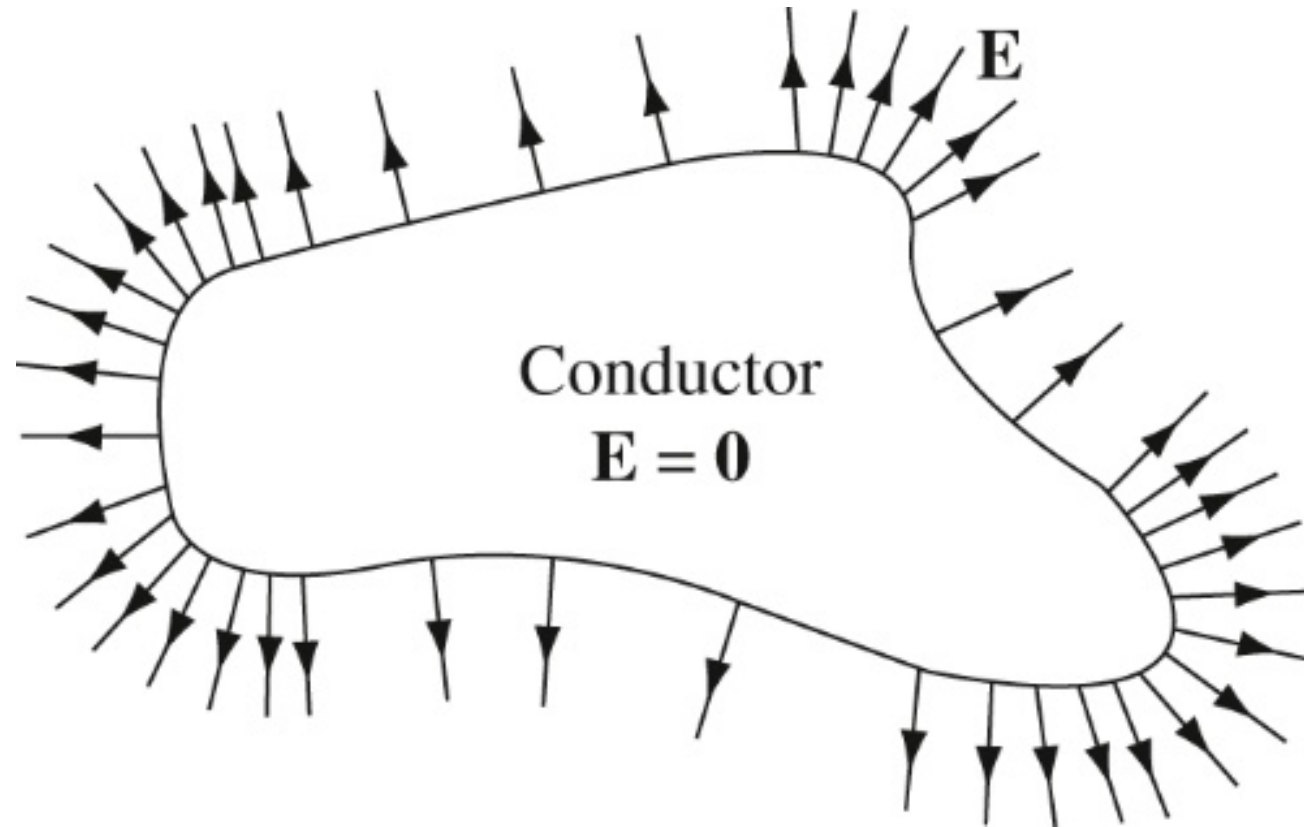


Lecture 11 Slides

Phys 313 Fall 2026

Excess charge on a conductor in EE flows to the outer surface



J3-21 FARADAY CAGE

