
# ENGINEERING PHYSICS

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# ENGINEERING PHYSICS

## Unit III : Application of Quantum Mechanics to Electrical transport in Solids

- ***Suggested Reading***

1. ***Concepts of Modern Physics, Arthur Beiser, Chapter 10***
2. ***Solid state Physics, S.O Pillai, Chapter 6***
3. ***Learning material prepared by the department-Unit III***

- ***Reference Videos***

1. ***https://nptel.ac.in/courses/115/104/115104109/***
2. ***https://physlab.org/class-demo/meissner-effect/***

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## Unit III : Application of Quantum Mechanics to Electrical transport in Solids

*Class #33*

***Superconductivity:***

- *Superconductivity as a phenomenon*
- *Meissner effect & Critical Field*
- *Type I and type II superconductors*
- *BCS Theory of Superconductors*

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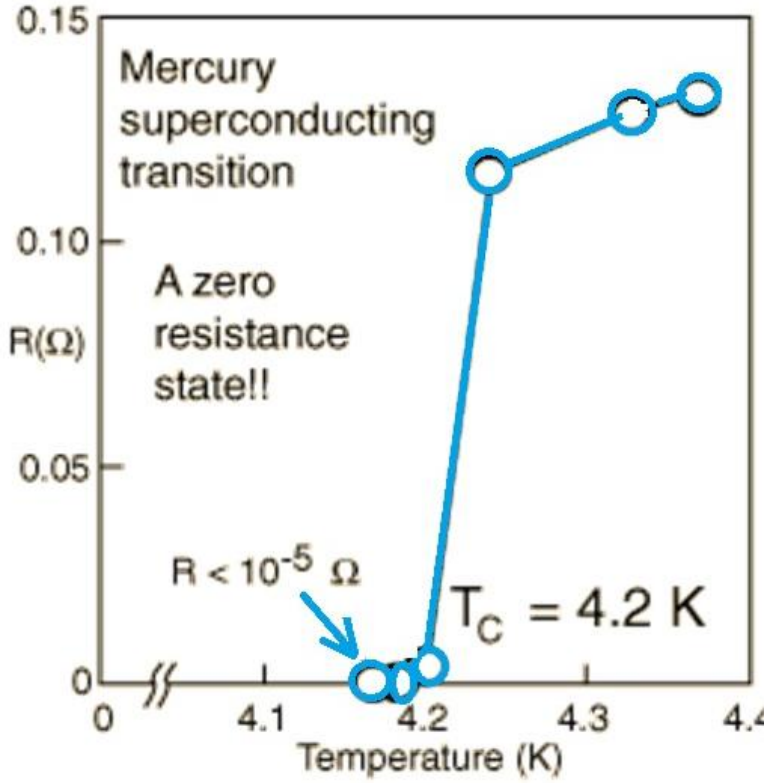
## *Superconductivity as a phenomenon*

