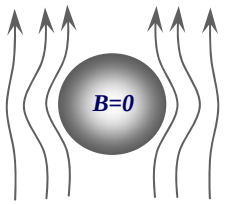
Chapter 6 Magnetic Materials

6.1 Magnetization M & Magnetization Current

6.2 Ferromagnetism

6.3* The Fundamental Magnetic Properties of Superconductors

6.4 Magnetic Circuit Theorem



6.3 The Basic MP of Superconductors

Critical temperature

- The most exciting property for a superconductor is the sudden disappearance of resistance at its critical temperature T_c under critical value of magnetic field.

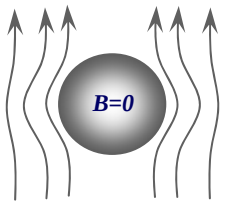
- Resistivity ρ : Normal, $10^{-15}\Omega\cdot m$

  Superconductor, $10^{-28}\Omega\cdot m$

- In RL circuit, once a current set up, it will flow forever, because $\tau(L/R) \to \infty$

- The highest $T_C \sim 134K$

$$i = I_0 e^{-\frac{R}{L}t} = \frac{\varepsilon}{R} e^{-\frac{R}{L}t}$$



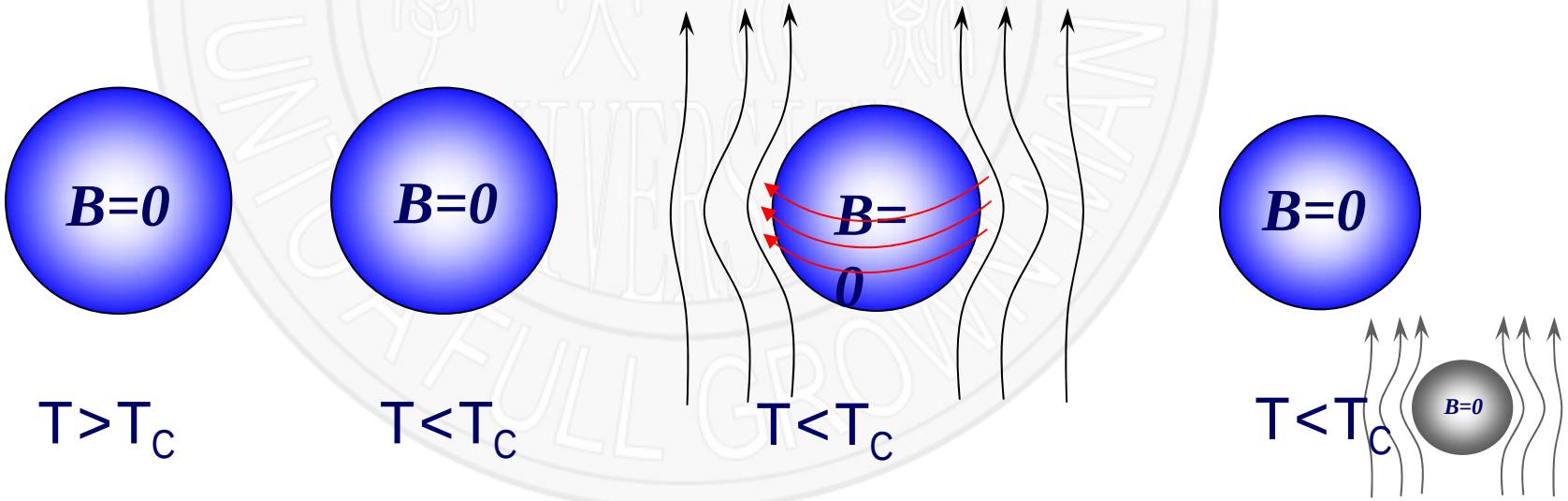
6.3 The Basic MP of Superconductors

- Magnetic properties of superconductors

$$\rho \to 0, \sigma \to \infty, J = \sigma E, E_i = 0$$

$$\frac{\partial \vec{B}_i}{\partial t} = -\Delta \times \vec{E}_i = 0$$

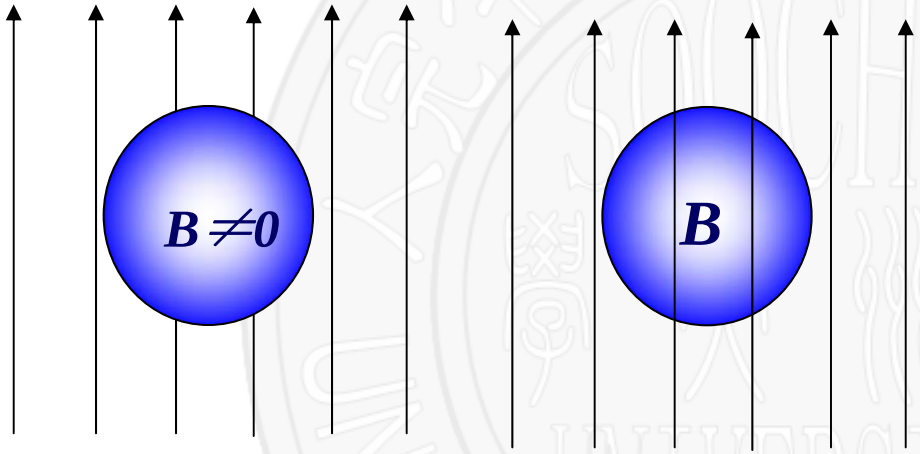
At perfect conductivity, there is no change of magnetic field inside conductors.



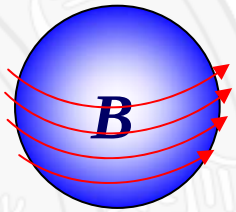
6.3 The Basic MP of Superconductors

Superconductive Permanent Magnetization

Perfect superconductors.



