**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period \_\_\_\_\_\_\_\_\_\_**

# **Unit 1: Reading 1-Realms of Astronomical Distance**

The distances to astronomical objects are vast indeed, more vast in some ways than others. Our commonly used metric units of distance are meters and kilometers and we also rely on miles in the United States. In astronomy, the relatively nearby things are all in our solar system where it’s possible to express distances in kilometers or miles without the numbers getting ridiculously large. They are, however, large enough for us to consider switching to a couple of convenient alternatives:

* ***astronomical unit*** (AU), the average Earth-to-Sun distance and
* ***light-second***, the distance that light travels in one second

Note that both of these are units of distance. Light-second might sound like a unit of time, but don’t be confused—it is a unit of distance based on the time it takes light to reach us from the object. It only takes a fraction of a second for light traveling at 300,000 km/s (186,000 mi/s) to reach us from any object we observe on Earth. By comparison, it takes about 1.5 seconds for light (or radio) to reach us from the Moon, so the Moon is considered to be 1.5 light-seconds away from us. One AU is defined precisely as 149,597,870,700 m, although it is commonly referenced as 150 million km.

Greater distances are expressed in ***light minutes*** (1 light-minute=60 light seconds) and ***light- hours*** (1 light-hour=60 light-minutes). For example, Mars is usually over 15 light-minutes from us and Neptune, at a distance of over 4 billion km, is 3 light-hours away. Note that distances between any two bodies in space are constantly shifting since objects are moving through the cosmos, therefore average distances are commonly given. The distance between Earth and the Sun ranges from a minimum of 147 million km to a maximum of 152 million km, with an average distance of 150 million km.

## 

## **Approximate average distances from Earth to objects in the solar system**

|  |  |  |  |
| --- | --- | --- | --- |
| The Sun  150,000,000 km  1 AU  8.5 light-minutes | The Moon  384,400 km  0.0026 AU  1.3 light-seconds | Saturn  1,275,000,000 km  9.3 AU  79 light-minutes | Ultima Thule  (Kuiper Belt Object)  6,500,000,000 km  43 AU  6.0 light-hours |

The vast distances also makes the precision of values an important consideration; closer objects can be measured more precisely than objects farther away. For distances outside our solar system, we often use the unit ***light-years***, abbreviated LY. There are 9,461,000,000,000 km (almost 10 trillion km) in a light-year. Also 1 LY = 63,241 AU.

## **Approximate average distances from Earth to objects outside our solar system - but in our Milky Way galaxy**

|  |  |
| --- | --- |
| M42. The Great Nebula - located in Orion  (cosmic gas & dust cloud, stars’ birthplace)  1,340 LY | M45\* The Pleiades - located in Taurus  (open star cluster; newly formed stars)  444 LY |
| M1\* The Crab Nebula - located in Taurus  (remains of a supernova; star death)  6,520 LY | M13\* Globular star cluster-located in Hercules  (dense collection of stars)  22,200 LY |

*\* Messier catalog numbers: Charles Messier, a French comet hunter, catalogued sky objects that looked like comets, but were not. They are mostly star clusters, galaxies, and nebulae (clouds of gas).*

The diameter of our Milky Way galaxy is about 100,000 LY. Recall from Activity 3 that a galaxy is a gigantic cluster of hundreds of thousands to hundreds of billions of stars. They range in size from tens of thousands to millions of light-years in diameter; the nearest galaxy comparable in size to our own Milky Way galaxy is the Andromeda galaxy, about 2.5 million LY away, whose location we will determine later in this unit.

## **Approximate average distances from Earth to objects outside our Milky Way galaxy**

|  |  |
| --- | --- |
| M31\* Andromeda galaxy  2,500,000 LY | M104\* Sombrero galaxy  29,000,000 LY |
| M33\* Triangulum galaxy  (spiral galaxy)  2,700,000 LY | Hubble deep field image  (shows about 10,000 galaxies)  some as far away as 13 billion LY |

How we determine such immense distances will be the subject of a reading later in this unit, when you will be introduced to the ***Cosmological Distance Ladder***, a model for comparing the variety of measuring tools used in astronomy. Our telescopes in a way act like time machines: the farther into space we see with them, the farther back in time we are seeing as well since light from something biliions of light-years away also takes billions of years to get to us. ***How could we go about making a scale model of the universe?***

In summary, astronomically speaking, objects in our solar system are referred to as “relatively nearby”. Objects outside our solar system, but still in our Milky Way galaxy, are described as “pretty far away”. Finally, objects outside our Milky Way galaxy are considered either “REALLY REALLY far away” or “ludicrously far” away.