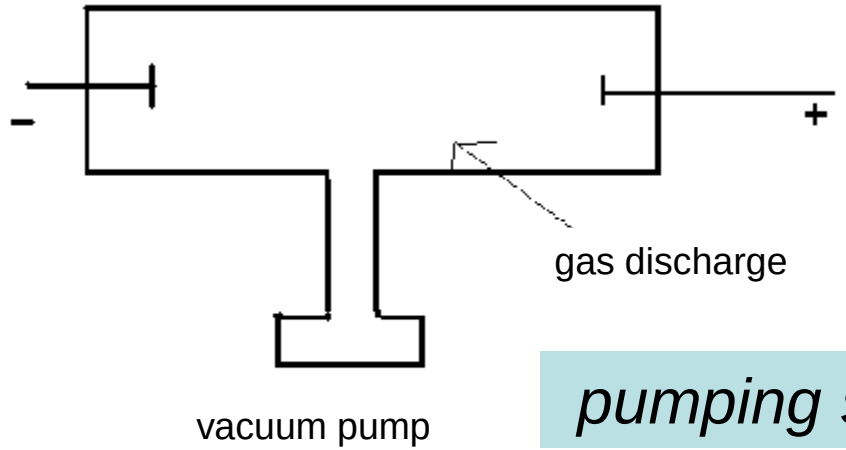
10.13. Selfcontained glow discharge in gases



Precondition: Vacuum
definition used in vacuum physics

pumping speed $S_V = \frac{dV}{dt}; [S_V] = \frac{l(iter)}{s}$:

through put $S_L = p\frac{dV}{dt}; [S_L] = \frac{mbar \cdot l}{s}$:

creation: mechanical pumps

rotary vane pump $\rightarrow 10^{-1} - 10^{-3} mbar$

turbo molecular pump: 20000 up to 60000 turns/min

$\Rightarrow 10^{-8} mbar$ *reachible*

cryopumps: cooled areas $\rightarrow$ *gases condense*

ion getter pumps: $10^{-8} mbar$

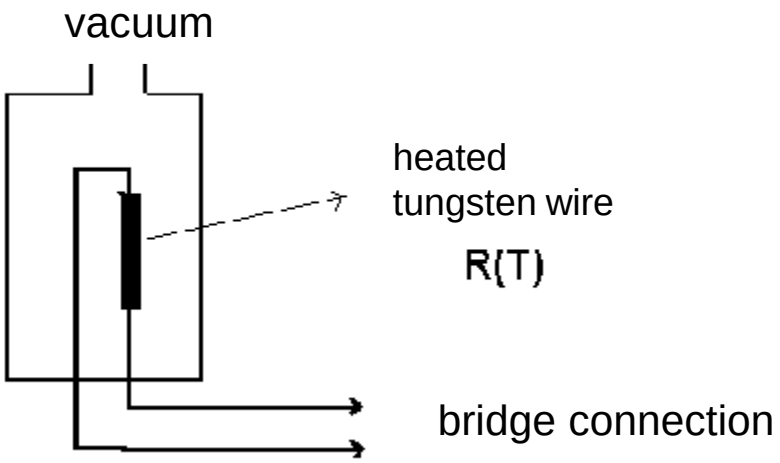
Measurement devices: *Fluid manometer(mercury)*

Heat conductivity manometer: *if free path length* $\succ$ *container*

$\Rightarrow$ e.g.: p $\rightarrow 1mb$

heat conductivity $\sim$ *pressure*

$p \Rightarrow 10^{-1} - 10^{-3} mbar$



Ionisation manometer:

hot cathode

$\rightarrow$ *ionisation* current

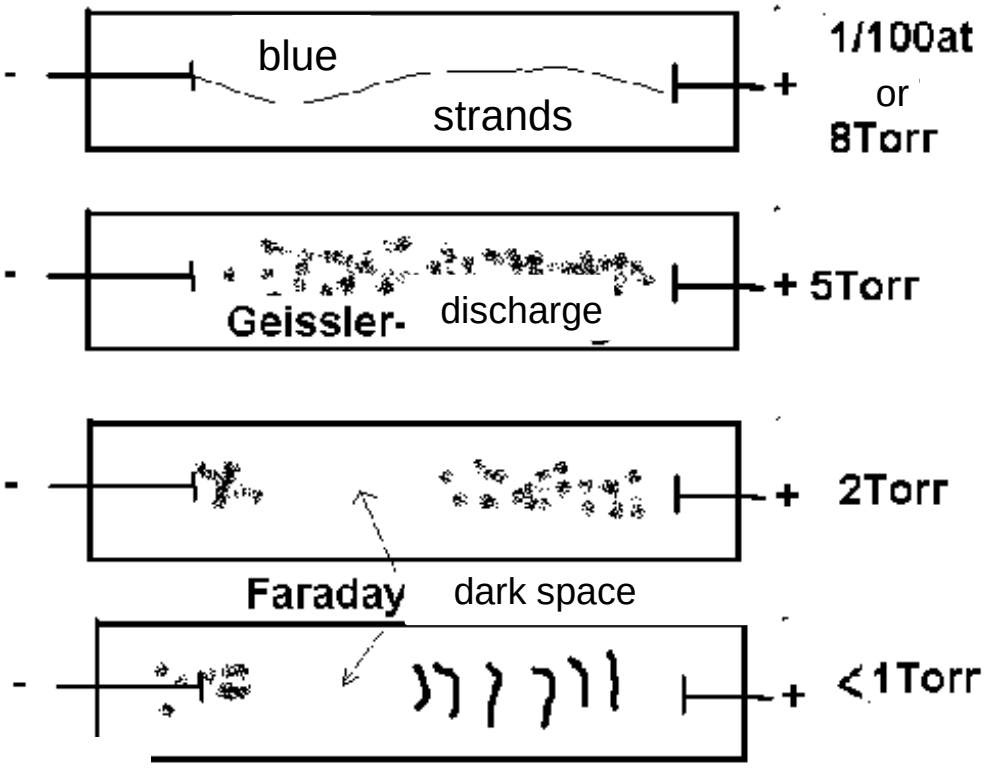
$\sim$ *density*
residual gas

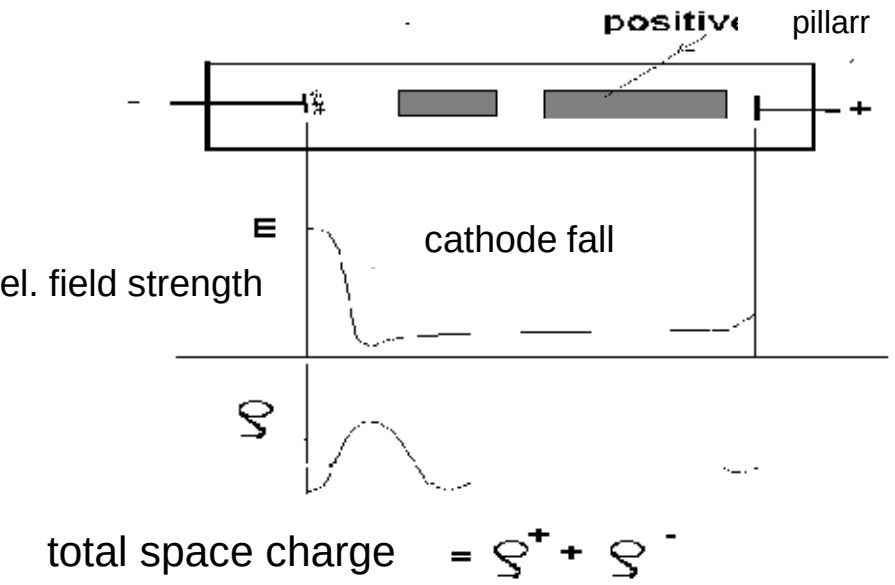
$p \sim 10^{-3} - 10^{-13} mb$

Gase discharge

normal pressure: few free e‘s

and ions, small energies





total space charge $= \varrho^{+} + \varrho^{-}$

pressure reduction:

Elektrons and ions reach larger average free path length λ(

length between two collisions)

Acceleration: $\vec{b} = \frac{\vec{F}}{m} = \frac{e \cdot \vec{E}}{m} \rightarrow$

additional velocity u in direction of the field

$u = b \cdot t = \frac{e}{m} E \cdot \tau$(: time between 2 collisions)

