Monday, April 10

Last Time:
- NMR Spectroscopy

Today:
- The solid state
  - why do solids form: energetics
- Describing solid structures
- Lattices, translation & other symmetry operations

Readings:
- Chang & Thoman: Chapter 18
- Solid state reading (posted on Blackboard)

Reminders:
- Spectroscopy assignment due Friday
- Reminder: Experiment 7 due April 14
  - OPTIONAL – can replace a summary report grade
  - No extension days can be used
Why is structure so important?

Crystalline metal  Amorphous metal

Link
Pairs
3-D Structure
Oblique net
(clinonet)
\(a \neq b\)
\(\gamma \neq 90^\circ\)
\(p2\)

Rectangular net
\(a \neq b\)
\(\gamma = 90^\circ\)
\(p2\text{mm}\)

Centered rectangle net
(Diamond net)
\(a \neq b\)
\(\gamma \neq 60^\circ, 90^\circ, \text{ or } 120^\circ\)
\(c2\text{mm}\)

Hexagonal net
\(a = b\)
\(\gamma = 60^\circ\)
\(p6\text{mm}\)

Square net
\(a = b \text{ (or } a1 = a2)\)
\(\gamma = 90^\circ\)
\(p4\text{mm}\)

The 17 Plane Groups
2011 Nobel Prize in Chemistry
"for the discovery of quasicrystals"

Daniel Shechtman
Technion – Israel Institute of Technology
Haifa, Israel

Images from nobelprize.org
In the mid-1970s the mathematician Roger Penrose manages to create an aperiodic mosaic, with a pattern that never repeats itself, using only two different rhomboid tiles: one fat and one thin.

In 1982, Alan Mackay experiments with a model, where he puts circles representing atoms at intersections in Penrose’s mosaic. He illuminates the model and obtains a tenfold diffraction pattern.

In 1984, Paul Steinhardt and Dov Levine connect Mackay’s model with Shechtman’s actual diffraction pattern. They realize that aperiodic mosaics can help to explain Shechtman’s peculiar crystals.

In 1982, Daniel Shechtman’s electron microscope captures a picture counter to all logic. The ten bright dots in each circle tell him he is looking at tenfold symmetry. But conventional wisdom says this is against the laws of nature.

Figure 4
M.C. Escher
Oblique net (clinnonet)
\(a \parallel b\)
\(\gamma \neq 90^\circ\)
p2

Rectangular net
\(a \perp b\)
\(\gamma = 90^\circ\)
p2mm

Centered rectangle net (Diamond net)
\(a \parallel b\)
\(\gamma \neq 60^\circ, 90^\circ, \text{or} 120^\circ\)
c2mm

Hexagonal net
\(a = b\)
\(\gamma = 60^\circ\)
p6mm

Square net
\(a = b \text{ (or} a_1 = a_2)\)
\(\gamma = 90^\circ\)
p4mm

The 17 Plane Groups

- \(p1\)
- \(p2\)
- \(pm\)
- \(pg\)
- \(cm\)
- \(pmm\)
- \(p2mg\)
- \(p2mm\)
- \(p2gm\)
- \(p22a\)
- \(c2mm\)
- \(p3\)
- \(p31m\)
- \(p3m1\)
- \(p6\)
- \(p4\)
- \(p4mm\)
- \(p4gm\)