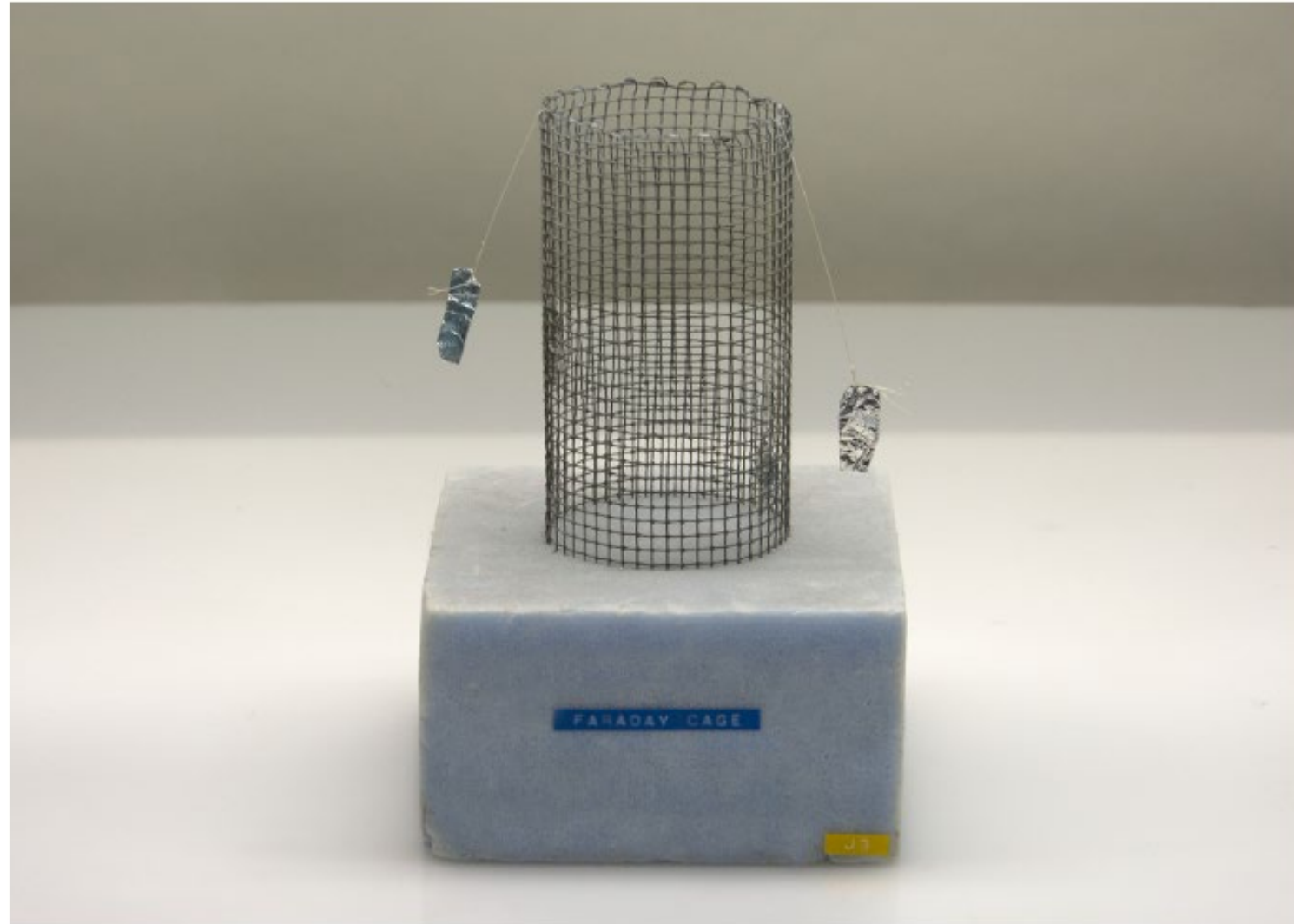
PHYS260

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PHYS142

Electrostatics

Electric Fields and Potential

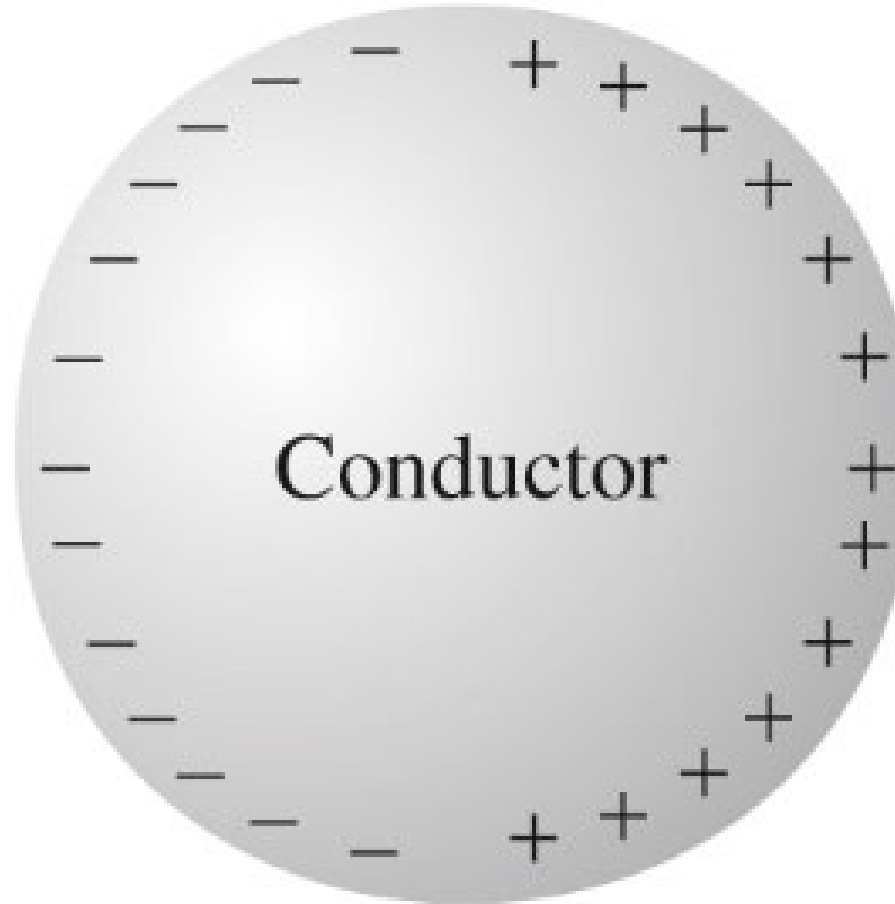


Charging a Conductor by Induction

The conductor is uncharged initially

Bringing a charge nearby induces charge on the conductor in order to keep $\vec{E} = 0$ inside

