

# UHV and Below Routine or Challenge?

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# Pressure Regimes

Rough Vacuum	Atmos – $10^{-3}$ mbar
Medium Vacuum	$10^{-3}$ – $10^{-6}$ mbar
High Vacuum (HV)	$10^{-6}$ – $10^{-9}$ mbar
Ultra High Vacuum (UHV)	$10^{-9}$ – $10^{-11}$ mbar
Extreme High Vacuum (XHV)	$< 10^{-11}$ mbar

# Vacuum Equation

$$P = \frac{Q}{S}$$

Where

- P is the base pressure in the system
- Q is the gas load in the system
- S is the pumping speed available in the system

Gas load includes

$$Q = \cancel{Q}_{inj} + Q_{outgas} + Q_{leak}$$

*Minimise*

Includes Backstreaming

# Challenges?

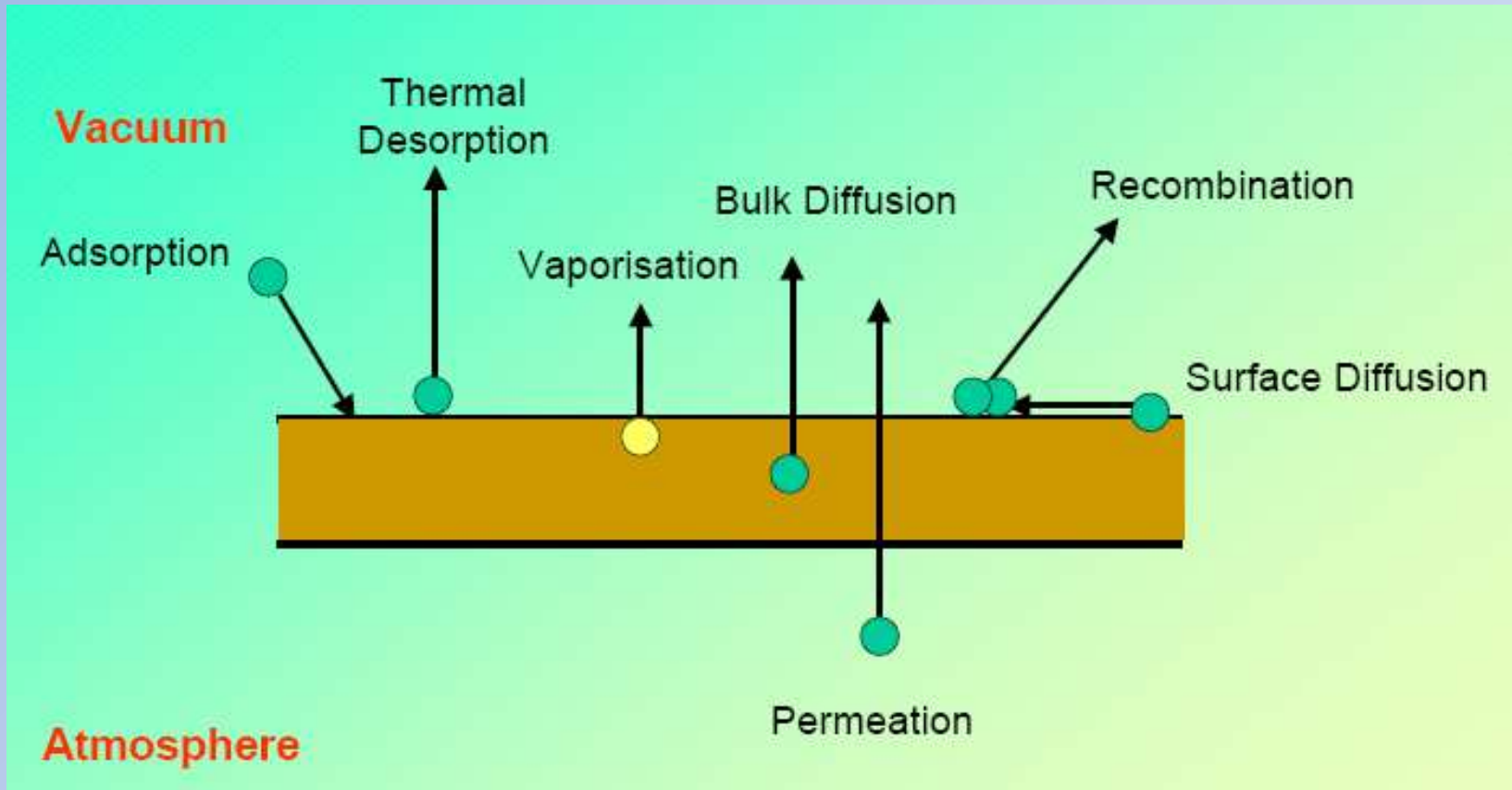
In general, for UHV outgassing rates can be reduced sufficiently and sufficient pumping speed can be applied.

