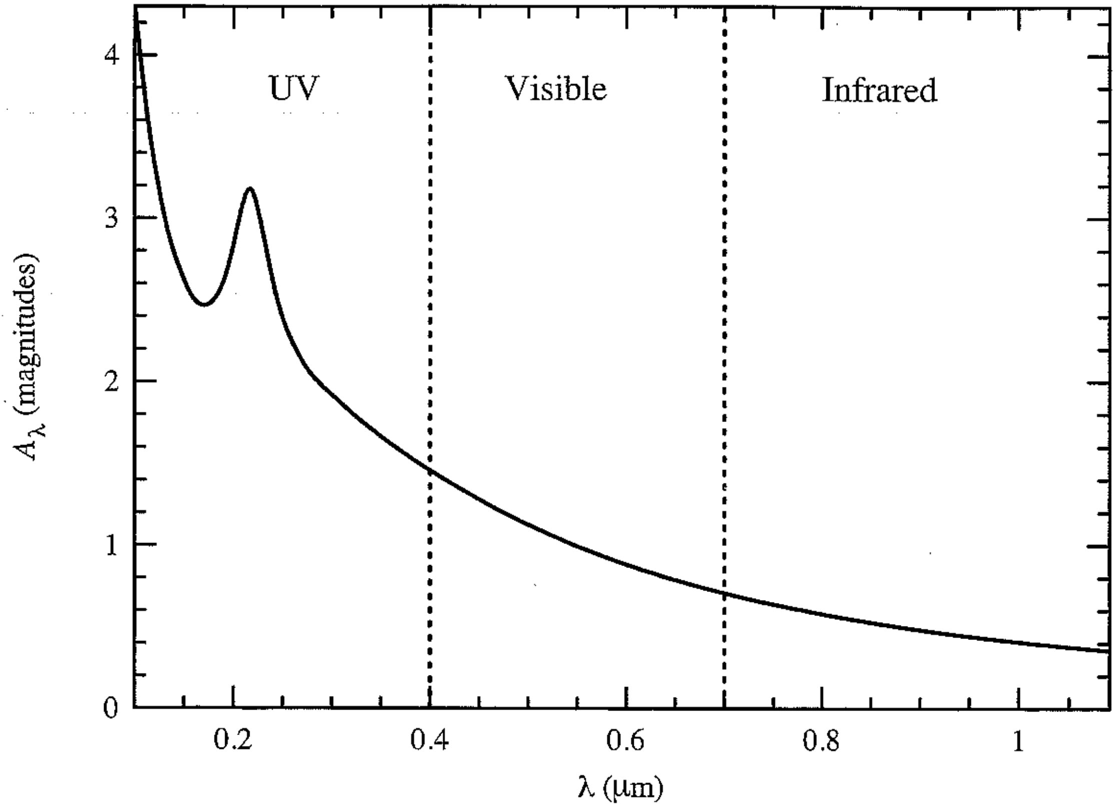

FIGURE 16.1 Dust extinction as a function of wavelength, normalized so that $A_V = 1$ magnitudes. The dotted vertical lines indicate the range of visible wavelengths.

preferentially in one direction.[2] If dust grains were perfect spheres, they wouldn't cause polarization of light.

Clue three. The plot of extinction versus wavelength (see Figure 16.1) has a "bump" at $\lambda \sim 0.22\ \mu\text{m}$. What causes the excess extinction at this wavelength? It is known experimentally that in graphite the bonds between carbon atoms absorb and emit light at wavelengths $\lambda \sim 0.22\ \mu\text{m}$. In the laboratory, an excellent fit to the extinction bump is given by graphite grains with $d \sim 0.02\ \mu\text{m} \sim 200$ Å. (On Earth, you find such tiny graphite particles in soot.)

Clue four. If you look at the infrared spectrum from isolated dusty clouds, you find that at long wavelengths ($\lambda > 100\ \mu\text{m}$), it's a blackbody spectrum with a typical temperature of $T \sim 20$ K. At shorter wavelengths (Figure 16.2), there are absorption bands at $\lambda \sim 4 \rightarrow 7\ \mu\text{m}$ due to ices (frozen water, carbon dioxide, carbon monoxide, and so forth), and at $\lambda \sim 10\ \mu\text{m}$ due to silicates (a.k.a. "rock"). Thus, dust seems to contain a mix of volatile material, like ices, and refractory material, like silicates and graphite.

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[2] Dust grains tend to line up perpendicular to the interstellar magnetic field.