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Article

On the Formation and Evolution of Planetary Atmospheres in the Solar System

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Abstract

Using the new theory of "cosmic expansion - atomic expansion" as a tool, this paper summarizes the evolution law of planetary atmospheres and draws the following main conclusions: All the planets in the solar system were born at the same time and had a primordial atmosphere of hydrogen and helium when they were born. The subsequent atmospheres and oceans of all planets are formed by the mixing of the primordial atmosphere with the gases continuously released by the material inside the planets due to the expansion of the universe. The planet's atmosphere and oceans have been in dynamic equilibrium, on the one hand, the atmospheric molecules continue to escape into space, on the other hand, the internal materials of the planet continue to release various gases into the atmosphere. The composition of the planet's atmosphere has been developing in the direction of increasing molecular weight, first dominated by small molecular weight molecules such as hydrogen and helium, and then dominated by medium molecular weight molecules such as nitrogen and water, and then dominated by large molecular weight molecules such as carbon dioxide. Once the planet is completely solidified, the planet's atmosphere will quickly disappear.

Keywords: planetary atmospheres; Mars; Venus; Jupiter; greenhouse effect

Introduction

How did the Earth's atmosphere and oceans form? Is the composition and amount of the atmosphere changing all the time? What will happen to Earth's atmosphere next? Will the atmosphere and oceans eventually disappear? Why is Venus's atmosphere 96% carbon dioxide? Was Venus once as vibrant and beautiful as Earth is today? How is Venus's atmosphere evolving? Did Mars once have an atmosphere and oceans? If so, how did they disappear? Are there any other reasons for the rise of the Earth's greenhouse effect besides human burning fossil fuels? At present, the scientific community has not given satisfactory answers to these questions. This paper analyzes and summarizes the evolution law of planetary atmosphere from the effect of cosmic expansion, and answers the above questions.

The Formation and Evolution of Planetary Atmosphere

As can be seen from formula (5.13) [1], with the deceleration of the expansion of the universe, all objects in the universe are decelerating in the cosmic background reference system, and the radii of all atoms constituting the objects are constantly increasing. When atoms expand, the distance between atoms becomes larger, and the larger distance between atoms leads to the smaller attraction between atoms, which leads to or accelerates the molecules of various volatile substances in the magma to break free from the bondage of the magma and become gases released from the magma[4]. In addition, the continuous expansion of atoms also causes the composition of the gas separated from the magma to change, that is, the molecular weight of the separated gas becomes larger and larger. The process of magma releasing gas is similar to that of oil refining, that is, as the temperature

increases, the molecular weight of the oil evaporates from the crude oil becomes larger and larger[5]. As the universe expanded, the planets initially separated and released small molecular weight gases such as hydrogen and helium, then mainly separated and released medium molecular weight gases such as H₂O and nitrogen, and finally mainly separated and released large molecular weight gases such as carbon dioxide. At present, the Earth should be in the stage where underground magma mainly separates and releases medium molecular weight gases such as H₂O and N₂. This conclusion can be confirmed by the fact that the main component of the gas released by the current volcanic eruption is H₂O[6]. A paper published by the University of California in Science on April 6, 2018 [2] found that as much as 26% of nitrogen in the ecosystem comes from the Earth's lithosphere, but the author of this paper believe that it should come from underground magma. Because atmospheric molecules obey the Maxwell rate distribution law, there is always a certain percentage of gas molecules faster than the second cosmic velocity at any time, so the atmosphere is constantly losing gas to space. With the expansion of the universe, the atoms keep getting bigger, and the liquid and gas of the planets are expanding, so the planetary atmospheres and the planets that are not completely solidified are also expanding [3]. As a result, the molecules at the top of the atmosphere are moving farther and farther from the planet's center of mass, getting less and less gravity. Therefore, the rate of air loss in the atmosphere is increasing, and the molecular weight of the lost gases is increasing. Small molecular weight gases such as hydrogen and helium are first lost, followed by nitrogen, oxygen, methane and water vapor, and finally large molecular weight gases such as carbon dioxide. Because the temperature of the magma inside the planet is decreasing, the decreasing temperature of the magma results in a decrease in the rate at which the magma separates and releases gas. When the magma completely cooled and solidified, the planet basically stopped releasing gas. There is still a very small amount of carbon dioxide left in the Martian atmosphere, suggesting that the planet's interior is nearly completely solidified. The moon's atmosphere is essentially a vacuum, suggesting that the moon's interior has cooled and solidified completely. All planets' atmospheres and oceans should have formed from gases released from the planet's interior. As the universe expands and magma temperatures drop, all planets should go through the same process of mainly releasing hydrogen and helium to finally releasing mainly carbon dioxide, and of first losing hydrogen to finally losing carbon dioxide. The smaller the mass of the planet, the smaller the specific gravity of the planet, and the closer the planet is to the sun, the earlier the planet begins the above atmospheric changes and the shorter the time period to complete all the processes of the above atmospheric changes. Because the smaller the mass and specific gravity of the planet, the easier it is for the planets to separate and release gas molecules, and the easier it is for the gas molecules to escape from the constraints of the planet's gravity and escape into space. Because the smaller the mass of the planet, the less time it takes for the planet to completely cool and solidify. Because the closer a planet is to the sun, the more solar energy the planet's atmospheric molecules get, the easier it is for them to break free from the planet's gravity and escape into space[9].