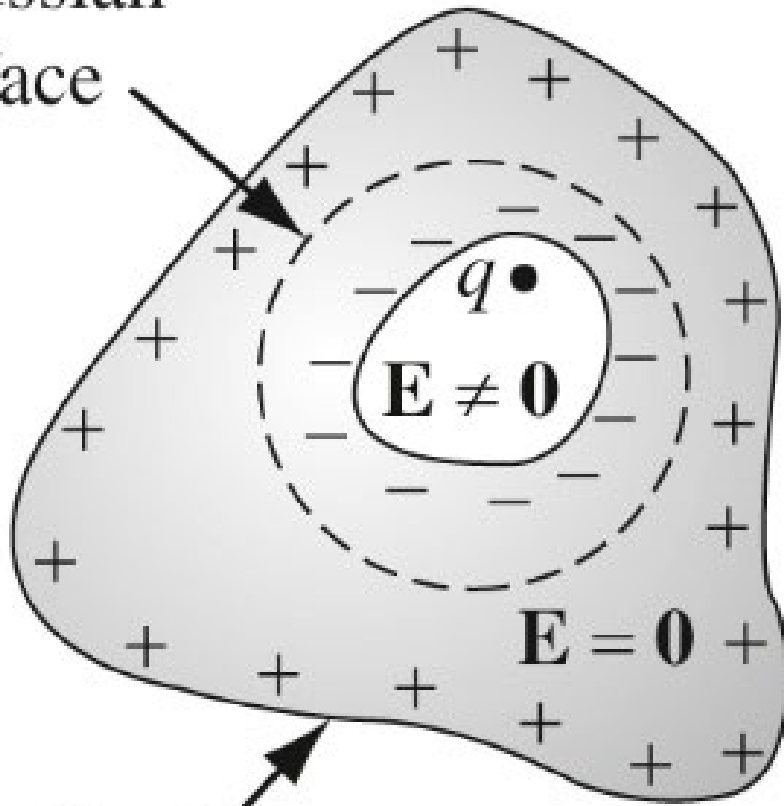
•
 $+q$



This creates an attractive force between the charge and the conductor

Charge q in a Cavity inside a Conductor in EE

Gaussian
surface



Conductor

- Charge q located inside cavity
- Conductor induces charge $-q$ on inner wall of cavity to create $\vec{E} = 0$ in conductor bulk
- Gaussian surface in conductor bulk has zero flux $\rightarrow Q_{enc} = 0$
- Compensating charge $+q$ is distributed over the outer surface
- The original charge q is thus “revealed” to the outside world!
- The conductor is overall charge-neutral

Capacitor

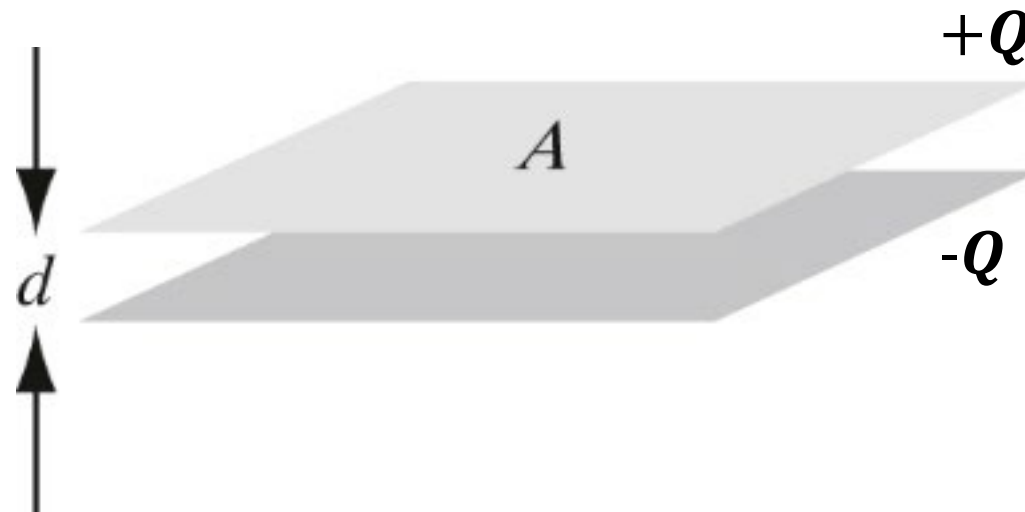
An electrical circuit element that stores charge and electric field

