

Theory and demonstration of plasma measurement using Langmuir probe

電漿量測之蘭摩爾探針原理與實作



Po-Yu Chang 張博宇

Institute of Space and Plasma Sciences

National Cheng Kung University

pchang@mail.ncku.edu.tw

2021 winter break

1/18(Mon.) – 1/22(Fri.) 14:00-17:40

<http://capst.ncku.edu.tw/PGS/index.php/teaching/>

Lecture 5

Course Outline



1. Introduction to plasma

- a. What is Plasma?
- b. How to generate plasma
- c. Applications of plasma

2. Theory of Langmuir probe

- a. Sheath
- b. Single Langmuir probe
- c. Double Langmuir probe
- d. Triple Langmuir probe

3. Demonstration of Langmuir probe

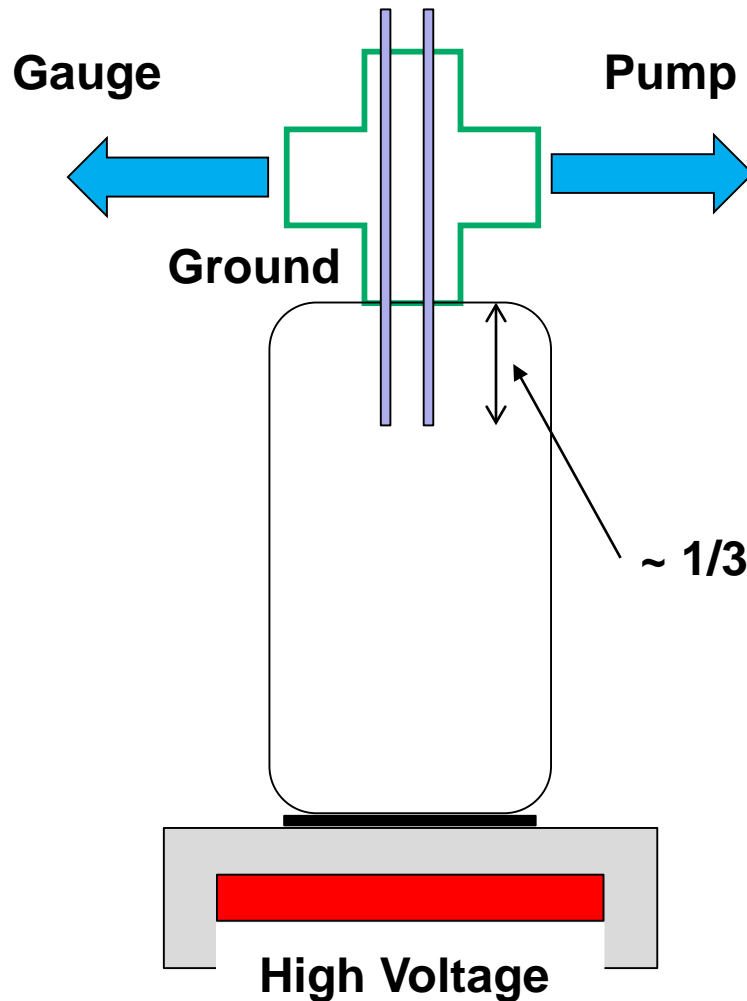
- a. Building vacuum systems
- b. Building Langmuir probes
- c. **Measuring temperatures and densities of plasma**

