

# Atomic Emission

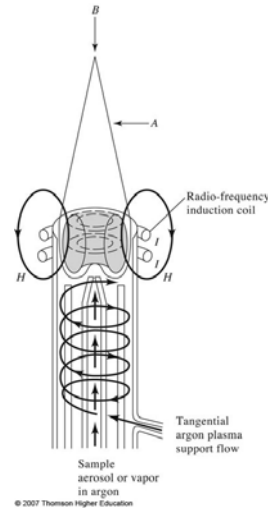
## Inductively Coupled Plasma (ICP)

### What is ICP?

- Inductively Coupled Plasma (ICP)= a plasma that is inductively coupled to a high energy radiofrequency field
- What is a Plasma?  
A plasma is an electrically conducting gaseous mixture with high concentration of ions (Argon) and electrons (net charge = 0)  
It is a very high temperature source.  
Temperatures can reach 10,000 K

## Components of an ICP

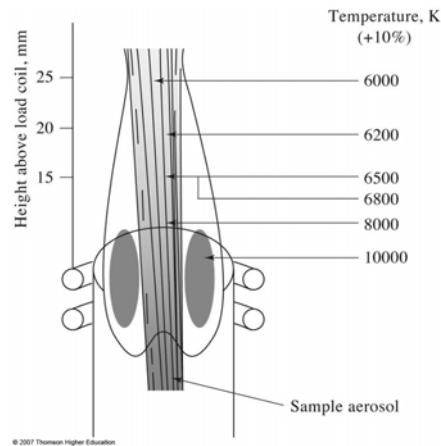
- Torch
  - Quartz tubes (three concentric quartz tubes)
- Induction coil
- Radiofrequency generator (27 -47 MHz, 0.5 to 2 kW): produces field in coil
- Tesla Coil: source of electrons that initiate ionization of argon



## Plasma Generation

- Seed electrons from tesla coil ionize argon atoms
- Ions and electrons produced interact with the radiofrequency field
- (ions and electrons act like the secondary coil of a transformer and the induction coil acts like the primary coil)
- The plasma absorbs energy from the rf field.
- Ohmic heating takes place due to the impedance of the plasma to the flow.

## Temperature Profile of Plasma



## Probable Excitation Mechanisms

- Production of excited analyte ion from collision with metastable excited Argon atoms
  - Relaxation of analyte ion by emission
  - Ionic emission
- Production of excited neutral analyte from electron impact
  - Relaxation of neutral analyte by emission
  - Atomic emission
- Production of analyte ions from electron impact
- Production of Argon ions from electron impact

## Profile of Analyte Emission

- Neutral atoms emission profile (e.g. CaI (423 nm) is highly dependent on analyte
- ion emission profile (CaII 393 nm) is relatively independent of analyte

## Interferences

- Excitation
  - Effects of easily ionizable elements (EIE): shift the equilibrium
    - Spatially, element and line dependent.
    - Can not be easily eliminated
    - Ionization equilibrium is more sensitive to electron concentrations
- Spectral line (complexity of spectra, overlap, need for high resolution system)
- Spectral Background (complex spectral background)

## ADVANTAGES

- Simultaneous Multielement Analysis
- Emission spectra for all elements obtained under a single set of excitation conditions.
- Wide dynamic range
- High sensitivity
- Low detection limits ( down to few ppb for some elements)
- High stability
- Low background (background correction possible)
- Low noise
- Good precision
- Minimal Interference (interelement) Effects
- Determination of elements that form refractory compounds highly resistant to thermal decomposition.
- Several lines per elements
- Determination of nonmetals
- High Accuracy
- Direct sample manipulation
- Easily operated, Safe
- Reasonable costs

## Inherent problems

- Complex spectra
- Need for higher resolution monochromator