$T > T_C$ $T < T_C$



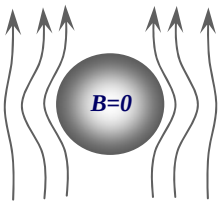
I_S

Permanent Magnetization

Magnet Floating

Principle of Maglev train

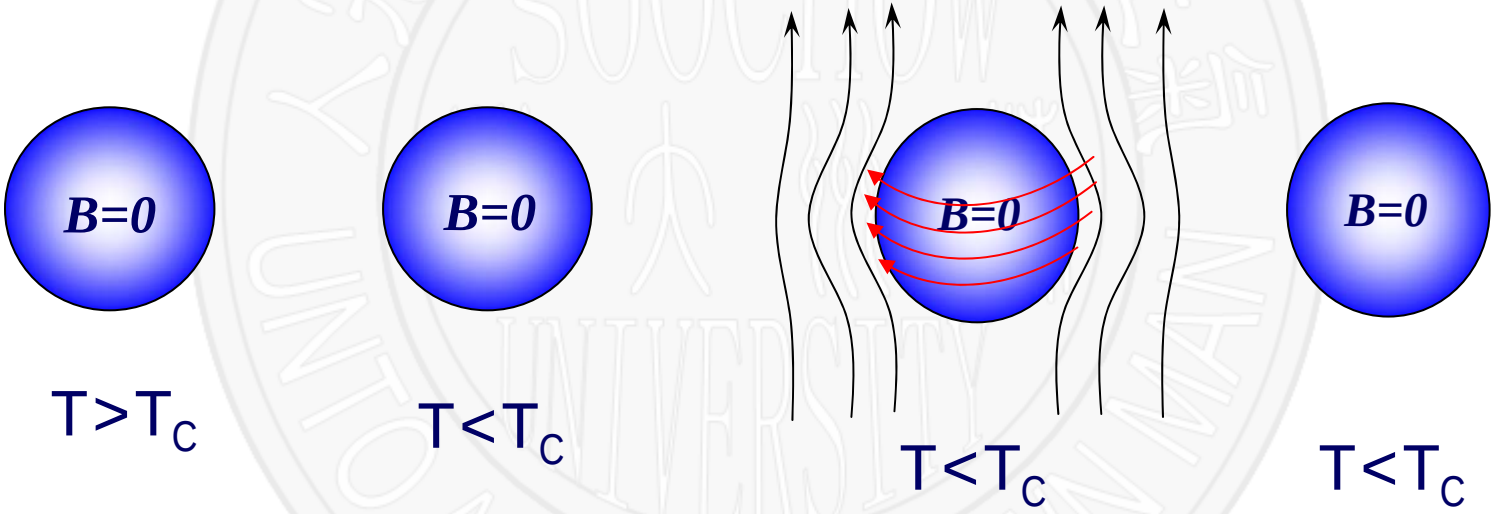
Maglev train in shanghai

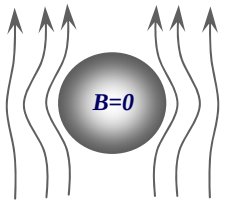


6.3 The Basic MP of Superconductors

Meissner Effect

- At perfect conductivity



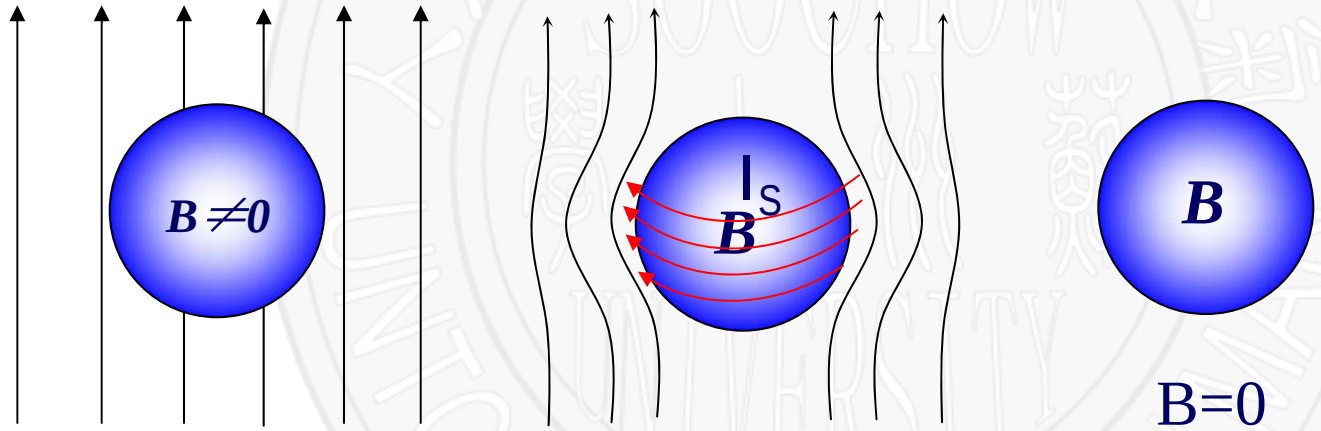


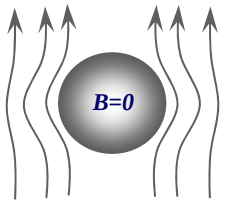
6.3 The Basic MP of Superconductors

Meissner Effect

At superconductivity, superconductors Perfect Diamagnetism

superconductors.

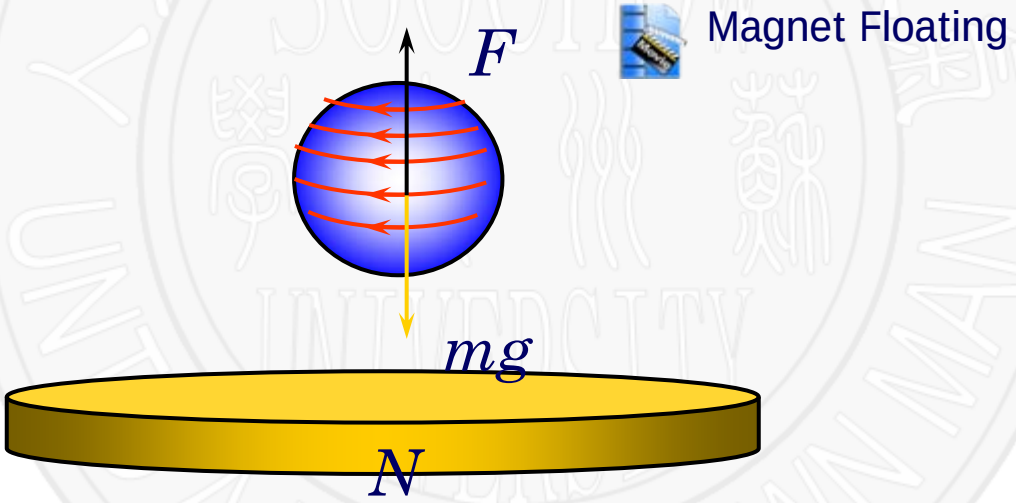


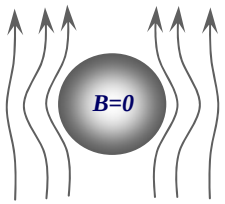


6.3 The Basic MP of Superconductors

Meissner Effect

1933 Meissner, Perfect Diamagnetism





6.3 The Basic MP of Superconductors

A magnetic levitation or maglev train runs on the test rail in Shanghai, China , Monday, Dec. 30, 2002. The train has reportedly reached speeds of 250 mph along a 19-mile-long track linking Shanghai's new financial district and airport. It travels faster than conventional trains because it floats on air- held a few fractions of an inch above its rails by powerful opposing magnets.