Day 1~3

Day 4~5:
Experiments

• **Wear shoes!**

Glow discharge test



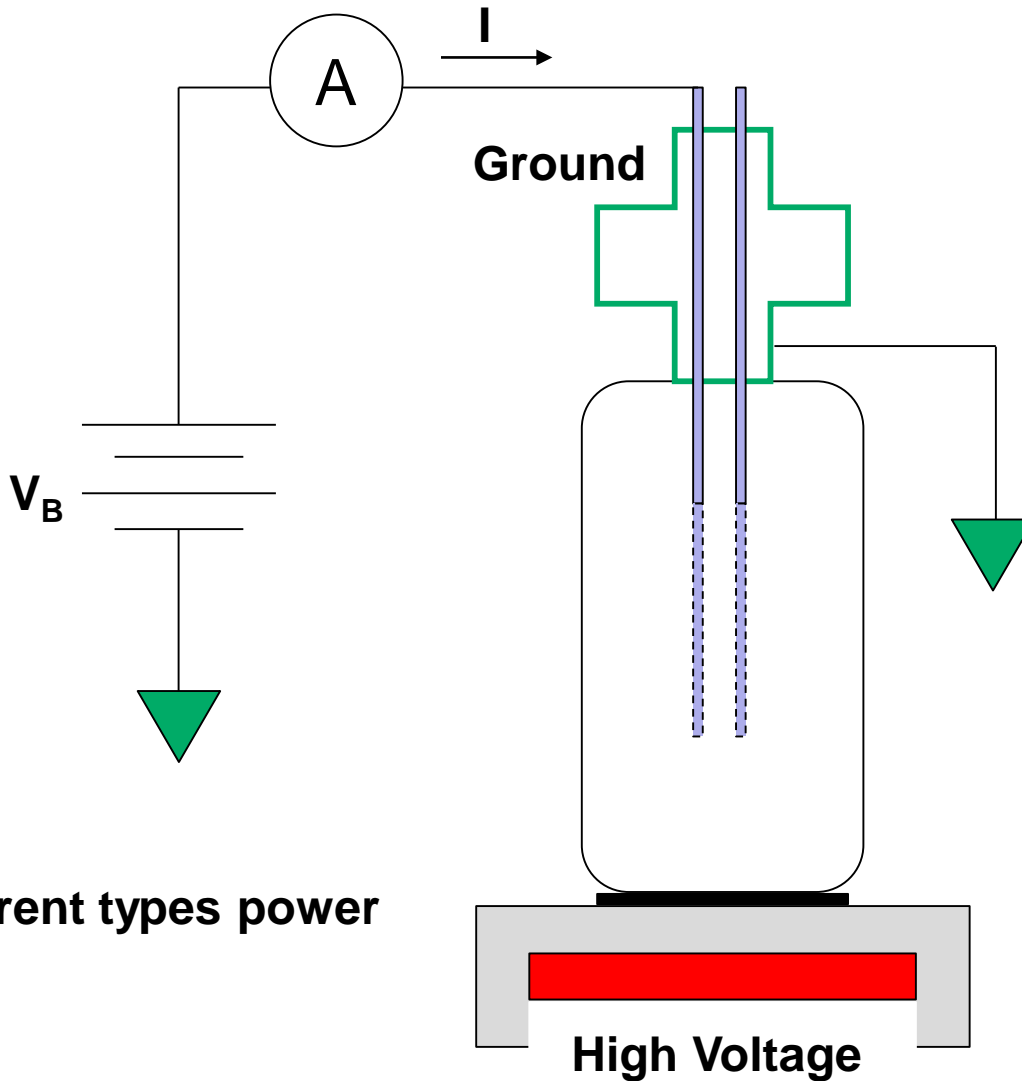
- Once the vacuum meet the requirements, connect the bottom plate to high voltage power supply for glow discharge test.

