

Comparing the Atmospheric Compositions of All Planets and Giant Moons in Solar System

Rauf KM, Hossieni H^{*}, Majeed D and Ibrahim R

Department of Physics, School of Science, University of Sulaimani, Kurdistan, Iraq

^{*}Corresponding author: Hossieni H, Department of Physics, School of Science, University of Sulaimani, Kurdistan, Iraq, Tel: +964 770 1991949; E-mail: hossien.hossieni@univsul.edu.iq

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Abstract

In this research we have studied the atmosphere in both giant gaseous and soil planets in solar system. The ratio of gases in atmosphere of the planets are compared and determined which of the elements has the maximum value in the planets. It is also shown that the composition of the majority of giant planets is Nitrogen and Hydrogen because they are massive and cold.

Keywords: Planet; Solar systems; Giant gaseous; Atmosphere

Introduction

Our Solar system is a star system including Sun, eight planets (Earth, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune) and five dwarf planet (Ceres, Pluto, Haumea, Makemake, Eris). First four planets, Earth, Mercury, Venus and Mars are soil planets. They are also called the inner planets, because their orbits are nearby the Sun but other planets are giant gaseous planets and they are classified as the outer planets. In addition to the planets, solar system contains moons, asteroids, comets, meteors and some particular region as asteroids belt, Kuiper belt, scattered disk and Oort cloud. Moreover, there is an ethereal matter in the planetary space that made of natural Hydrogen, plasma gaseous, cosmic rays and dust particles [1].

Besides the planets, giant moons of the solar system hold atmosphere. Composition of the planets and the moons are widely different. Atmosphere of mercury consist of those atomic and subatomic particles which stemming from the Sun [2]. On the other hand, Earth's atmosphere is typically dense and consists of a wide range of different gases. The ratio of oxygen gas in celestial bodies' atmosphere is very low except Earth's atmosphere because oxygen is very active gas and interacts with other elements. Moreover, the ratio of hot oxygen in higher levels of the atmospheres of Mars and Venus is considerable [3].

The force that holds atmosphere around the planets is gravity force. A massive planet means its atmosphere is thick and the elements with high escape velocity like Hydrogen and Helium elements remain in its atmosphere while the majority of gases in the atmosphere of small celestial bodies are massive gases like CO₂ and other massive chemical components [4]. In this study the atmosphere of the planets and the moons in Solar system has been studied and a comparison has been made in compositions of the atmospheres of the planets and moons.

Atmosphere of the Bodies in Solar System

In solid matter, atoms and molecules are kept together hardly while in gases the situation is different because the connections between the molecules are very weak and they can move freely. Since the

gravitational force keeps the molecules around the planets therefore the smaller planet means its gravitational force is weaker and in the result the density of the gases is low. For example moon, Mercury and other small objects in solar system cannot hold gases around themselves because of their low gravity. On the other hand, if the planet is cold it can hold gases. This is the reason why Mars has a tiny atmosphere but mercury does not. The density of Mars's atmosphere is about 1/100 of Earth's atmosphere, but of course with different gases. Existing Oxygen gas in an atmosphere of a planet is bizarre because this gas is so active and disappears in very short time. Earth's atmosphere holds oxygen because of the plants on the surface of our planet [5].

In the other hand, the giant gaseous planets can hold Hydrogen and Nitrogen and they have remained huge [6] while moons of these planets are small and cannot have the atmosphere with an exception of Titan. Titan is the large moon of Saturn, it is big and cold, and it has held its atmosphere where Nitrogen is the most of its composition [7].

Beside gravitational force, another reason for holding gases is physical conditions. The speed of small atoms or molecules in a certain temperature is very high and gravitational force cannot hold them such as Venus. There are Oxygen and Nitrogen in the atmosphere of Venus. Although it has the atmosphere that is comparable to the Earth's size, but it is nearby the Sun thus it is very hot and all chemical carbonate compositions decays. Therefore the Venus's atmosphere is filled by CO₂ and it is denser than the Earth's atmosphere. This is the answer of why Venus is hotter than Mercury [8].

Distribution of Gases in the Atmosphere of the Planets

Figure 1 shows the amount of hydrogen gas in the atmosphere of each of the planets set in tables. Probable source for existing hydrogen in the atmosphere of the planets is the solar wind. It can be noticed that the atmosphere of Saturn contains the maximum amount of hydrogen than the other planets by the amount of 88% of total amount of its atmosphere while Jupiter's atmosphere covered 86.4% of its atmosphere with hydrogen. 82.5% of Uranus's atmosphere is hydrogen and 80% for Neptune's atmosphere while in Mercury's atmosphere is only 22% and Earth's atmosphere has the lowest value among the planets which is 6 x 10⁻⁵ % of its atmosphere.

