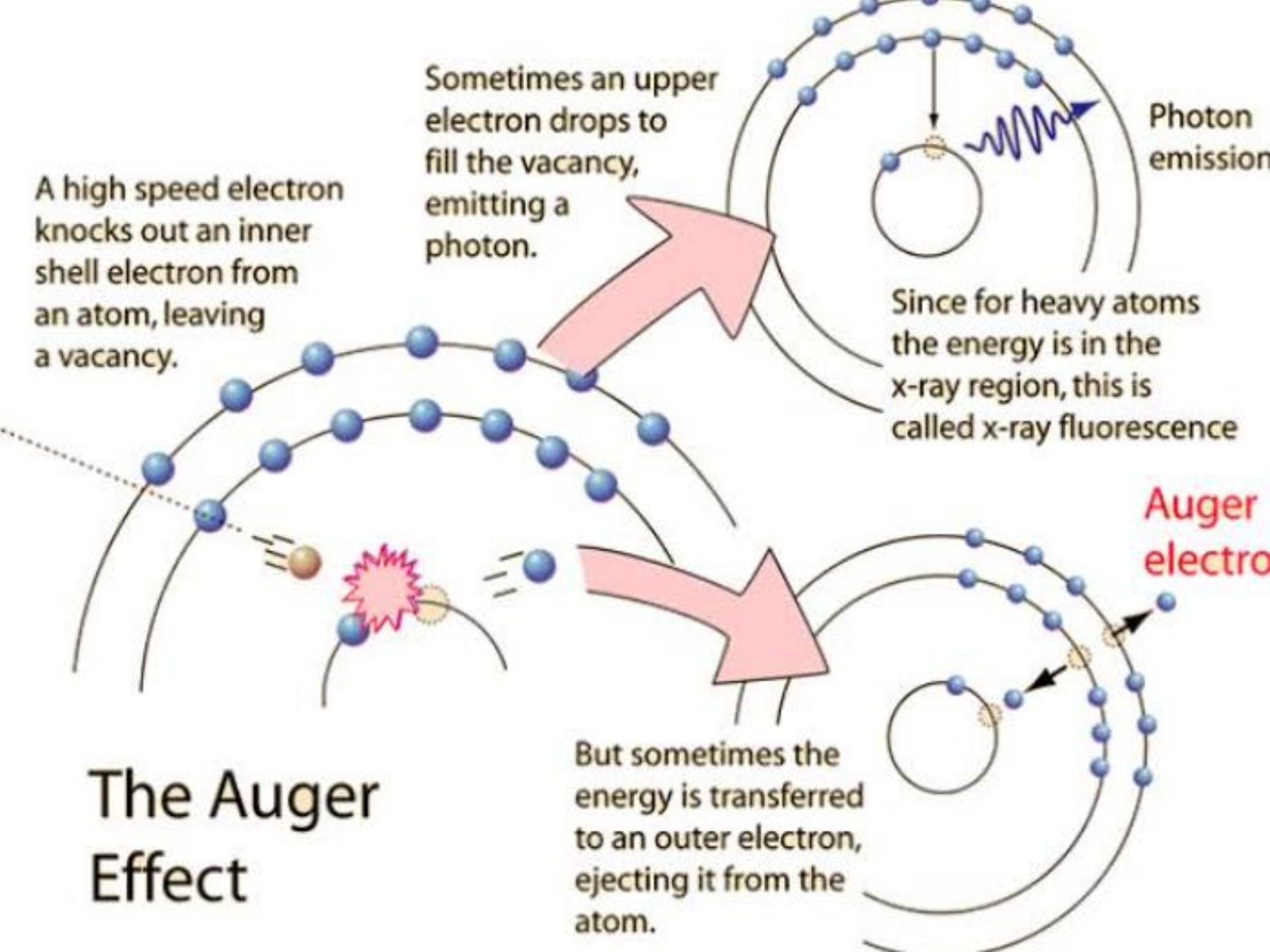
# PRINCIPLE

- When an incident X-ray or an energetic electron bombard the sample the core electron is ejected .
- An electron from a higher level will drop in to fill the vacancy.
- The energy released by this transition is sufficient to remove another electron from the same shell in the atom.
- Thus if a K electron is ejected in the primary process, one L electron may take its place in the K shell and at the same time a second L electron is ejected from the atom.