- DC
- AC

~ 1/3 of the height of the jar

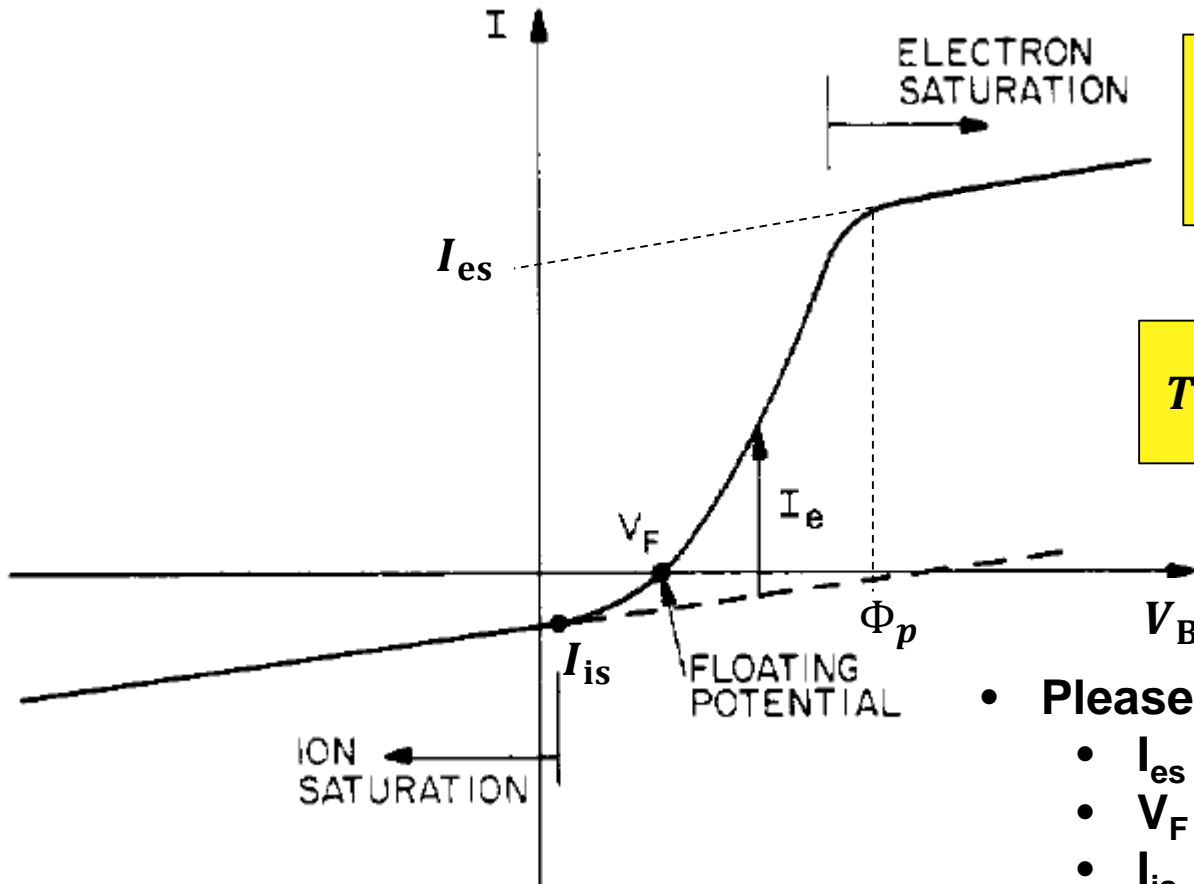
Single Langmuir probe measurements

- Vary V and measure I



- Two different types power supply

Expected I-V curve of single Langmuir probe



$$n_0 = \frac{I_{es}}{eA} \sqrt{\frac{2\pi m}{kT_e}}$$

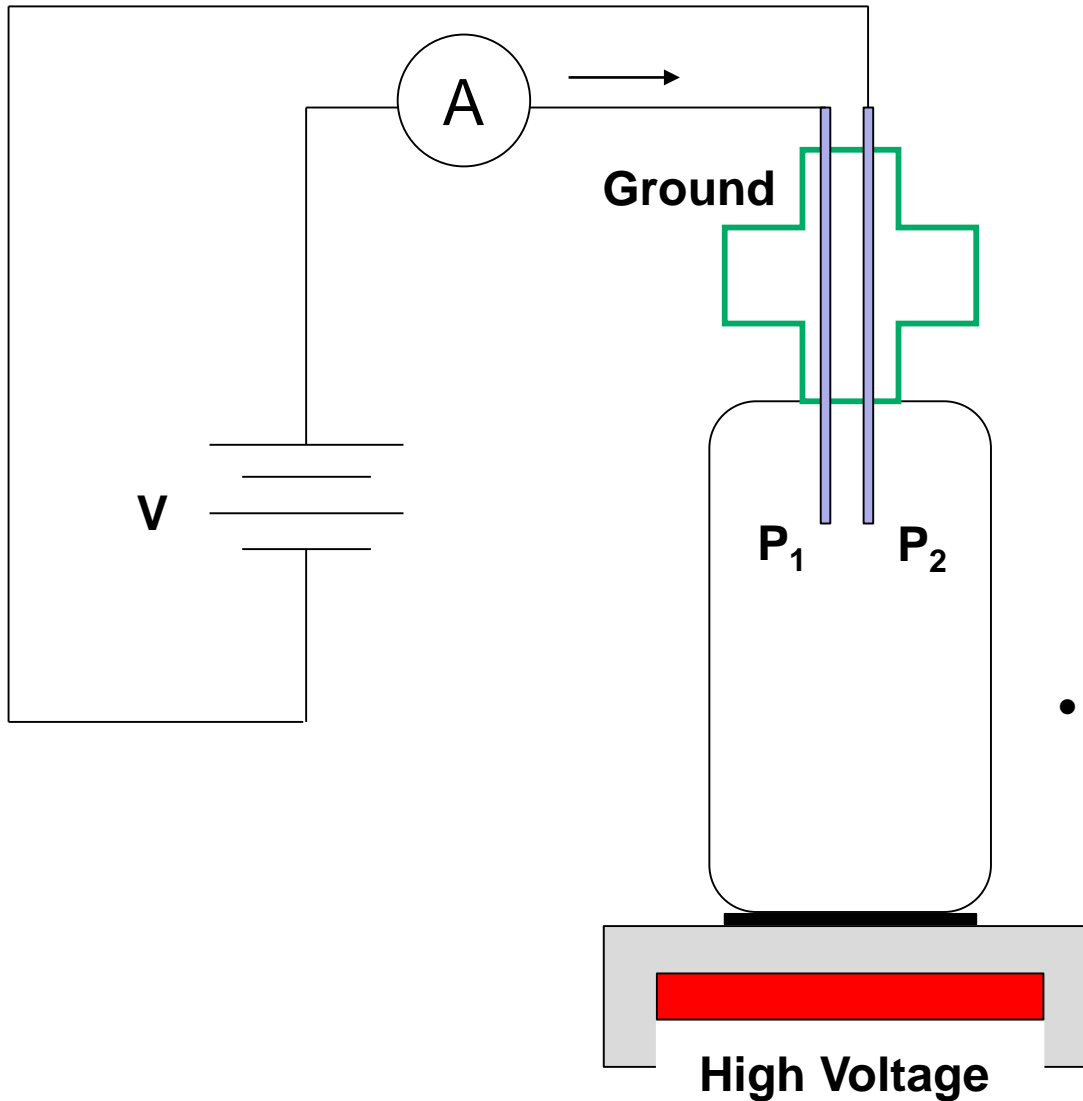
$$T_e = \frac{e(V_B - \Phi_p)}{k(\ln I_e - \ln I_{es})}$$