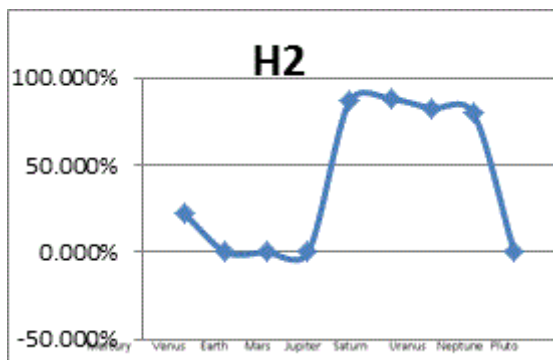


Figure 1: the abundance of Hydrogen gas in atmosphere of the planets. It is clear that this abundance has the maximum value in giant planets.

Similarly Figure 2 shows the amount of helium gas in the atmosphere of each of the planets set in tables. The atmosphere of Neptune contains the maximum amount of helium than the other planets by the amount of 19% of total amount of its atmosphere while 15% of Uranus's atmosphere is helium and 13.6% of Jupiter's atmosphere and 12% for Saturn's atmosphere. Earth has very low helium in its atmosphere which is only $5.24 \times 10^{-4}\%$ of the total amount of the gases and Venus's atmosphere has (12 ppm) helium in its atmosphere.

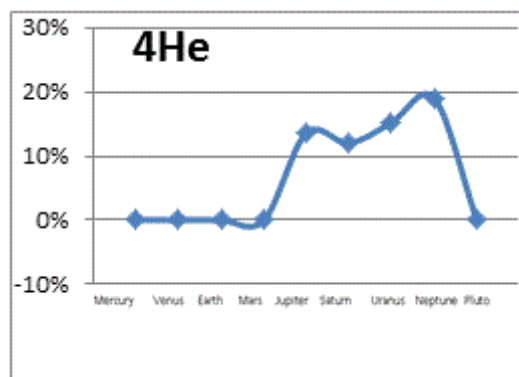


Figure 2: the abundance of Helium gas in atmosphere of planets. Similar to Hydrogen rate the Helium in giant gas planets is large and in Neptune is maximum

Moreover, Figure 3 shows the amount of Methane gas in the atmosphere of each of the planets. The atmosphere of dwarf planet such as Pluto contains the maximum amount of Methane than the other planets by the amount of 2.5% of total amount of its atmosphere. Uranus's atmosphere has Methane of about 2.3% of its atmosphere and 2% for Neptune's atmosphere.

Other planets have less methane in their atmosphere such as Saturn's atmosphere which contains 0.0047% methane and 0.00181% of Jupiter's atmosphere is covered by Methane while Earth's atmosphere has 0.00018% Methane of the total amount of the gases and 10-250 ppb for Mars.

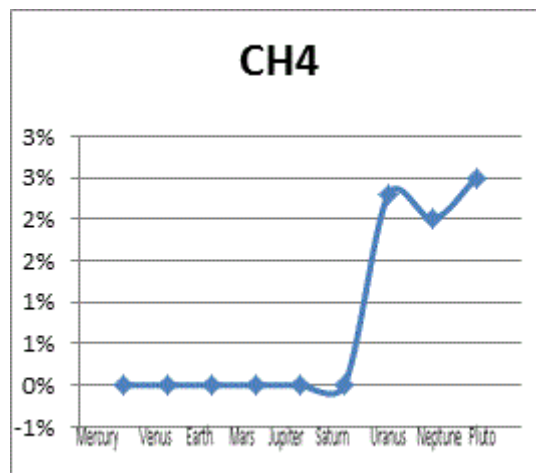


Figure 3: the abundance of Methane gas in atmosphere of planets. It can be seen that far planets have maximum amount of methane.

Furthermore, Figure 4 shows the amount of Ammonia gas in the atmosphere of each of the planets. The atmosphere of Jupiter contains the maximum amount of Ammonia than the other planets by the amount of 0.0006% while 0.00016% of Saturn's atmosphere covered by Ammonia and only <100 ppb of Uranus's atmosphere is Ammonia and <600 ppb for Neptune's atmosphere.

