

Chapter 8

Exaworld

1 000 000 000 000 000 000 (1.0 x 10¹⁸) E

8.1 Exaworld Length

1 – 1000 Exameters (Em) 1 x 10¹⁸ m

Exameter Distant Stars

Star	Distance
HIP 56948	1.9 Em
Bellatrix	2.4 Em
Polaris (North Star)	3.5 Em
Antares	5.2 Em
Betelgeuse	6.1 Em
Saiph	6.2 Em
Rigel	7.7 Em
Deneb	24 Em
P Cygni	52 Em
Pistol Star	245 Em
UDF 2457	558 Em
Radius of The Milky Way	1000 Em

Table 8.1: “Far Away” Stars

The distances to those stars still in the Milky Way, yet furthest from us, are on the order of Exameters. One can describe nearby

stars as those in the realm of Petameters. Stars an Exameter or farther from our Solar System, can be called “far away” stars. Antares, Betelgeuse, and Rigel are all in this category. HIP 56948 is solar twin star, which means it is very similar in its properties to our Sun. The farthest currently known star in the Milky Way Galaxy, is UDF 2457. It is 558 Em distant.

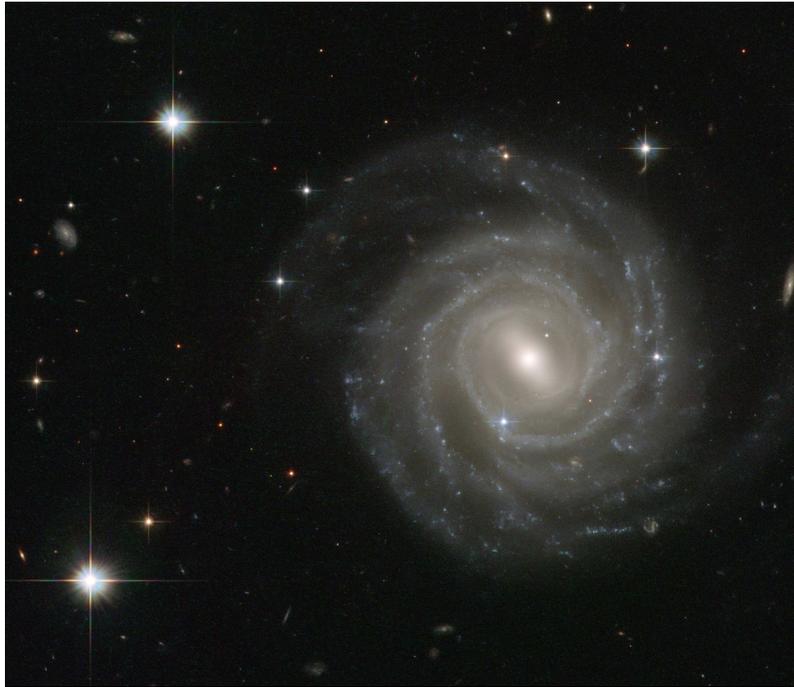


Figure 8.1: A Hubble Space Telescope image of galaxy UGC 12158, which is thought to resemble the Milky Way in appearance. (Wikimedia Commons)

The Milky Way Galaxy is thought to be a barred spiral galaxy.^[1] Figure 8.1 shows UGC 12158, which is thought to resemble the Milky Way Galaxy. The radius of the Milky Way Galaxy is about 1000 Exameters (1 Zm). The diameter is about 1.9 Zm. In 1901, Guglielmo Marconi (1874-1937), is thought to have transmitted a

radio signal across the Atlantic Ocean. We have been transmitting information using the radio wave section of the electromagnetic spectrum ever since. Electromagnetic (EM) waves travel a distance of 9.4607 Petameters per year. After about 118 years, these radio waves have traveled about 1.12 Exameters from Earth. In other words, these electromagnetic waves have only propagated a meager one-thousandth of the distance of the length of our galaxy, or only about half way to Bellatrix.