***Superconductivity was discovered by H. Kammerlingh Onnes in 1911.***




***About 30 metals exhibit superconductivity, with superconducting transition temperatures between 0K and 9.3K.***

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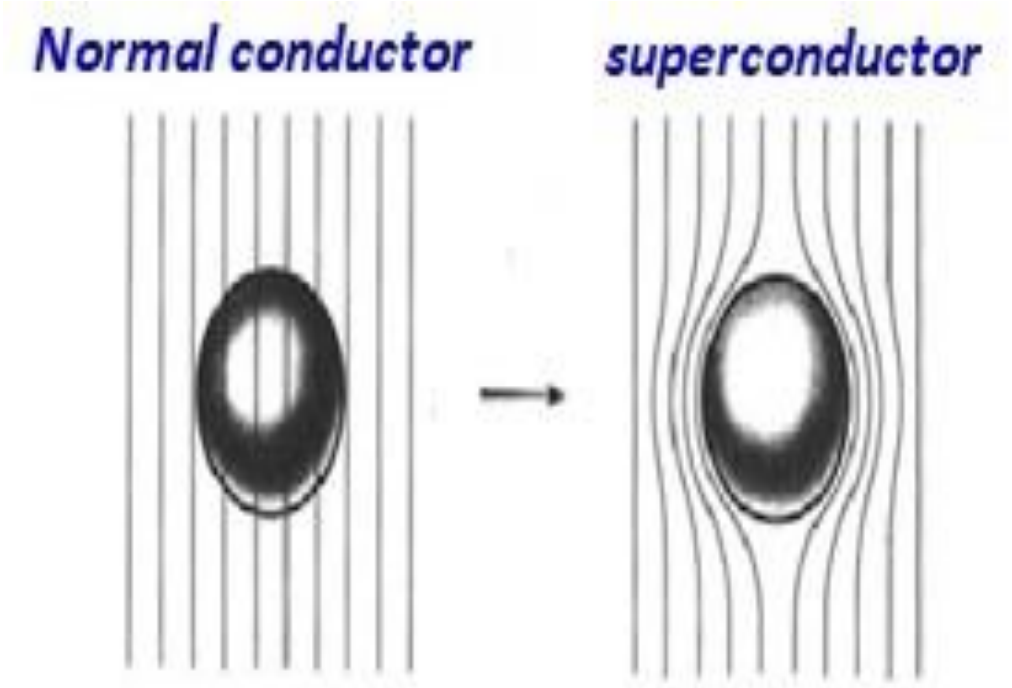
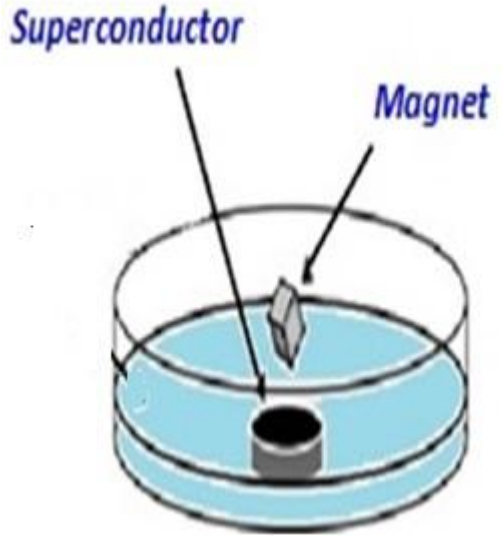
## Meissner effect

***Superconducting materials excludes the magnetic lines of force from its interior – like a perfect diamagnetic material***



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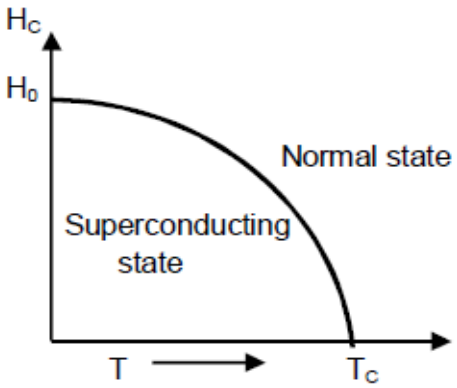
## Critical field

*Presence of strong external fields – drives superconducting material to normal conducting state.*

*Magnetic field at which the material loses it superconducting state - Critical Field ($H_c$).*

*The critical field strength is temperature dependent and is given by* $H_c = H_o\left[1 - \left(\frac{T}{T_c}\right)^2\right]$