Two conductors with equal and opposite charges

General capacitor

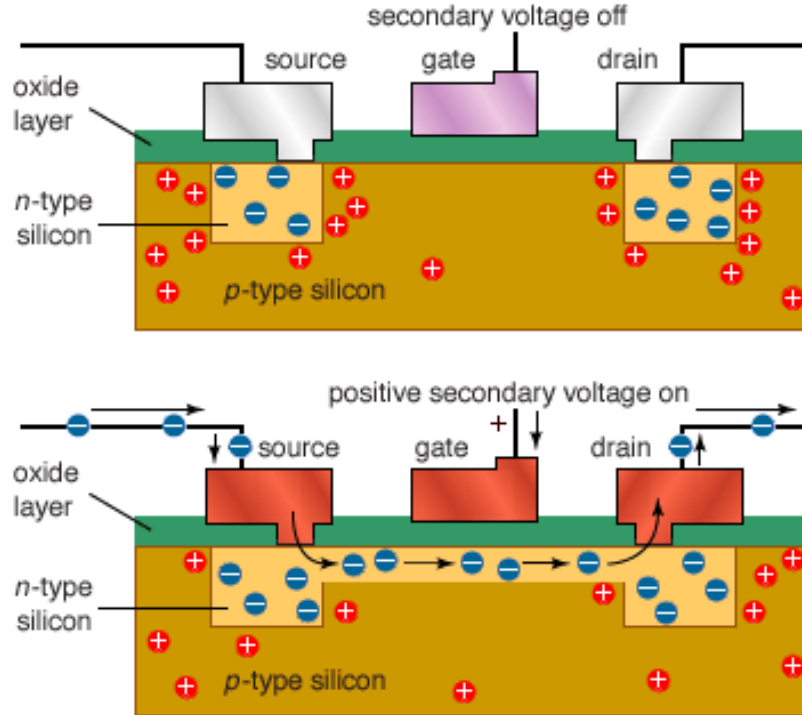


Parallel plate capacitor



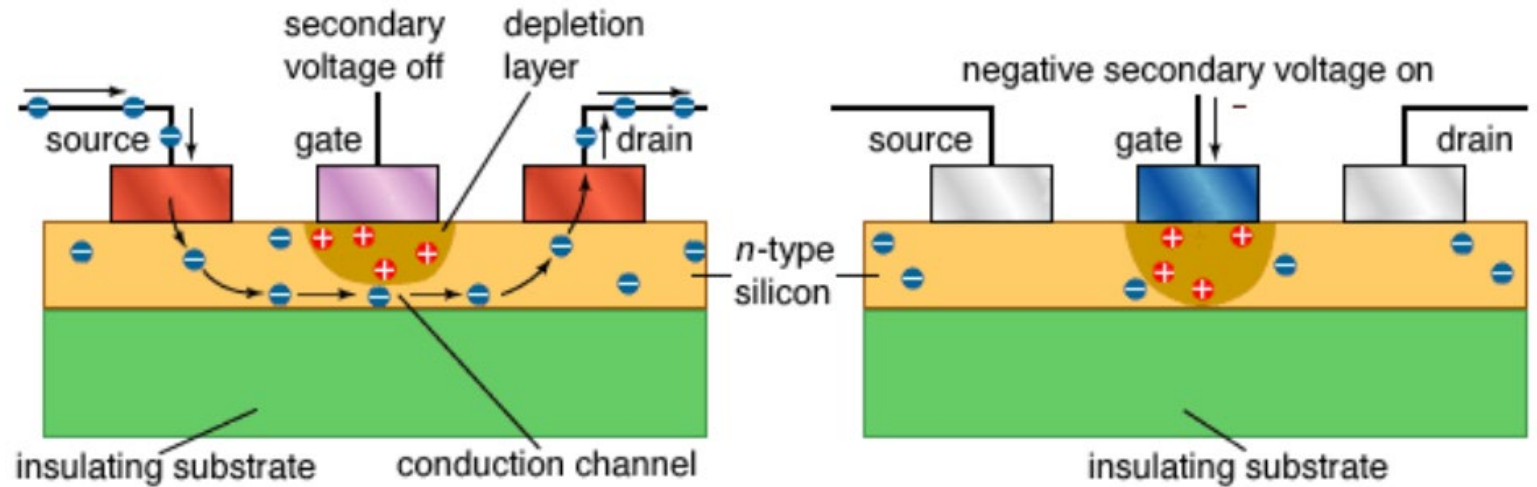
$$C = \frac{Q}{V}$$

Field Effect Transistor



Negative-channel metal-oxide semiconductors (NMOS) employ a positive secondary voltage to switch a shallow layer of *p*-type semiconductor material below the gate into *n*-type.

Metal-semiconductor field-effect transistor (MESFET), current is normally on. A secondary voltage is applied to the gate to deplete charge carriers beneath it, thereby pinching off the current, or changing the state to off.