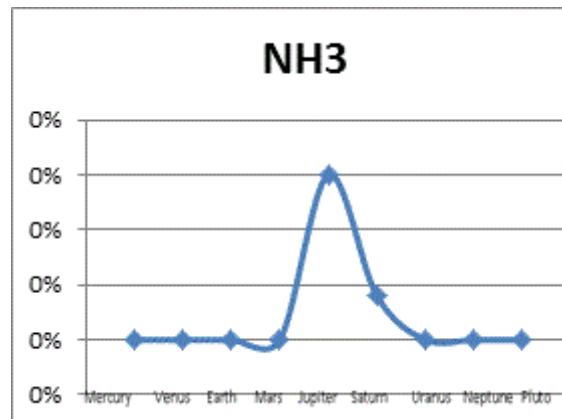


Figure 4: the abundance of Ammonia gas in solar system, maximum ratio of the gas is in Jupiter

Additionally, Figure 5 indicates the amount of H₂O in the atmosphere of each of the planets in solar system. Certainly the atmosphere of Earth contains the maximum amount of H₂O than the other planets by the amount of 0.0001% of total amount of its atmosphere. Jupiter's atmosphere has only 520 ppm H₂O and <100 ppm of Mars's atmosphere is H₂O while Venus's atmosphere contains 2 ppm H₂O and 2-20 ppb for Saturn's atmosphere.

In Table 1a-1c we summarized all chemical components and elements in the atmosphere of the planets in solar system. These components started with hydrogen and end with HF [9].

(a)											
Planet	H ₂	4He	CH ₄	NH ₃	H ₂ O	H ₂ S	HD	13CH ₄	C ₂ H ₆	PH ₃	CH ₃ D
Mercury	22.000%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Venus	0%	12ppm	0%	0%	2 ppm	0%	0%	0%	0%	0%	0%
Earth	0.000060%	0.000524%	0.000180%	0%	0.000100%	0%	0%	0%	0%	0%	0%
Mars	0%	0%	10-250 ppb	0%	<100 ppm	0%	0%	0%	0%	0%	0%
Jupiter	86.400%	13.600%	0.001810%	0.000600%	520 ppm	67 ppm	45 ± 12 ppm	19 ± 1 ppm	5.8 ± 1.5 ppm	1.1 ± 0.4 ppm	0.2 ± 0.04 ppm
Saturn	88.000%	12.000%	0.004700%	0.000160%	2-20 ppb	<0.4 ppm	110 ± 58 ppm	51 ± 2 ppm	7.0 ± 1.5 ppm	4.5 ± 1.4 ppm	0.3 ± 0.02 ppm
Uranus	82.500%	15.200%	2.300%	<100 ppb	0%	<0.8 ppm	148 ppm	0%	0%	0%	8.3 ppm
Neptune	80.000%	19.000%	2.000%	<600 ppb	0%	<3 ppm	192 ppm	0%	0%	0%	12 ppm
Pluto	0%	0%	2.500%	0%	0%	0.00%	0%	0%	0%	0%	0%
(b)											
Planet	C ₂ H ₂	HCN	HC ₃ N	C ₂ H ₄	CO ₂	C ₂ H ₆	CH ₃ C ₂ H	CO	CH ₃ CN	GeH ₄	C ₄ H ₂
Mercury	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Venus	0%	0%	0%	0%	96.500%	0%	17 ppm	0%	0%	0%	0%
Earth	0%	0%	0%	0%	0.040000%	0%	0%	0%	0%	0%	0%
Mars	0%	0%	0%	0%	96.000%	0%	0%	0%	0%	0.055700%	0%
Jupiter	0.11 ± 0.03 ppm	60 ± 10 ppb	0%	7 ± 3 ppb	5-35 ppb	0%	2.5-1+2 ppb	1.6 ± 0.3 ppb	0%	0.70.4-0.2 ppb	0.3 ± 0.2 ppb
Saturn	0.3 ± 0.1 ppm	<4 ppb	0%	0.2 ppb	0.3 ppb	0%	0.6 ppb	1.4 ± 0.7 ppb	0%	0.4 ± 0.4 ppb	0.09 ± ppb
Uranus	10 ppb	<15 ppb	<0.8 ppb	0%	40 ± 5 ppt	10 ± 1 ppb	0.25 ± 0.3 ppb	<40 ppb	0%	0%	0.16 ± 0.02 ppb
Neptune	60 ppb	0.3 ± 0.15 ppb	<0.4 ppb	0%	0%	1.5+25-0.5 ppm	0%	0.65 ± 0.35 ppm	<5 ppb	0%	0%
Pluto	0%	0%	0%	0%	0%	0%	0%	0.500%	0%	0%	0%
(c)											
Planet	AsH ₃	Ar	N ₂	Ne	Kr	O ₂	Na	SO ₂	HCl	HF	Other gases
Mercury	0%	0%	0%	0%	0%	42.000%	29.000%	0%	0%	0%	7.000%
Venus	0%	70 ppm	3.500%	7 ppm	0%	0%	0%	150 ppm	0.1-0.6 ppm	0.001 ppm	0%
Earth	0%	0.934000%	78.000%	0.001818%	0.000114%	20.946%	0%	0%	0%	0%	0%
Mars	0%	1.900%	1.900%	0%	0%	0.150000%	0%	0%	0%	0%	0%
Jupiter	0.22 ± 0.11 ppb	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Saturn	2.1 ± 1.3 ppb	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Uranus	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Neptune	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pluto	0%	0%	97.000%	0%	0%	0%	0%	0%	0%	0%	0%

