29:52 Exploration of the Solar System
Class Notes for March 12, 2008
Radar Mapping of the Surface of Venus

Last time we dealt with the concept of a spectrum in physics. An important piece of physics that helps us understand Venus, and other objects in the solar system, is how light is emitted by hot objects.

The relevant physics is contained in *Kirchoff's Laws of Radiation* and in *Wien's Law*. The first of Kirchoff's Laws says that a hot solid, liquid, or dense gas emits a *continuous spectrum*, in which the intensity of light changes smoothly as a function of wavelength. This means that a hot object emits some radiation at all wavelengths.

Wien's Law states a mathematical relation between the temperature of an object and the wavelength at which the object is brightest,

$$w_{max} = \frac{2.9 \times 10^{-3}}{T} \tag{1}$$

where w_{max} is the peak wavelength (in meters) and T is the temperature in Kelvin. Wien's law says that the hotter an object, the shorter the wavelength at which the object is brightest.

The application of these results to Venus (or any other planet) means that if we can measure the spectrum of electromagnetic radiation emitted by an object, we can measure its temperature.

The first results from radio astronomy came in the late 1950s, and showed that the surface temperature of Venus is about 730K, or 850 degrees Fahrenheit. This is a horribly hot temperature. Despite the physical similarities between the Earth and Venus, the surface conditions could hardly be more different.

The most fundamental reason for this difference can be understood by looking at Table 10.4. Venus has a very dense atmosphere of carbon dioxide. In Venus, carbon dioxide constitutes 96.5 % of the molecules in the atmosphere. On Earth CO2 is 0.035 %. We'll discuss later why CO2 is the culprit.

A Map of Venus

From about 1990 to 1994, the Magellan spacecraft orbited and used its radar to map the surface of Venus. As a result, we have a detailed map of the surface of Venus.

First let's consider a global view. Let's compare Venus with the Earth. If we boiled away the oceans, the Earth would look like Figures 8.11 and 8.18. You see the ocean floor, the continents several kilometers higher, and huge cracks in the Earth's crust called the plate boundaries. These plates move around in the phenomenon of *continental drift*.

A similar picture of Venus is shown in Figure 10.20, and has some similarities. Again, there are large, low, flat plains that resemble the ocean bottoms on Earth. There are also 2 higher land masses that seem similar to continents on Earth. However, there is no indication of the plate boundaries that are so prominent and so important on Earth.