0.3: Special Units Used in Astronomy

Learning Objectives

- Students will know the astronomy-specific units for distance and when to use them: AU , light-years, etc.

What about distances in space? In addition to the SI units, astronomers use several specialized units. Our nearest neighbor, the Moon, is about 380,000 km away from Earth. The Sun is about 150 million km away. Neither of those distances is very suitable for the kilometer unit. If we go to other objects, the numbers get even bigger. For example, the planet Jupiter is about five times as distant as the Sun. One way to avoid using inconveniently large numbers for the Solar System is to invent a larger unit of measure, which is exactly what astronomers have done. The astronomical unit (AU) is defined to be the average distance from Earth to the Sun. So, we would say that the planet Jupiter is about 5 AU from the Sun, while Saturn is about 10 AU from the Sun. That system works well for distances within the Solar System. It is several hundred AU across, so the numbers never become too big and cumbersome. If we want to convert back to kilometers for some reason, then we just have to remember that each AU is about 150 million, or 1.5×10^8, km.

What about for larger distances, like those to the stars? For that we will need an even bigger unit. Even the most nearby stars are about 100,000 AU away. Before we talk about what that bigger unit is, we will have a look again at distances in the Solar System, not in terms of AU, but in terms of light travel.

It turns out that light takes about 8 minutes to travel from the Sun to Earth. So instead of saying that the Sun is 150 million km away (not very convenient), or that it is 1 AU away (more convenient, but not particularly illuminating), we might say that the Sun is 8 light-minutes away from Earth. A light-minute is the distance that light travels in one minute, equal to 1.8×10^7 km. There is no ambiguity with this definition because light travels at a constant speed of about 3×10^5 km/s.

Notice that we are talking about a distance here, *not* about a time or a speed. Specifically, a light-minute is the distance that light will travel in one minute. So, just to be clear, a light-minute is a distance, not a time. It is much easier to deal in light-minutes than in kilometers for sizes encountered in the Solar System. If we use light-minutes as our unit of measure, then we would say that Jupiter is about 40 light-minutes from the Sun, Saturn is about 80 light-minutes, and the Solar System is several thousand light-minutes across (or several light-hours, or about one light-day, perhaps).

If we only had to worry about distances in the Solar System, we could content ourselves with the light-minute, or even the AU. But the Universe is much bigger than that. For instance, if we want to describe the distance to the Sun's nearest stellar neighbor (Alpha Centauri, also called Rigel Kentaurus), then the most convenient unit might be the light-year. After our discussion above, you will not be surprised to learn that a light-year is the distance that light will travel in one year, i.e., about 9.5 trillion kilometers (6 trillion miles). That is a pretty hard distance to visualize, even for astronomers. Most do not even try; they just realize that Alpha Centauri is about 4 light-years from the Sun. That means it takes light 4 years to travel between the Sun and Alpha Centauri; 4 is a much easier number to deal with than 9 trillion!

Astronomers also have special units for quantities like speed, time, and brightness. We will encounter some of them in later chapters, but for right now, we will concentrate our attention on the sizes, distances, and masses of objects that we will confront.