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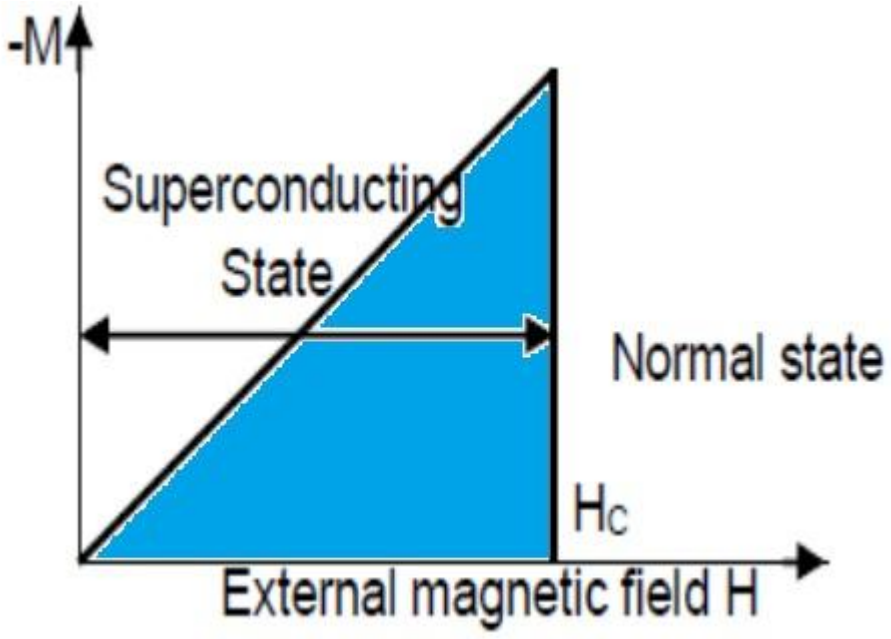
## Type I and type II superconductors

***Classification of Superconductors:***

***Type I superconductors (Soft superconductors):***




***Examples for Type I superconductors - Aluminum, Lead and Indium etc.***

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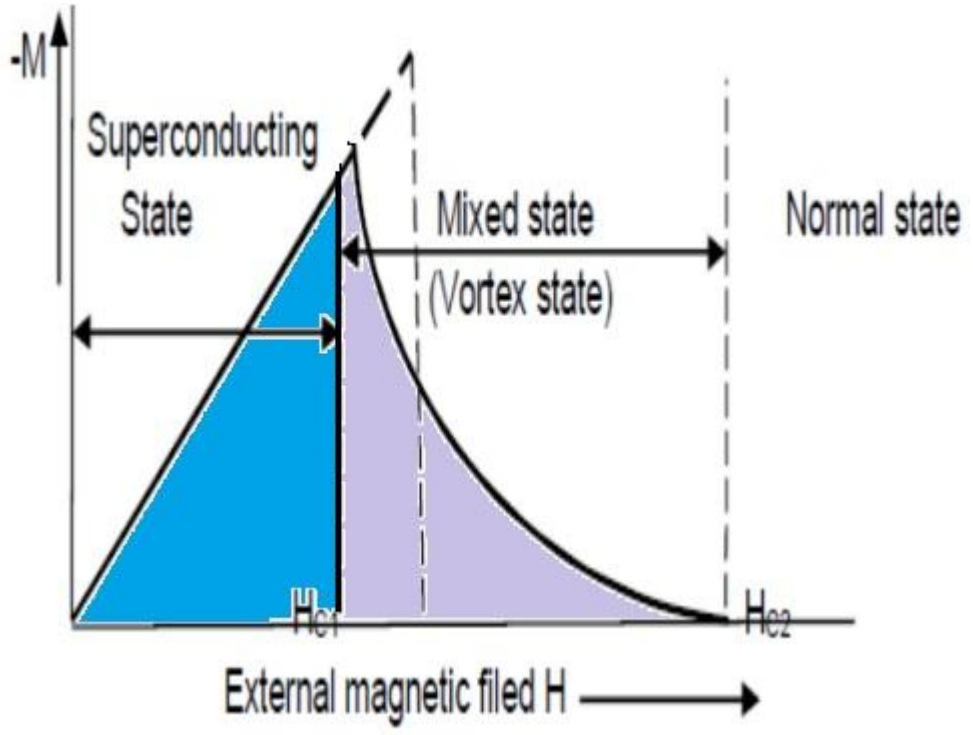
## Type I and type II superconductors

***Type II superconductors:***




***Examples for type II superconductors: Transition metals and alloys containing niobium, silicon and vanadium.***

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## Superconductivity : Some Key Observations

- *Current in the superconductor persists for a long time.*
- *Not observed in Mono valent metals.*
- *Exhibited by metals for which the valence electrons number are between 2 & 8.*
- *Observed in metals having a higher resistivity at normal temperatures .*
- *Destroyed by applying high magnetic fields or excessive currents.*
- *Ferro and anti ferromagnetic materials are not superconductors.*