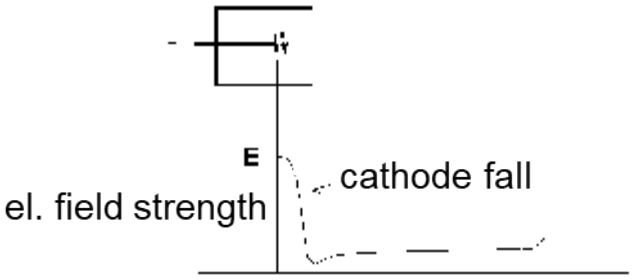
or in a fall by a potential gets a particle with charge e: $eV = e \cdot E \cdot \lambda = \frac{1}{2} m u^2 \rightarrow$ u

for a electron $\sqrt{1880A}$ larger than a ion with atomic weight A

Ions knock out from the cathode e, those get accelerated! -→! knock out from molecules electrons

→ *multiplication* :collision *ionisation*

cathode fall:



Accumulation of positive charges

Positive column : Ions + e move with relatively small velocity

Momentum: Ass.: particles have a kin. energy of 40 eV electron:

$$p = \sqrt{2E_{kin} \cdot m} = \sqrt{80 \cdot 5 \cdot 10^5} = 2000\sqrt{10} = 6324.6 eV/c$$

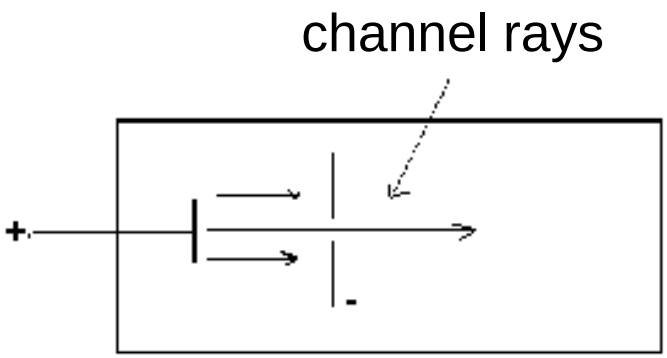
Ion(^{14}N) $\sqrt{40 \cdot 13 \cdot 10^9} = 7.2111 \times 10^5 eV/c$

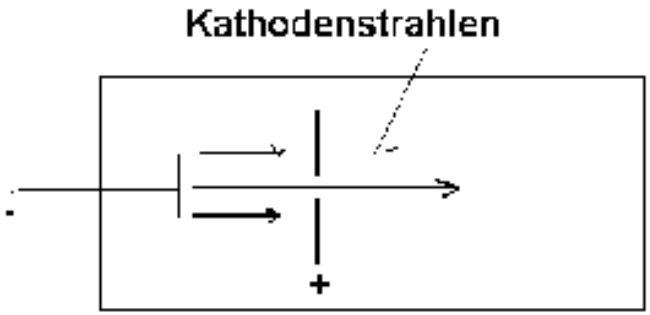
Deflection in a magnetic field: e.g.:

a 0.3 GeV/c electron extends its radius in a 1 T- B-field to to1m:

Lorentz-force

Ions have almost no deflection



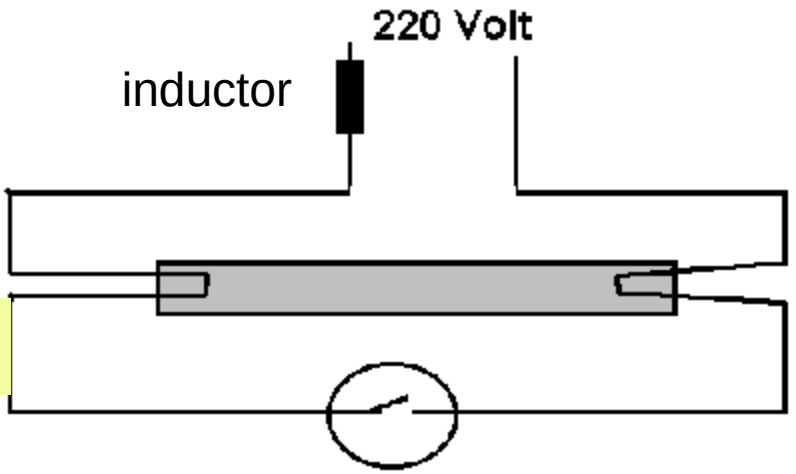


Application: Fluorescent tube

1) Heating via glow current → circuit closed

2) No glow

3) open→ voltage surge of inductor



Fluorescent tube ignites!