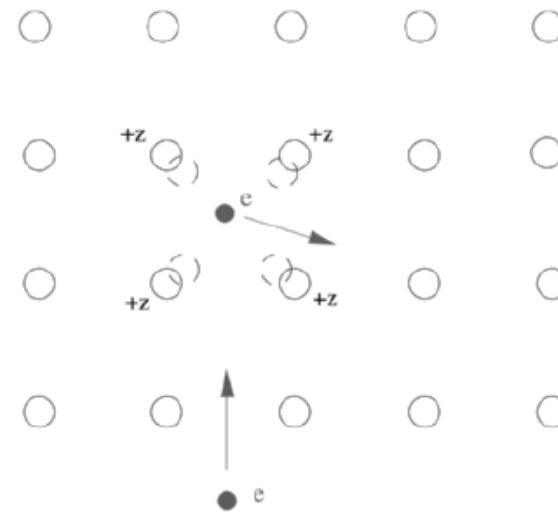
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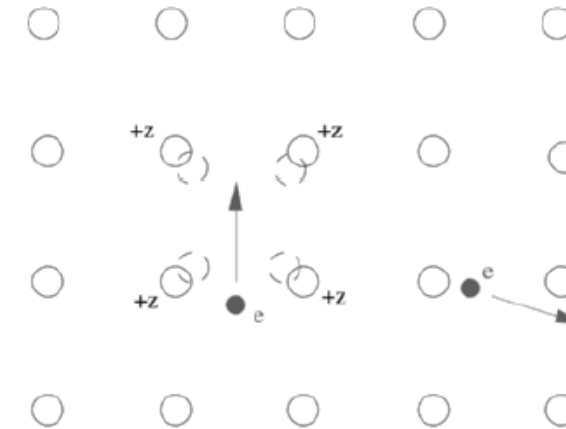
<https://www.britannica.com/technology/transistor/Junction-transistors>

The Electron-Phonon Interaction

(a)



(b)



[Superconductivity](#)
[Conventional and Unconventional Superconductors](#)
[K. H. Bennemann](#) and [John B. Ketterson](#)

3 Electron-Phonon Superconductivity*

F. Marsiglio University of Alberta, Dept. of Physics, Edmonton, Canada
J. P. Carbotte McMaster University, Physics Dept. Hamilton, Canada

Fig. 3.1. In (a) one electron polarizes the lattice (indicated by *dashed circles* displaced towards uppermost electron); in (b) that electron has moved away. In the meantime a second electron (seen below in (a)) is attracted to the polarized region, *which has remained polarized long after the first electron has left the region*. The figure is schematic only, and does not, for example, properly convey the opposite momenta such a pair should possess