Table 1(a-c): All three tables shows that, amount of different gases in the atmosphere of different planets in solar system.

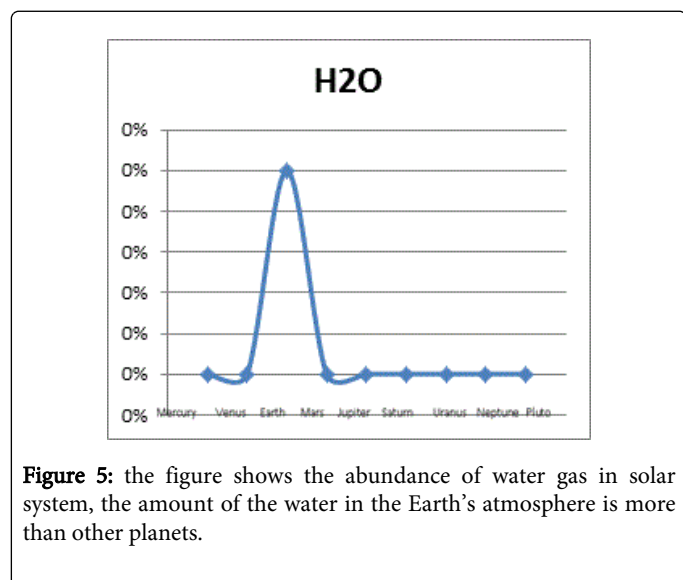


Figure 6 shows the amount of CO₂ in the atmosphere of each of the planets set in the tables. The atmosphere of Venus contains the maximum amount of CO₂ than the other planets by the amount of 96.5% of total amount of its atmosphere and the reason for having such amount of CO₂ has been clarified above. And Mars's atmosphere has 96 ppm CO₂ whereas 0.04% of Earth's atmosphere is covered by CO₂. The amount of CO₂ for Jupiter's atmosphere is about 5-35 ppb and for Saturn's atmosphere is 0.3 ppb and this amount is 40 ± 5 ppt for Neptune's atmosphere.

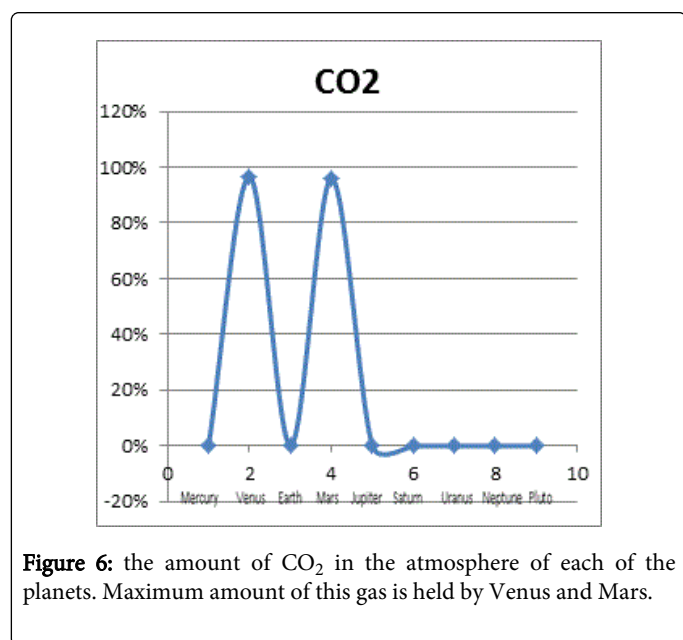


Figure 7 shows the amount of N₂ in the atmosphere of each of the planets. The atmosphere of Pluto contains the maximum amount of N₂ than the other planets by the amount of 97% of total amount of its atmosphere while Earth's atmosphere contains 78% N₂. Also 3.5% of Venus's atmosphere is N₂ and 1.9% for Mars's atmosphere.