So UHV is routinely achievable.

However, for XHV, the following challenges remain

- Increasing pumping speed by orders of magnitude
- Reducing gas sources by orders of magnitude

# Outgassing



# Pumping

At pressures in which we are interested, gas flow is molecular, therefore there is no “pumping”.

Gas finds its way to a place where it is removed from the system or trapped.

## Lumped pumping

- Maximum pumping speed is the conductance of the entrance aperture

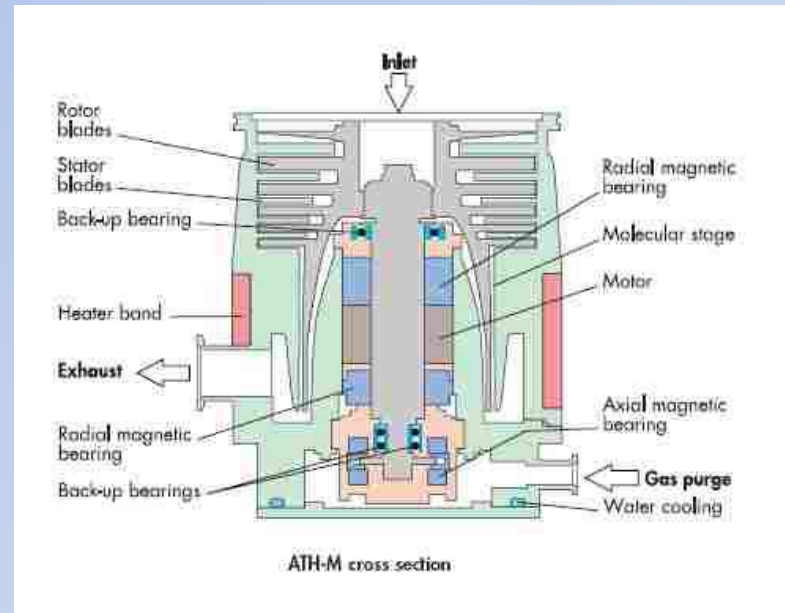
## Distributed pumping

- Maximum pumping speed is determined by the area of the pumping surface

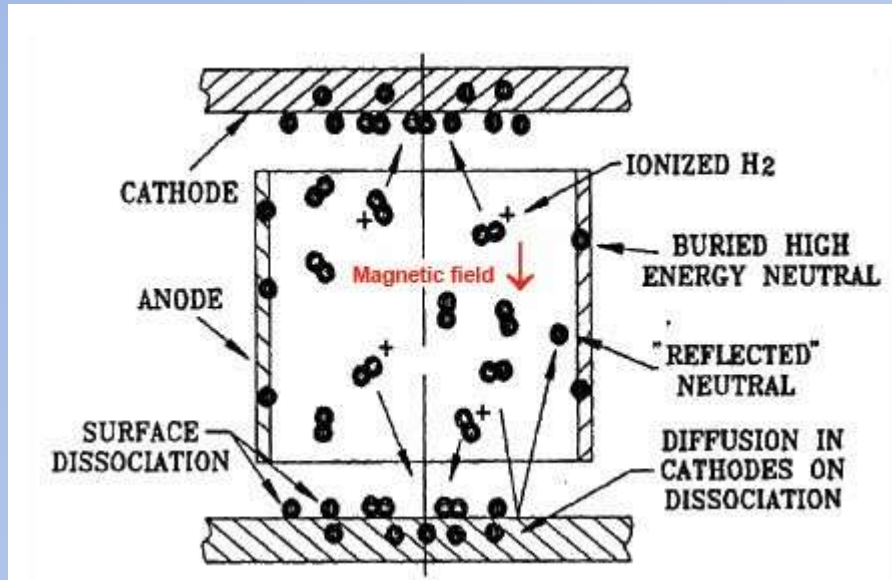
# Lumped pumps

## Turbomolecular pumps

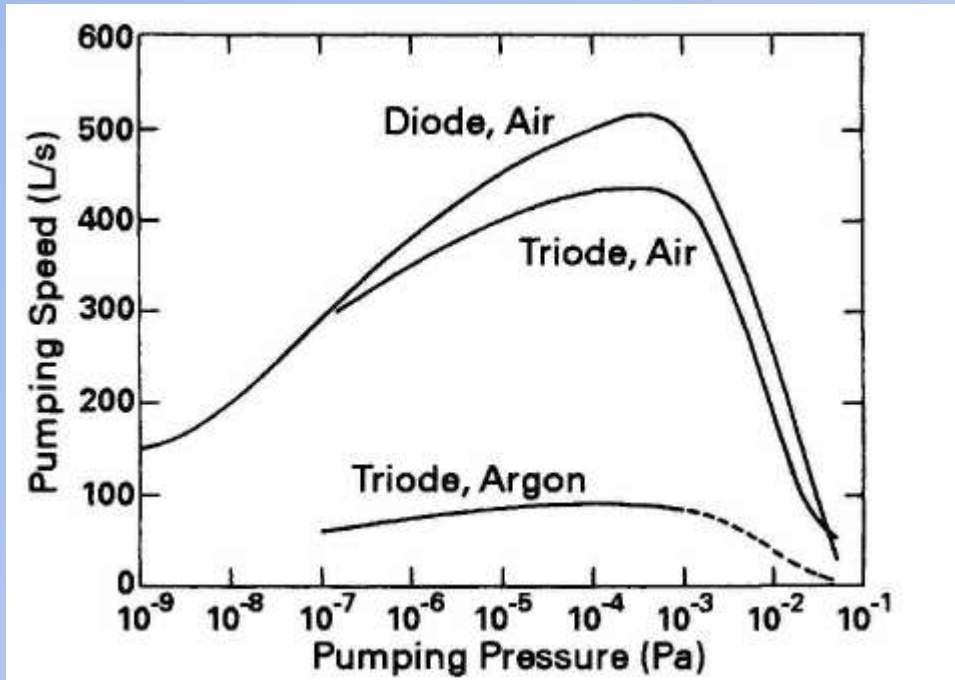
- Good pumping speed
- Compression ratio lower for light gases



