

The earth and her moon– changing the definition of a binary planet

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As long as humanity has existed, so has curiosity about the night sky. For thousands of years, people have looked upon the star-filled darkness with awe, and with a desire for understanding. In all of the cosmos, the celestial body that has been most easily and frequently studied is the one that is nearest to the Earth, and that is the Moon. It is easy to comprehend how much is understood about the moon when it is realized how accessible information about the moon is to us. Its gentle rays provide a beautiful and immaculate opportunity for viewing with the naked eye.

The information that was gained during the 1969 Moon landing far surpasses any information that can be gained about other celestial bodies in our solar system with available technological resources. The Moon landing was able to provide humankind with a sense of tangibility about the Moon that cannot be gained by simply observing through a telescope. With information about the Moon being so readily accessible, it is astonishing how much about the Moon is still unknown. New information about the Moon can change scientific understanding about the way that Earth itself operates. Perhaps the most applicable and controversial theory regarding both the Earth and her Moon is that they are not what they have been defined as- that is, a single planet orbited by a natural satellite. Instead, given the mass of the Moon in direct proportion with Earth's mass, the planet-like components and behavior of the Moon, and Earth's reliance on the Moon, it makes much more sense to redefine the Earth and Moon as a binary planet.

The Earth's Moon is the fifth largest natural satellite in the solar system."

Fifth largest" does not sound very impressive until the circumstances of the

larger satellites are considered. The largest natural satellite is one of

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Jupiter's moons. With a radius of 5, 268 km, Ganymede is larger than Mercury. However, the radius of Jupiter is much larger, and stretches out to 43, 441 km. It is true that Ganymede could be considered a planet if it were to break away from Jupiter, but compared to the size of Jupiter, Ganymede is insignificant in size.

Two of Jupiter's other moons, (Callisto and Io) as well as one of Saturn's moons, (Titan) are also larger than Earth's Moon, but are proportionally insignificant in size in comparison to the planets that they orbit. What makes the Moon unique in the solar system is how close its size is compared to the Earth. The Moon's diameter is $\frac{1}{4}$ the diameter of the Earth (Earth's Moon: Overview). The only other moon in the solar system that is closer in size in comparison to the celestial object that it orbits is Charon, which orbits Pluto. Because of this, Charon and Pluto are often referred to as a binary dwarf planet system (Charon: Overview).

The similar size of the Earth and Moon, as well as the short distance between the Earth and Moon, both play a part in the location of the Earth and Moon's barycenter. The barycenter, or location of the center of mass where the two celestial bodies orbit each other, is only 2, 950 miles beneath the surface of the Earth. According to Isaac Asimov, this is why the Earth has tides. The oceans themselves are always still, but the "wobble" of the Earth (the Earth's orbit around the Earth-Moon barycenter) gives the impression that the waters are what is moving (The Double Planet 101-103). The vast majority of barycentric coordinates are so close to the center of the larger body that the orbit of the larger body is negligible. For instance, when

applying the calculations presented by Asimov to find the tug-of-war value between the Sun and the Earth, it is discovered that the Sun-Earth barycenter is far under the surface of the Sun.

This means that the Earth does give the Sun a trivial “wobble”(“Of Time and Space and Other Things”). It is easy to see that the Earth’s orbit around the barycenter is highly unusual in the solar system. The Earth and Moon both orbit around a fixed point that is inside of the Earth but is not the Earth itself. That is why it is incorrect to teach that the Moon “orbits the Earth” because the Moon is not orbiting the Earth any more than the Earth is orbiting the Moon. The Earth and Moon do, however, orbit the Sun. The aforementioned tug-of-war theory was a distinctive definition that Asimov offered to show the difference between a planet-moon and a binary planet system.

The point of the calculation involved in the theory is to show whether the Sun or the larger celestial body in the system has the greater gravitational pull on the smaller body. Asimov applied this calculation to every natural satellite in the solar system. With the exception of the Moon, the larger celestial body in the planet-satellite system “won” the tug-of-war every time. However, with the Moon, the Sun “won” the tug-of-war, meaning that the Sun’s gravitational pull on the Moon has a greater affect than the Earth’s gravitational pull(“Of Time and Space and Other Things”). With Asimov’s findings, it is easy to conclude that in the absence of the Earth, the Moon would continue to orbit the Sun with very little difference to its current orbit

pattern. Another formerly accepted definition for something to be considered a planet required that it be geologically active.

Recent research from NASA shows that the Moon is, in fact, geologically active, and is forming new valleys(Dunbar). Another major factor to consider when referring to the Earth-Moon system is Earth's reliance upon the Moon. As aforementioned, the Moon controls the Earth's tides in ways that are hard to even imagine. Tides may appear to have a very small affect on Earth, but the fact of the matter is just the opposite. Tides affect very much on Earth, such as the Earth's rotation, and according to some researchers tides could even be indirectly related to the origin of life.

It also needs to be considered that without the Moon, the tides would differ greatly from their current form, as the only thing that would exist to create tides would be the Sun. The Sun's tides are only 1/3 of the size of the tides that the Moon creates(Asimov, The Double Planet 101-103). The Moon also affects the axis of the Earth (which causes the northern pole to always point to the star Polaris, or the north star) and drastically affects the seasons of the Earth(Asimov, The Double Planet 104-108). In conclusion, it is evident that the Moon and Earth act independently in the orbit of the Sun, and that the Earth is very reliant upon the Moon. The ways in which the Earth and Moon exist, as well as their orbit patterns, go to show that they are two individual planets that act together as one binary planet. The International Astronomical Union currently has no standard definition as to what a " binary planet" is, but many astronomers unofficially consider two celestial bodies to be a binary planet if their barycenter is not under the surface of either of the

planets(“ Pluto and the Solar System). This simplistic definition falls short, and does not examine the credentials that should be considered in order to define two celestial bodies as a binary planet. The tug-of-war definition would require objective calculations to be performed in order for two celestial bodies to be called a “ binary planet.” This definition shows whether the larger body or the Sun has the greatest gravitational impact on the smaller body, and by this definition, the Moon is, indeed, a part of the Earth-Moon binary planet system.