This is known as Auger Effect.

This process require 3 electron , thus we cannot detect H and He . But all other elements can be detected.




A high speed electron knocks out an inner shell electron from an atom, leaving a vacancy.
Sometimes an upper electron drops to fill the vacancy, emitting a photon.
Photon emission
Since for heavy atoms the energy is in the x-ray region, this is called x-ray fluorescence
Auger electro
But sometimes the energy is transferred to an outer electron, ejecting it from the atom.
The Auger Effect

# Auger Transition

- This is based upon a two step process

1. Involves formation of an electronically excited ion A+* by exposing the analyte to a beam of electron or with X-ray , the reaction occurs as

$$A + h\nu = A^{+*} + e^-$$

- For an electron ,the process of excitation can be expressed as

$$A + e_i^- \rightarrow A^{+*} + e_i'^- + e_A^-$$

- ei- represent incident electron from source
- ei-’ represent the same electron after it has interacted with A( and has lost some energy)

- eA- represent an electron that is ejected from one of the inner orbital of A

2.Relaxation of excited ion A+* can take place in either of following 2 ways

$$A^{+*} \rightarrow A^{++} + e_A^-$$

$$A^{+*} \rightarrow A^{+} + h\nu_f$$

hvf fluorescence photon

- For excited step polychromatic radiation may be used

- The energy of Auger electron is independent of the energy of photon or electro that originally created the vacancy in energy level Eb.
- So monoenergetic source is not required for excitation .