The name Antares is derived from the word Ares, the name of the Greek god of war. Antares has a reddish hue and means “equal-to-Ares.” The reddish color of Antares is similar to the planet Mars, which is named for the Latin god of war. The Greeks referred to Mars as Ares and so the name Antares followed from their designation for the red planet.

Perhaps the most recognizable constellation in the night sky is Orion, shown in Figure 8.2. Orion was a hunter in Greek mythology. It contains the stars Betelgeuse and Rigel. Both names are Arabic in origin. Betelgeuse is the upper left star of Orion, and is quite red in appearance. The name Betelgeuse means “the hand of Orion” in Arabic. Betelgeuse is a variable red giant star, which means its brightness changes over time. Rigel is a blue-white supergiant star located on the lower right of the Constellation of Orion. Rigel is about 120 000 times as bright as our Sun. The name Rigel is from Arabic, and roughly means “the left leg of Orion.”

The compliment of stars making up the outer grouping of Orion are Bellatrix, located on the upper right, which means “female warrior” in Latin, and Saiph on the lower left, which comes from the Arabic “sword of the giant.”

The star P Cygni has a curious history. It is a far away star, 52 Exameters from Earth, and yet P Cygni is visible with the unaided eye in an appropriately dark sky. The difficulty of seeing P Cygni caused it to remain undiscovered until the waning of the 16th century, when it suddenly became brighter. On August 18, 1600 P Cygni was sighted by Dutch Astronomer Willem Blaeu

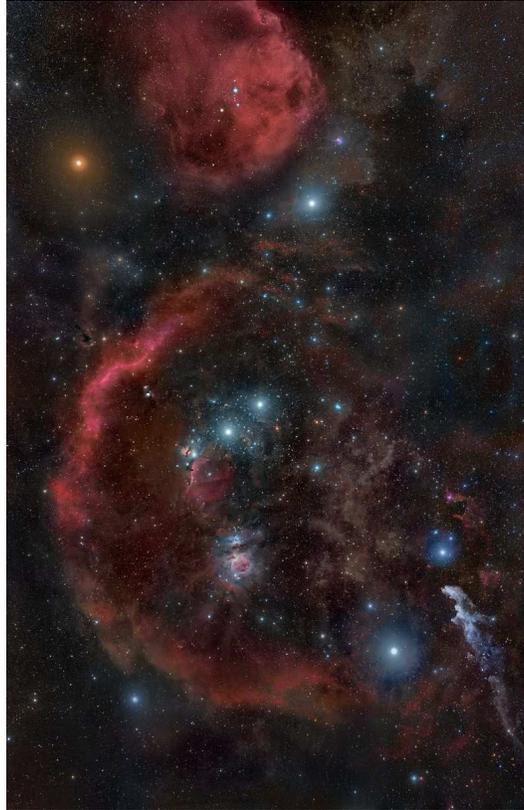


Figure 8.2: The Orion constellation. The reddish star on the upper left is the red giant star Betelgeuse. The star on the lower right is Rigel. The three horizontal stars in the center are “Orion’s Belt” and the three vertical stars below it are “Orion’s Sword.” The star on the upper right is Bellatrix, which means “female warrior” in Latin. The lower left star is Saiph which means “sword of the giant.” The crescent shape is known as Barnard’s Loop and is about 4.9 Exameters distant. (Photo Credit: Rogelio Bernal Andreo – Wikimedia Commons)

(1571-1638). The luminosity of the star slowly diminished over the next six years and fell below the threshold of detection with the unaided eye in 1626. The star again brightened in 1655 and faded away again by 1662. The star brightened again in 1665 and then fluctuated, finally stabilizing in 1715 and has been relatively constant since.

