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A1 4 What if Mars was made of Mars Bars?

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Abstract

We investigate the outcomes of a scenario that the planet Mars has suddenly changed its composition and become a giant spherical Mars bar of the same volume as planet Mars. We find that both the mass and the gravitational field strength would decrease by 75%, and the escape velocity would reduce by 50%. It would also last as a food source for around 100 billion years.

Introduction

Many scientists have investigated the consequences of what would happen if the moon were suddenly made of cheese. We take inspiration from that hypothesis, and apply it to the planet Mars; what would happen if Mars was made out of Mars bar chocolate? We investigate the change in the gravitational field strength and the escape velocity. We also determine how long the planet could last as a food source for the human race.

Mass of the New Mars

To investigate the gravitational effects of the change that would occur if Mars was made out of Mars bars, we first have to calculate the mass of the planet. We assume the new Mars has the same volume as before, which is 1.6×10^{20} m^3 [1].

We then estimate the volume of a typical Mars bar, which is $\approx$ 10 cm long, $\approx$ 3 cm wide, and $\approx$ 1.5 cm tall. This gives a volume of a Mars bar to be approximately 5×10^{-5} m^3. Around 3.4×10^{24} Mars bars are needed to fit the volume of Mars. The mass of one Mars bar is around 50 g [2] (assuming the wrapper weighs around 1 g), so we calculate the new mass of Mars to be 1.6×10^{23} kg.

Change in Gravitational Field Strength

To calculate the gravitational field strength, we use equation (1):

$$g = \frac{GM}{r^2} \tag{1}$$

where g is the gravitational field strength [m s^{-2}], $G = 6.67 \times 10^{-11}$ [N m^2 kg^{-2}] is the gravitational constant, M [kg] is the mass of the planet, and r [m] is the radius of Mars [3].

Substituting $M = 1.6 \times 10^{23}$ kg and $r = 3400$ km [1] into equation (1), the gravitational field strength on Mars is found to be 0.92 m s^{-2}. Comparing this to the initial gravity of Mars, which is 3.7 m s^{-2} [1], the gravity is reduced by approximately 75%. This is lowest among all the other planets in the solar system [1].

Change in Escape Velocity

The equation for the escape velocity of the planet is given by:

$$v = \sqrt{\frac{2GM}{r}} \tag{2}$$

where v [m s^{-1}] is the escape velocity [3].
Substituting $M = 1.6 \times 10^{23}$ kg and $r = 3400$ km [1] into equation (2), the escape velocity is approximately 2500 m s^{-1}.

Food Source

We also calculate how long the planet could be used as a food source for a population of 8 billion humans.
The average male calorie intake is 2500 kcal, and the average female intake is 2000 kcal [4]. Taking the average, the calorie intake is 2250 kcal a day per person. A 50 g Mars bar has 225 kcal [2], so the planet has a total of 7.2×10^{26} kcal. We calculate that it would take $\approx 1 \times 10^{13}$ days, which is around 100 billion years, for humans to consume the planet.

Discussion

Returning to the change in gravitational field strength, the reduction in gravity could have a significant effect on the planet's atmosphere, which is already quite thin. The reduced gravitational strength could cause the atmosphere to be lost. The reduced mass may also impact the orbit of the planet around the sun, as its gravitational interaction with the sun would weaken, this would be accompanied by a reduction in its orbital velocity as a consequence of angular momentum. There would not be any significant effect on any other planets, as its distance to the closest planet, Earth, is so large. The gravitational influence on Earth is already weak, a (relatively) small reduction in mass would not have a significant effect.

As for the change in escape velocity, the usual escape velocity on Mars is ≈ 5000 m s^{-1} [1], this is a reduction of approximately 50%, meaning it would be much easier to escape the planet's orbit if it was made from Mars bars.

Conclusion

To conclude, if the planet Mars was made of Mars bars, this would have a drastic effect on the gravitational field strength and the escape velocity. The orbits of its moons, Phobos and Deimos could be affected. They could experience a shorter orbital period, and move closer to Mars over time due to its weakened gravitational strength, and possibly fall into the planet.
The removal of the planets atmosphere could make it even less habitable for life, and the lack of molten metals within the planets internal structure would mean it would no longer have a magnetic field.

References

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[4] `https://www.nhs.uk/live-well/healthy-weight/managing-your-weight/understanding-calories/` [Accessed 24 October 2023]