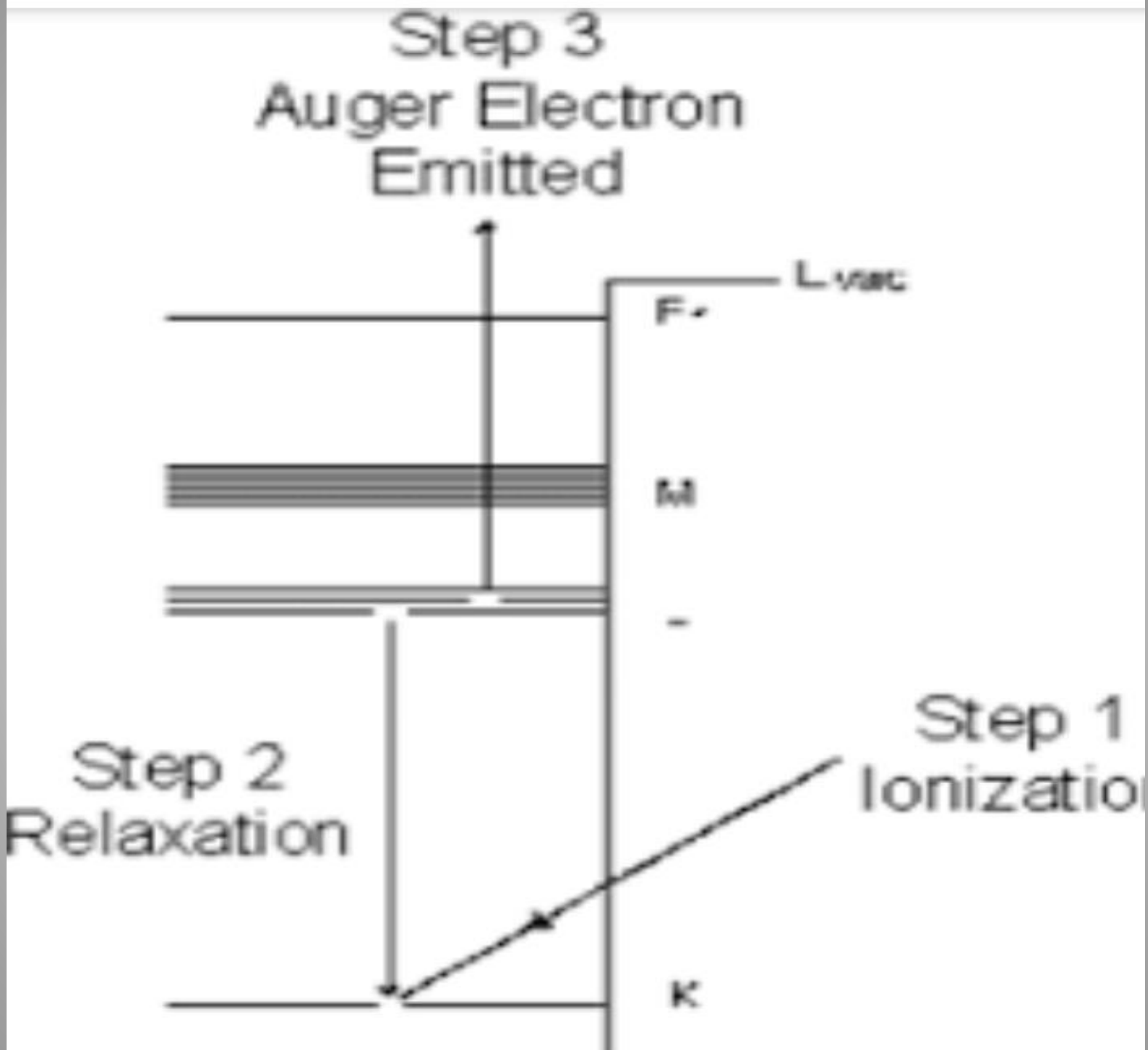
- K.E of Auger electron is

$$E_k = (E_b - E'_b) - E'_b = E_b - 2E'_b \ldots$$

- (Eb – Eb’) is the energy released in relaxation of the excited ion.
- Eb’ is the energy required to remove the second electron from its orbital.
- K L L Auger transition

