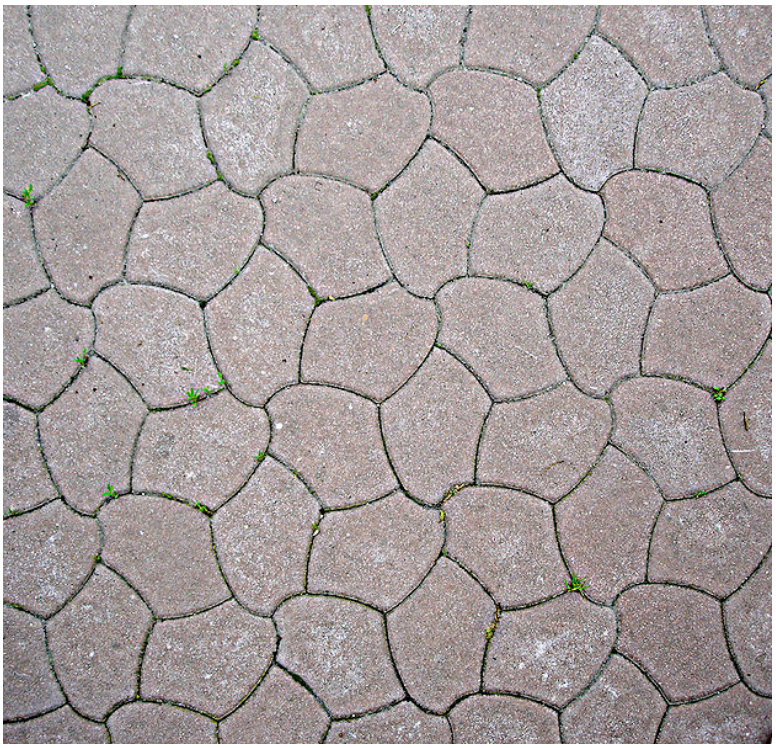
Phy472/555 Homework 1 Due Friday Sept. 9, 2011

1. The figure shows a patch of pavement from Zakopane. What is the (2d) crystal structure? To be precise, specify the lattice by choosing two primitive translation vectors. Label them a and b, and draw them on the figure. Draw a primitive unit cell in the form of a parallelogram. Make an alternative (but equivalent) choice for a and b, and draw the new primitive unit cell. Describe the basis. "Primitive" means simply that the cell is the translational unit of minimum area.



2. Consider a cubic close-packed lattice of touching spheres. The "conventional cubic cell" contains 4 atoms as a basis, but the primitive unit cell contains one atom. If the side of the conventional cubic cell is designated $a$, what is the radius $r$ of the touching spheres? What is the radius of the largest sphere that fits into the octahedral interstitial sites? What is the radius of the largest sphere that fits into the tetrahedral interstitial sites? [Note: the octahedral interstitial sites are the ones that are occupied in NaCl; the tetrahedral interstitials are occupied in GaAs.]

3. Silicon crystallizes in the diamond structure, with lattice constant $a$ = 5.43 Å. This is the side of the conventional cube, not the primitive unit cell. If silicon atoms are modeled as touching spheres, what is their radius? What fraction of space in a silicon crystal is filled with silicon atoms? How many first and how many second neighbor atoms does each silicon atom have?

4. Under pressure, silicon can adopt the "simple hexagonal" structure (one atom per unit cell). In the touching-spheres model, what is the ratio c/a? What fraction of space is filled? How many nearest neighbors does each silicon atom have?