Superconductivity : Background

- \( R = 0 \)
- Discovered in 1911 by Kammerlingh Onnes
- Many metals superconduct at low temperatures (< 4 K)
- Manifestation of a new state of matter at low temperatures

PERFECT DIAMAGNETISM : MEISSNER EFFECT

**Part 1** : Magnetization of a Type I Superconductor (Pb)

**Part 2** : Magnetization of a Type II Superconductor (Pb\(_{85}\)In\(_{15}\))
The Meissner Effect in Type I SC

Type I: "All or Nothing"

Perfect Diamagnetism

Normal State

SS-10: Superconductivity

Images: Britannica Online, U. Birmingham, RIKEN
Apparatus

SS-10: Superconductivity

PUMPING MANIFOLD

INTEGRATOR

VOLTMETER

ELECTROMAGNET

LIQUID HELIUM

SC

VACUUM JACKET

LIQUID NITROGEN

ELECTROMAGNET

VACUUM JACKET
Critical Field of a Type I SC (Pb)

SS-10 : Superconductivity

**Reading on Integrator (mV)**

- Magnetization at 4.2 K
- Magnetization at 2.8 K

**Applied Field (Gauss)**

0 200 400 600 800

0 10 20 30 40

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**Legend:**

- Red circles: Magnetization at 4.2 K
- Green squares: Magnetization at 2.8 K
Critical Field of a Type I SC (Pb)

![Graph showing the critical field of a Type I superconductor (Pb)]

- **Magnetization at 4.2 K**
- **Magnetization at 2.8 K**
- **Linear Fit**

**Applied Field (Gauss)**

- **2/3 Hc**

**Reading on Integrator (mV)**

**Intermediate State**
Determining $T_c$ from $H_c$ vs. $T$ in Pb

From intercepts:
$T_{c,\text{est}} = 8.0 \pm 0.4 \text{ K}$
$H_{c0,\text{est}} = (890 \pm 30 \text{ G})$

Previous Results:
$T_c \text{ (Pb)} = 7.2 \text{ K}$
$H_{c0} = 803 \text{ G}$
Discussion & Conclusions

SS-10 : Superconductivity

**TYPE I SC (Pb)**

- Meissner state measured for Pb sample

- $T_{c0}$ estimated to be $8.0 \pm 0.4$ K
  (7.19 K from literature)

- $H_{c0}$ estimated to be $(8.9 \pm 0.3) \times 10^2$ G
  (803 G from literature)

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