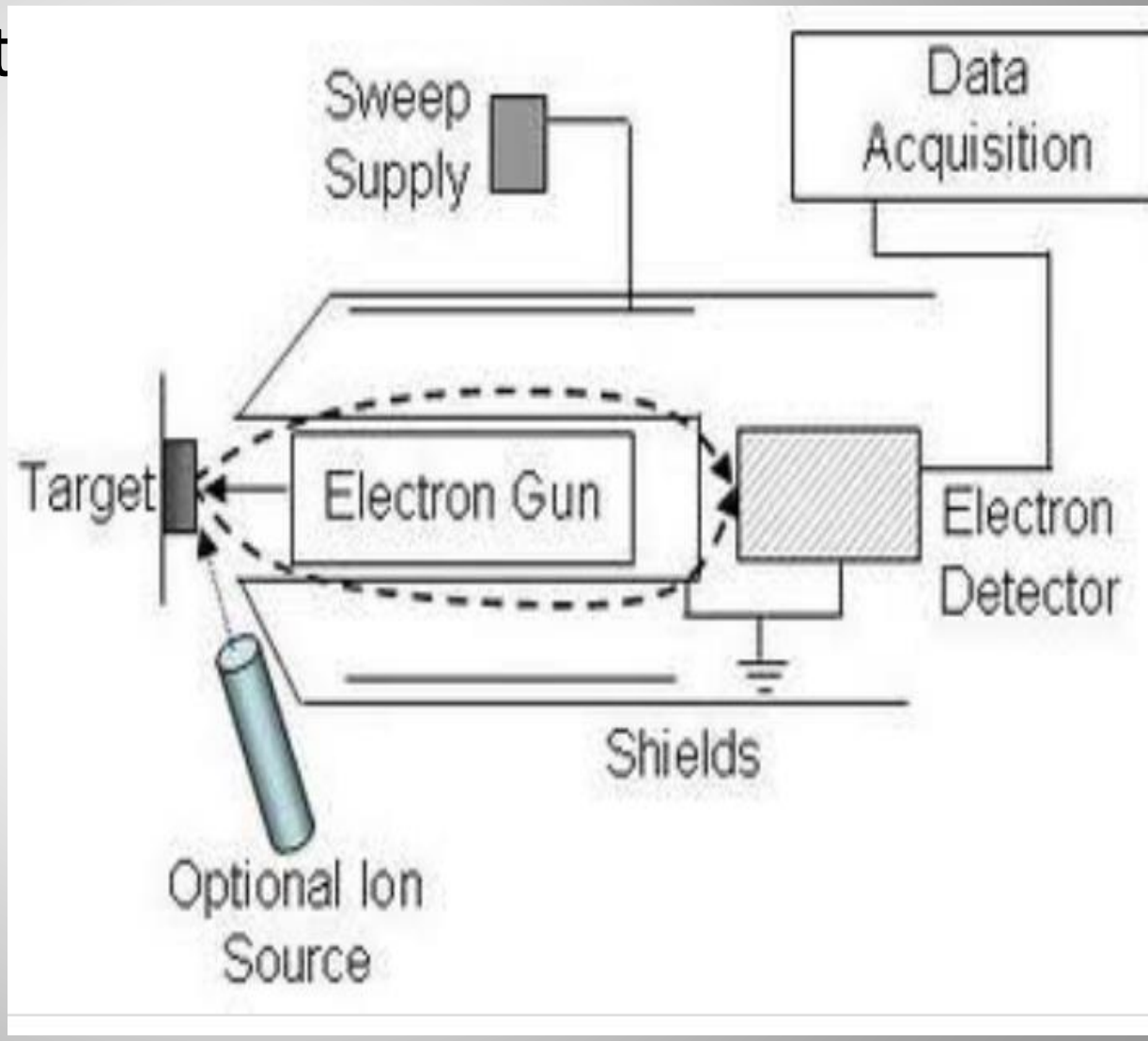
$$E_A = (E_K - E_L) - E_L$$

- EK and EL is the binding energy of electron in the K and L shell.


Step 3
Auger Electron
Emitted
L vac
F
M
Step 2
Relaxation
Step 1
Ionizatio
K

# INSTRUMENTATION

- UHV environment
- Electron gun
- Electron energy analyzer
- Electron detector
- Output devise



# WORKING

- The instrumentation for AES is similar to that for XPS.
- The sample is irradiated with electrons from an electron gun.
- The experiment is carried out in a UHV environment because the AES technique is surface sensitive due to the limited mean free path of electrons in the kinetic energy range of 20 to 2500 eV.
- The sample compartment is evacuated to pressure of 10^-8 – 10^-12) in order to prevent the attenuation of electron beam. Sample surface must be chemically clean.
- A conventional Auger electron spectrometer uses a lock in amplifier.

• The oscillator in this amplifier superimposes a sinusoidal modulation on the potential applied to the outer cylinder of the analyzer.

- Electrons of various kinetic energy can be focused on detector by varying field.
- Electron multiplier is used as detector.
- The AC component of the signal is decoupled from the multiplier high voltage and detected in amplifier.
- The output is then fed to an recorder.
- The images are visualised in the monitor.

# ADVANTAGES

- Surface sensitive
- Elemental and chemical composition analysis by comparison with standard samples of known composition.
- Detection of elements heavier than Li . Very good sensitivity for light element.
- Depth profiling analysis : quantitative compositional information as a function of depth below the surface.
- Spatial distribution of the elements : elemental or even chemical Auger maps analysis in lines, points and area.

# DISADVANTAGES

- Lateral resolution;<50nm
- Analytical volume ; 10-18cm3
- Insulators are difficult to study due to surface charging.
- Surface may be damaged by the incident electron beam.
- Expensive , slow, poor spatial resolution , require high vacuum.
- Quantitative detection is dependent on the element but to high sensitivity.
- Samples must be conductive.

# APPLICATION

- Spatial resolution is high.
- Analysis is relatively rapid
- Surface or subsurface analysis can be performed.
- It is sensitive to light element (H and He)
- It provide reliable semi quantitative analysis.
- Chemical information is available in some cases.

# THANK YOU