Cooper Pairing and Superconductivity

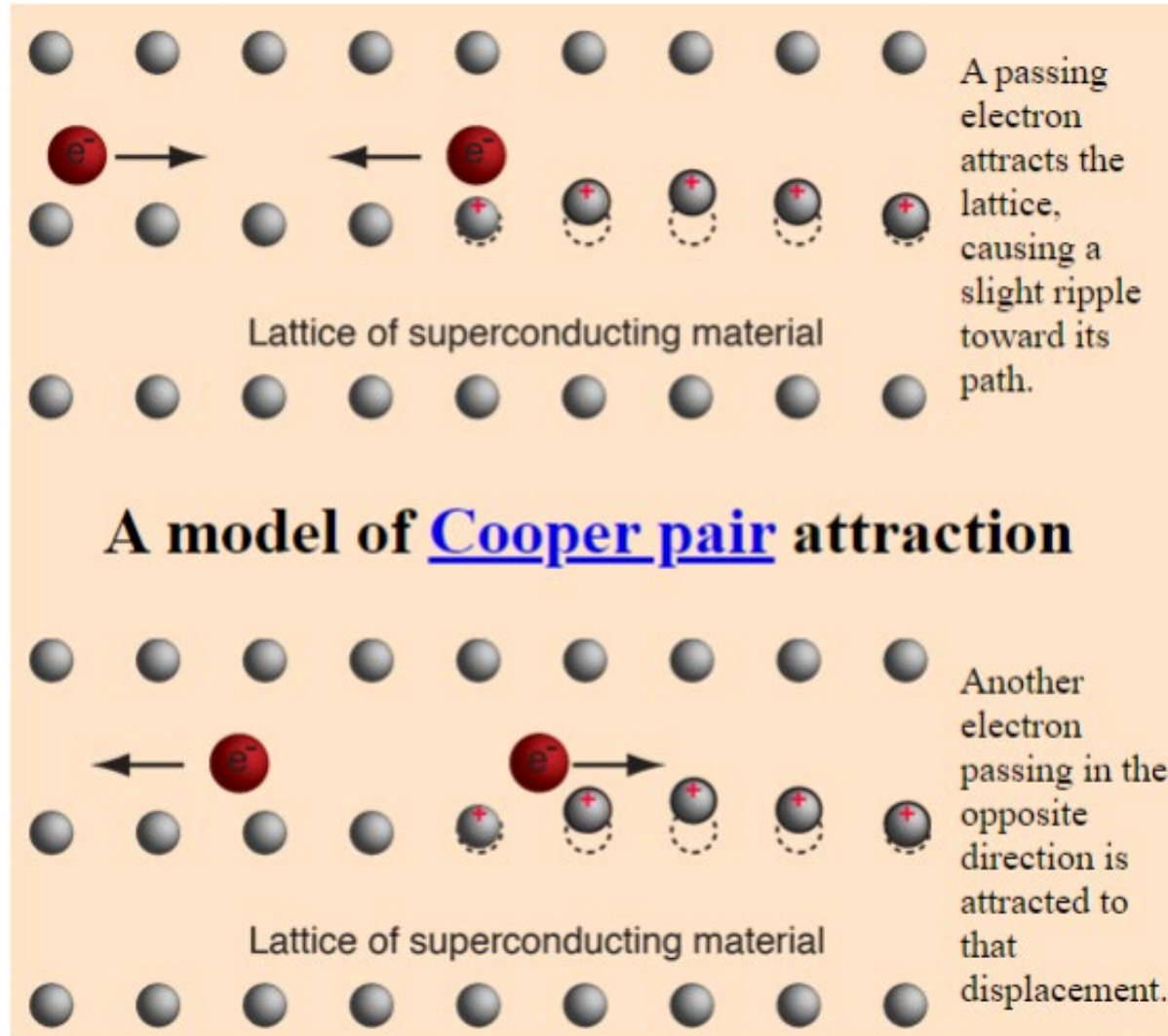


Table 51.1 Thermodynamic properties of typical superconductors

	$T_c, ^\circ\text{K}$	$\theta = \hbar\omega_D/k_B, ^\circ\text{K}$	$N(0) V$	$\frac{\Delta_0}{k_B T_c}$	$H_c(0), \text{Oe}$	$\frac{T_c C_n(T_c)}{H_c(0)^2 V}$	$\left. \frac{C_s - C_n}{C_n} \right _{T_c}$
BCS				1.76		0.168	1.43
Cd	0.56	164	0.18	1.6	29	0.177	1.32–1.40
Al	1.2	375	0.18	1.3–2.1	106	0.171	1.45
Sn	3.75	195	0.25	1.6	305	0.161–0.164	1.60
Pb	7.22	96	0.39	2.2	805	0.134	2.71

$N(0) V$ is calculated from Eq. (51.43). $k_B T_c \approx 1.13 \hbar \omega_D e^{-1/N(0)V}$

Source: R. Meservey and B. B. Schwartz, Equilibrium Properties: Comparison of Experimental Results with Predictions of the BCS Theory, in R. D. Parks (ed.), "Superconductivity," vol. I, pp. 122, 141, 165, Marcel Dekker, Inc., New York, 1969; D. Shoenberg, "Superconductivity," 2d ed., p. 226, Cambridge University Press, Cambridge, 1952.

Note the difference between T_c and the pairing interaction temperature scale ($\hbar\omega_D/k_B$)

A. L. Fetter and J. D. Walecka, Quantum Theory of Many Particle Systems, p. 448