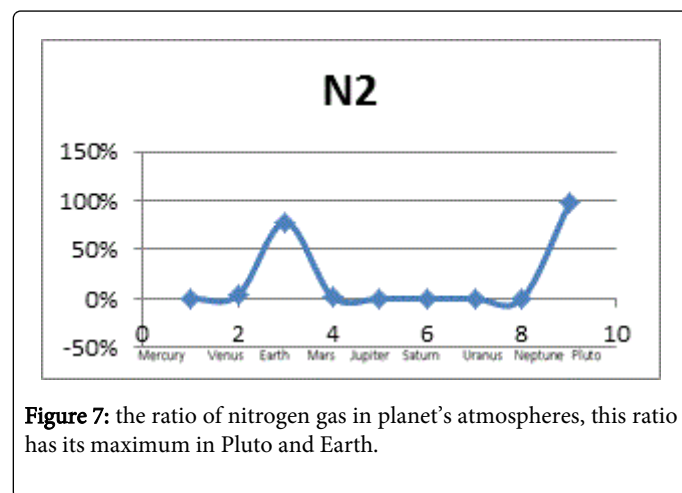
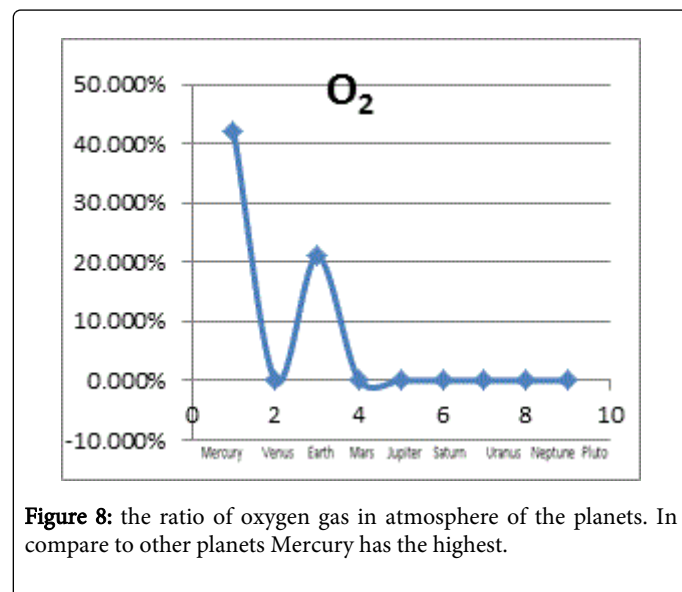


Figure 8 indicates the amount of O₂ in the atmosphere of each of the planets set in the tables. The atmosphere of Mercury contains the maximum amount of O₂ than the other planets by the amount of 42% of total amount of its atmosphere while 20.946% of Earth's atmosphere is covered by O₂ and 0.15% of Mars's atmosphere is O₂.



Conclusion

Our Solar System is hardly a microbe compared with the Universe. This research has studied the atmosphere of the planets of solar system

that contain eight planets (Mercury, Venus, Earth, Mars, Jupiter, Uranus, Saturn and Neptune). The rate of gases in the atmosphere of the planets change from planet to other that mostly contain of hydrogen (H₂), oxygen (O₂) and carbon dioxide (CO₂). From our graphs it can be noticed that the maximum rate of 4He appear in Neptune, H₂ appear in Saturn, CH₄ in Pluto, NH₃ in Jupiter, H₂O in Earth, CO₂ in Venues, N₂ in Pluto and O₂ in Mercury.

References

1. Murray CD, Dermott SF (1999) "Solar System Dynamics". Cambridge University press, UK.
2. Potter A, Morgan T (1985) "Discovery of Sodium in the Atmosphere of Mercury". *Science* 229: 651-653.
3. Richard R, Hodges Jr. (2000) "Distributions of hot oxygen for Venus and Mars", *Journal of Geophysical Research* 105: 6971-6982.
4. Lewis JS, Prinn RG (1984) *Planets and their atmospheres: Origin and evolution*. Academic Press, Orlando, Florida.
5. Michael Seeds, Dana Backman (2015) *Foundations of Astronomy* (13th edn) Cengage Learning, Independence, KY.
6. Mizuno H (1980) Formation of the Giant Planets. *Progress of Theoretical Physics* 64: 2
7. Lindal GF, Wood GE, Hotz HB, Sweetnam DN (1983) The atmosphere of Titan: An analysis of the Voyager 1 radio occultation measurements. *Icarus* 53: 2.
8. Lyttleton RA (1969) On the internal structures of mercury and Venus. *Astrophysics and Space Science* 5: 1
9. Pidwirny M (2013) Atmospheric composition. *The encyclopedia of the Earth*.