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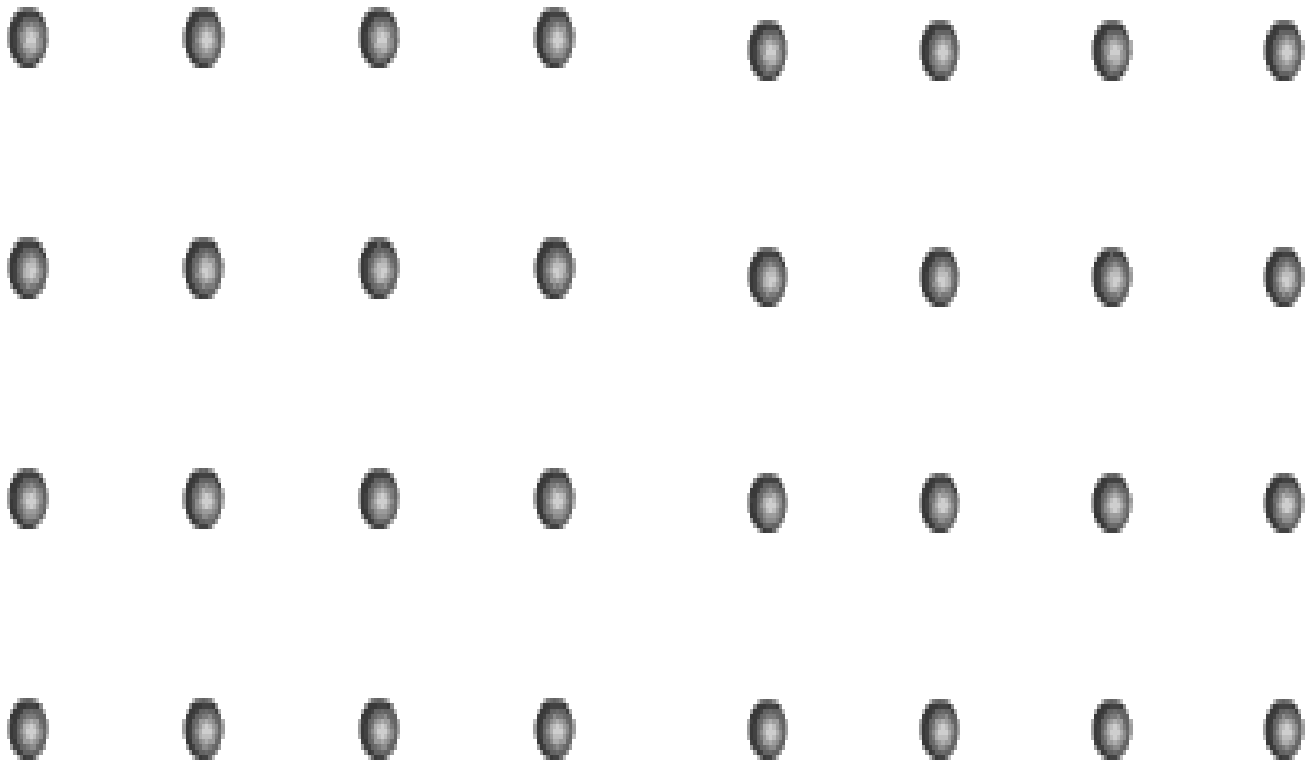
## BCS-Theory of Superconductors

***Theory of superconductivity in metals was unveiled by J. Bardeen, L.N. Cooper and J.R. Schrieffer in the year 1957***



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## Class 33 . Quiz …

**The concepts which are correct are….**

1. *The temperature at which the conductivity of the metal increases sharply is known as the transition temperature $T_c$.*
2. *Superconductivity cannot be destroyed by a high magnetic field or excessive currents.*
3. *Materials in the superconducting state, expels the magnetic lines of force.*
4. *Type I superconductors exhibits mixed state Meissner effect.*
5. *The electrons in the Cooper pair have either equal spins or opposite momentum.*

# THANK YOU

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