The Pistol Star is a blue hypergiant star which illuminates the Pistol Nebula, which gives the star its name. The Pistol star has a radius of 213 Gigameters. If it replaced the Sun, it would encompass Earth and just spare Mars. The Pistol Star is one of the most luminous objects in our galaxy, and is near the galactic center, about 245 Exameters distant. The Pistol Star would be visible to the naked eye, but it is obscured by interstellar dust.

8.2 Exaworld Area

1 – 1 000 000 Square Exameters (Em²) 1 x 10³⁶ m²

The area of the galactic disk of the Milky Way is approximately 700 000 Em².

8.3 Exaworld Volume

1 – 1 000 000 000 Cubic Exameters (Em³) 1 x 10⁵⁴ m³

1 – 1000 Exaliters (EL) 1 x 10¹⁸ L

The total volume of water on Earth is estimated to be 1386 Exaliters. The Earth's oceans are thought to contain 1338 Exaliters of water. If the Earth's crust was perfectly level, the sea would blanket the globe with water to a depth of 2.6 Km. The amount of fresh water on Earth is 10.5 Exaliters. Water contained in the world's ice caps, glaciers, and permanent snow is 24 Exaliters. The volume of water residing in the world's lakes is only 176 Petaliters or 0.176 Exaliters.

At the beginning of the twenty-first century, researchers began to suspect molten rock inside the Earth could contain large

Exaliter Examples

Item	Volume
Total Water on Earth	1386 EL
Water in Earth's Oceans	1338 EL
Water in Earth's Ice and Snow	24 EL
Fresh Water on Earth	10.5 EL
Water in Earth's Lakes	0.176 EL

Table 8.2: Exaliter Illustrations

quantities of water. In 2002, seismic disturbances suggested water-containing minerals might exist within the Earth's interior. In 2014, a small diamond was discovered which originated deep underground, and was later expelled from a volcano. This diamond had inclusions of ringwoodite, which can encompass the components of water within its structure. Ringwoodite is a mineral which can only be formed by high pressures like those found in the Earth's mantle. The diamond encasement of the ringwoodite specimen preserved the high pressure environment it requires to remain stable. Ringwoodite's presence, combined with the seismic data, suggests a considerable amount of water exists in a layer about 600 Kilometers below the Earth's surface. The water does not exist in liquid form, but only as the components of water. The equivalent amount of water contained within this mantle layer is thought to be roughly three times the amount found in the world's oceans, or about 4000 Exaliters.

$$\text{Em}^3 \bullet \bullet \bullet \text{Em}^3$$

NGC 2419 is a globular cluster. It has a diameter of 4.92 Exameters and encloses a volume of about 62.3 cubic Exameters.

The Large Magellanic Cloud is a nearby galaxy with a diameter of approximately 132.45 Exameters. An encompassing sphere would have a volume of 1 216 620 Em^3

The radius of our Milky Way Galaxy is approximately 1000

Cubic Exameter Examples

Item	Volume
NGC 2419 Globular Cluster	62.3 Em ³
Large Magellanic Cloud (Enclosing Sphere)	1 216 620 Em ³
Milky Way Galaxy (Enclosing Sphere)	523 600 000 Em ³

Table 8.3

Exameters. A sphere surrounding our galaxy would contain a volume of 523 600 000 Em³.

8.4 Exaworld Mass

1 – 1000 Exagrams (Eg) 1×10^{18} g

The atmosphere of the Earth has a mass of about 5.15 Exagrams.

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List of Exagram Mass Items

Item	Mass
Earth's Atmosphere	5.15 Eg
Toba Supereruption	7 Eg
Earth's Biomass	560 Eg

Table 8.4: Exagram Illustrations

Approximately 74 000 years ago, the Toba volcanic supereruption ejected a mass of about 7 Exagrams. This eruption mass is thought to have covered all of South Asia to a thickness of about 150 millimeters.

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The Earth's total biomass is approximately 560 Exagrams.

References

- [1] Mark J. Reid & Xing-Wu Zheng “New View of The Milky Way” *Scientific American*, April 2020, pp 29-35

