SOLID-STATE PHYSICS: CONDUCTION

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Supplementary Material for
PHY 3305 (Modern Physics)
Harris, Ch. 10.5-10.6
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ANNOUNCEMENTS/ REMINDERS

● Announcements
  ● No homework this week
  ● Spend time preparing your presentation
  ● Next week we'll have a summary homework assignment of solid-state physics

● Mandatory Practice Talks
  ● Please schedule with me for the week of April 5-9
  ● Use this Doodle Poll to sign up:
    • http://doodle.com/55ztf5rua7f65kwm
  ● Plan for 1 hour
  ● First come, first served
Class-participatory exercises

- build a 1-D model of a solid using existing pieces:
  - Coulomb and finite-square-well potentials
  - Wave functions in square well
  - Many thanks to Jason S., Tyler, and Vladimir for going to the board

Implications of 1-D solid model

- energy levels group together in bands, and bands are separated by regions with no allowed energies (gaps)

Classification of solids by atomic bonding
Large N Lattice (1-D)

Figure 10.25 Band gaps occur when $a = n\lambda/2$ or $k = n\pi/a$. Top-of-the-band states are zero between atoms, where the potential energy is high, whereas bottom-of-the-band states are large there.
ENERGY VS. WAVE NUMBER

- $E$
- $n = 4$ band
- Energy gap
- $n = 3$ band
- Energy gap
- $n = 2$ band
- Energy gap
- $n = 1$ band

Wave number $k$

- $-3 \frac{\pi}{a}$
- $-2 \frac{\pi}{a}$
- $-1 \frac{\pi}{a}$
- $0$
- $+1 \frac{\pi}{a}$
- $+2 \frac{\pi}{a}$
- $+3 \frac{\pi}{a}$
SOLID, NO ELECTRIC FIELD APPLIED

$k_{avg} = 0$

Filled

$\text{Electric field} = 0$
SOLID, WITH ELECTRIC FIELD APPLIED

The net effect of a field is to shift some electrons moving in the field’s direction...

...to states at slightly higher energy moving opposite the field.

$k_{\text{avg}} > 0$

Electric field
NEXT TIME

- Semi-conductivity
- Super-conductivity
- Reading for next week: Harris Ch. 10.6-10.9, 11.1