The mass of the moon (7.342×10^{22} kg) is only about 1.23% that of the Earth, and the acceleration of gravity on the moon's surface is about 1/6 that of the Earth's surface. The fact that the moon now has almost no atmosphere indicates that the interior of the moon has completely cooled and solidified, and the lunar atmosphere has long gone through all the processes described above. It is speculated that the moon once had an atmosphere, but because the mass of the moon is too small, it was quickly lost as the universe expanded and the magma inside the moon cooled and solidified.

Mercury's mass (3.3011×10^{23} kg) is only about 5.53% of Earth's mass. Mercury's specific gravity (5.4g/cm³) is about 97.8% of Earth's. Mercury's average distance from the Sun (57.91 million km) is 38.7% of Earth's average distance from the Sun. Mercury's atmosphere is now close to a vacuum, which means that the interior of Mercury is close to being completely solidified, and the atmosphere of Mercury is close to completing all the processes described above. It is speculated that Mercury once had an atmosphere, but because Mercury's mass is too small, too close to the sun, so as the universe expanded and Mercury's internal magma cooled and solidified, Mercury's atmosphere soon nearly disappeared. Mercury is the least massive of the eight planets in the solar system and the

closest to the sun, so Mercury is the first planet to lose most of its atmosphere, and will be the first planet to completely lose its atmosphere.

The mass of Mars (6.4171×10^{23} kg) is only about 10% of that of Earth, and the specific gravity of Mars (3.94g/cm³) is about 71.6% of that of Earth. Mars is slightly farther from the Sun (227.94 million km) than Earth. The main component of the Martian atmosphere is carbon dioxide, and the density of the Martian atmosphere is less than one percent of the Earth's atmosphere, which indicates that the interior of Mars has been nearly completely cooled and solidified, and the Martian atmosphere has nearly completed all the processes of the above atmospheric changes. It is assumed that Mars also originally had an atmosphere and oceans[8]. As the universe expands, Mars and its atmosphere expand [3], the gravitation on atmospheric molecules decreases, the flow of atmospheric molecules out of the atmosphere into space accelerates, and the evaporation of water from the ocean accelerates. Eventually, due to the near-solidification of underground magma and the relatively low gravity of Mars, almost all of the atmosphere of Mars was lost, and at the same time, the oceans continued to evaporate into gas and eventually all broke away from Mars.

The mass of Venus (4.8675×10^{24} kg) is larger than that of Mars, about 80% of that of Earth, and the specific gravity of Venus (5.19g/cm³) is about 94.2% of that of Earth. The average distance of Venus from the Sun is 108.2 million km, which is about 72.3% of the average distance of Earth from the Sun. The atmosphere of Venus is composed mostly (96%) of carbon dioxide, with a small amount of nitrogen. The atmospheric pressure on the surface of Venus is 93 times that of Earth. It is speculated that Venus's atmosphere has previously gone through the phase dominated by hydrogen and helium, followed by the phase dominated by H₂O (including liquid water) and nitrogen, and then into the phase dominated by carbon dioxide. As the universe expands and underground magma continues to cool and solidify, the atmosphere of Venus will then continue to lose carbon dioxide, and the atmospheric pressure of Venus will continue to drop until only thin carbon dioxide is left like the atmosphere of Mars today. As the expansion of the universe continues, Venus will eventually lose its atmosphere completely and become like the Moon today.