$$n_0 = \frac{1}{0.61} \frac{I_{is}}{eA} \sqrt{\frac{M}{kT_e}}$$

- Please measure if possible:
 - I_{es}
 - V_F
 - I_{is}
- Please calculate if possible:
 - T_e
 - n_0
 - Ionization fraction

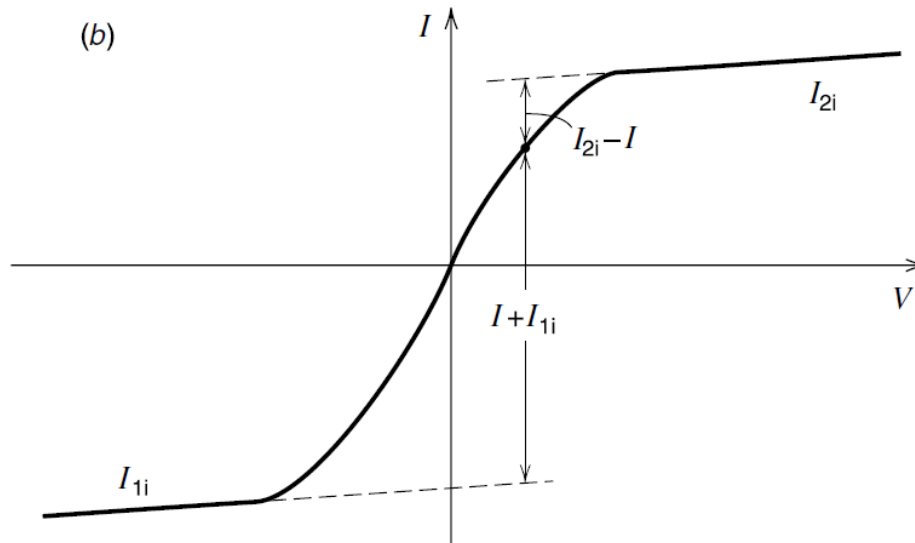
Double Langmuir probe measurements

- Vary V and measure I



- DC HV power supply

Expected I-V curve of double Langmuir probe



$$I = I_{is} \operatorname{Tanh}\left(\frac{eV}{2kT_e}\right)$$

$$\frac{dI}{dV}_{V=0} = \frac{e}{2kT_e} I_{is}$$

- Please calculate if possible:
 - T_e
 - n_0
 - Ionization fraction

$$n_0 = \frac{1}{0.61} \frac{I_{is}}{eA} \sqrt{\frac{M}{kT_e}}$$

Experiments



- **DC glow discharge (do not change the voltage setting)**
 - **Single Langmuir probe**
 - **Double Langmuir probe**
- **AC glow discharge ($V=20$ V)**
 - **Single Langmuir probe**

- **DC HV power supply: x3 – one for each group.**
- **AC HV power supply: x1 – shared between all groups.**

Final report



- Introduction
- Plasma source
- Experimental setup
- Results
 - Raw data
 - Calculated data (T_e , N_0 , Ionization fraction)
- Discussions
- Conclusions

• Due at 23:59, 2021/1/29(Friday).