# Sputter Ion Pumps

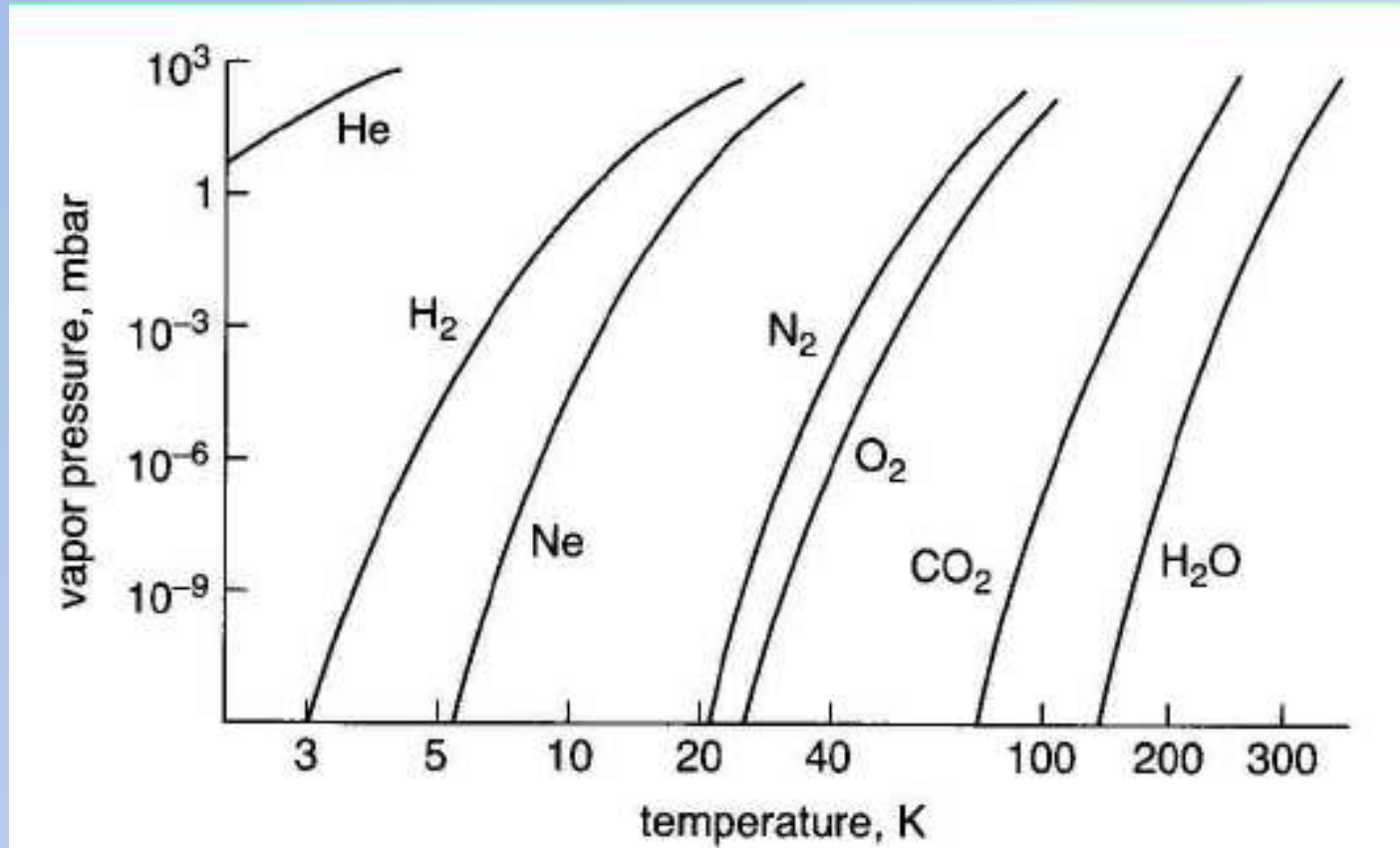


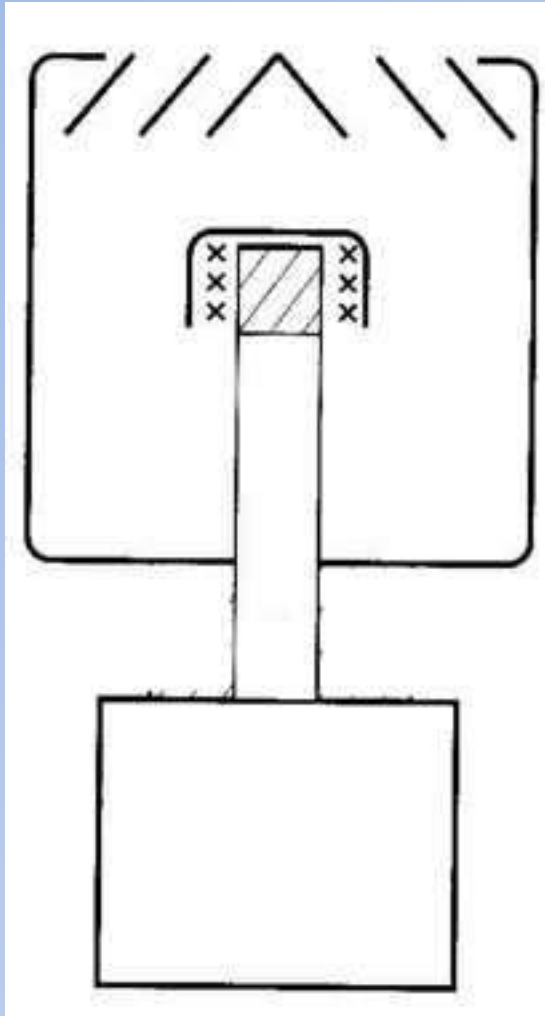
# Sputter Ion pumps



Moderate pumping speed  
Low for noble gases

# Cryogenic Pumps





Very high pumping speed

Sorbent required for Hydrogen, helium

Regeneration required

# Getter Pumps

## Evaporated metal films

- Barium
- Titanium
- Good pumping speed
- Active gases only

## Non evaporable films (NEG)

- Alloys (Ti – V – Zr)
- Good pumping speed
- Active gases only
- Very low outgassing

# XHV

XHV is not routine, but is not an impossible challenge provided

- Outgassing is minimised by
  - Cleaning
  - Degassing materials
- Pumping is provided
  - Lumped for noble gases
    - Reduce outgassing/backstreaming by use of NEG coating
  - Distributed pumping by getters for active gases

Thank you for your attention