Earth has a slightly larger mass than Venus and is slightly farther from the sun than Venus, so Earth's atmosphere may be following in the footsteps of Venus's. At present, the Earth should be in the stage where underground magma mainly releases moderate molecular weight gases such as H₂O and N₂. This conclusion can be confirmed by the fact that the gas emitted by volcanic eruptions is mainly composed of H₂O. The presence of oceans on Earth is also strong evidence. Because without the continuous replenishment of H₂O from underground magma, the oceans would have disappeared long ago after hundreds of millions of years of evaporation and space escape. A paper published by the University of California in Science on April 6, 2018 [2] found that as much as 26% of nitrogen in the ecosystem comes from the bedrock of the Earth's lithosphere. This paper suggests that the nitrogen should have been released from underground magma due to the expansion of the universe. The nitrogen content of the Earth's atmosphere is as high as 78%, which is also strong evidence that the Earth is currently in the stage of mainly releasing medium molecular weight gases such as H₂O and N₂. At some point in time, Earth's magma began to release carbon dioxide, which is known from the composition of the gas emitted by volcanoes. As the universe expands, the rate at which Earth's magma releases carbon dioxide is accelerating. The continuous increase of carbon dioxide in the Earth's atmosphere promotes the continuous increase of plants on Earth, so the rate at which plants decompose carbon dioxide through photosynthesis is also accelerating[10]. Plants break down carbon dioxide, release oxygen and solidify the carbon into biomass[10]. In the history of the Earth, a large part of this biomass has been buried underground under the action of geological changes such as volcanoes or earthquakes into coal and oil, so the rate of carbon dioxide production and decomposition of the Earth has been in a rough balance. As the universe expands, the release of carbon dioxide from magma beneath the Earth is accelerating. On the other hand, with the continuous increase of the earth's population, the speed of carbon dioxide emissions from human production and life is accelerating, and the speed of carbon dioxide decomposition of Earth's plants is decreasing due to the continuous reduction of Earth's forests. Finally, the increase rate of carbon dioxide in the

earth's atmosphere will exceed the speed of carbon dioxide decomposition of Earth's plants. As a result, the carbon dioxide content of the Earth's atmosphere continues to increase and the greenhouse effect continues to strengthen. If there were no humans on Earth, according to the natural process, as the universe expands, the proportion of carbon dioxide in the Earth's atmosphere will become higher and higher, and the Earth's atmosphere will gradually become like the current atmosphere of Venus. Of course, this natural process is very slow in time. This natural process can be slowed, or perhaps halted, by reducing greenhouse gas emissions, reforestation on a large scale, and the development of practical technologies that can decompose carbon dioxide from the atmosphere on a large scale. But as underground magma continues to cool until it solidifies, the rate at which Earth's magma releases gas will continue to slow down to zero. After the Earth's magma has solidified and stopped producing gas, as atmospheric molecules continue to escape into space, the Earth's atmosphere will eventually become like the current Martian atmosphere, leaving only thin carbon dioxide. As the expansion of the universe continues, the Earth will eventually lose its atmosphere completely and become like the Moon today.

Jupiter's mass (1.8982×10^{27} kg) is 318 times that of Earth. Jupiter's specific gravity (1.326 g/cm^3) is about 24% that of Earth's. Jupiter's average distance from the Sun (778.33 million km) is about 5.2 times the average distance between Earth and the Sun. Jupiter's atmosphere is made up of 88 to 92 percent hydrogen and 7 to 11 percent helium. Due to its large mass and distance from the Sun, Jupiter basically maintains the primitive atmosphere dominated by hydrogen and helium formed when it was born. According to natural processes, as the universe expands and underground magma continues to cool and solidify, Jupiter's atmosphere will also go through the process of becoming dominated by H_2O and nitrogen, then carbon dioxide, and eventually losing all of its atmosphere.

The mass of Saturn (5.6834×10^{26} kg) is about 95 times that of Earth. Saturn's specific gravity (0.687 g/cm^3) is about 12% of Earth's. Saturn's average distance from the Sun (1,429.4 million km) is about 10 times that of Earth. The main components of Saturn's atmosphere are hydrogen and helium, accounting for 92.4% and 7.4% respectively. Due to its large mass and distance from the Sun, Saturn basically maintains the primitive atmosphere dominated by hydrogen and helium that was formed when it was born. According to natural processes, as the universe expands and Saturn's magma continues to cool and solidify, Saturn's atmosphere will also go through the process of becoming dominated by H_2O and N_2 , then CO_2 , and eventually losing all of its atmosphere.

The mass of Uranus (8.681×10^{25} kg) is about 145 times that of Earth. Uranus's specific gravity (1.27 g/cm^3) is about 23% that of Earth's. The average distance of Uranus from the Sun (2870.99 million km) is about 19 times that of Earth. Uranus' atmosphere is composed mainly of hydrogen, helium and methane. Due to its large mass and distance from the Sun, Uranus basically maintains the original atmosphere of hydrogen and helium that was formed when it was born. According to the natural process, as the universe expands and the magma inside Uranus continues to cool and solidified, the atmosphere of Uranus will also go through the process of dominated by H_2O and nitrogen, then dominated by carbon dioxide, and eventually the loss of the entire atmosphere.

Neptune's mass (1.0241×10^{26} kg) is about 17 times that of Earth. Neptune's specific gravity (1.638 g/cm^3) is about 30% that of Earth's. Neptune's average distance from the Sun (4,504 million km) is about 30 times greater than Earth's average distance from the Sun. The atmosphere of Neptune is mainly composed of hydrogen and helium, with trace amounts of methane. Due to its large mass and distance from the Sun, Neptune basically maintains the original atmosphere of hydrogen and helium that was formed when it was born. According to the natural course, as the universe expands and the magma inside Neptune continues to cool and solidified, the atmosphere of Neptune will also go through the process of dominated by H_2O and nitrogen, then dominated by carbon dioxide, and eventually the loss of the entire atmosphere.

Discussion

How did the planets of the Solar System and their primordial atmospheres form? Guess: The planets of the solar system were formed by a collision between the sun and a celestial body about 4.6 billion years ago. The "plasma balls" of different sizes splashed out by the collision formed all the planets of the Sun, so all the planets of the solar system orbit the Sun in the same direction. Because the greater the mass, the greater the inertia, so at the same initial speed, the massive "plasma ball" can overcome the resistance of the sun's atmosphere to move a longer distance, resulting in the massive "plasma ball" located in the outer orbit. Although these "plasma balls" have the same elemental composition as the Sun, because the mass of the "plasma balls" is much smaller than the mass of the Sun, the pressure and temperature inside the "plasma balls" cannot produce nuclear fusion reactions. As a result, these "plasma balls" quickly cooled and evolved into "gas planets" like Jupiter. Because the mass and gravity of these "plasma balls" are much smaller than that of the Sun, these "plasma balls" quickly release hydrogen and helium gas after leaving the Sun to form the primitive atmosphere of the planets. Because these "plasma balls" have less mass and gravity than the Sun, most of the hydrogen and helium in these primordial atmospheres quickly escaped into space shortly after the primordial atmosphere formed[7]. The smaller the mass of the "plasma ball" and the closer it is to the sun, the faster the "plasma ball" releases hydrogen and helium, and the faster the released hydrogen and helium escape into space. So the lower the mass of the planet and the closer it is to the Sun, the lower the hydrogen and helium content of the planet. Guess: Excluding hydrogen and helium, the material composition of the planets in the solar system (especially Saturn, Jupiter, Neptune, and Uranus) is basically the same as that of the sun.

Conclusions

Through the above analysis, we can draw the following conclusions:

1. The primordial atmospheres of all the planets in the solar system are mainly composed of hydrogen and helium gas, which were formed at the same time as the planets formed.
2. The subsequent atmospheres and oceans of the Earth and all planets were formed by the mixing of gases released by underground magma with the primordial atmosphere during the expansion of the universe.
3. The atmosphere and oceans or liquid gas of the Earth and all planets are in dynamic equilibrium. On the one hand, due to the expansion of the universe, underground magma continues to release various gases into the atmosphere, and on the other hand, atmospheric molecules continue to escape from the atmosphere into space.
4. The composition of the planet's atmosphere has been developing in the direction of increasing molecular weight, first dominated by small molecular weight molecules such as hydrogen and helium, and then dominated by medium molecular weight molecules such as nitrogen and water, and then dominated by large molecular weight molecules such as carbon dioxide.
5. Once the interior of the planet has completely solidified, the planet's atmosphere will quickly disappear and the planet will become like the Moon.

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