1 HYPOTHESIS TESTING: SUPERMOON CASE

Some supermoon intro. Lunch anecdote. Assume bigger means increasing size; *i.e.*, increasing volume. We test it by a quick-and-dirty method: back-of-the-envelope calculations using ball-park figures.

The hypothesis can be tested by estimating the value of the temperature required to expand the size of the moon from full to super and then analyzing such a value.

1.1 HYPOTHESIS

More formally, we would like to test the idea that

the moon increases its volume due to thermal expansion.

1.2 MATH MODEL

Imagine the moon being heated by an external agent, say the sun. Consider then the moon size increasing due to the heating (thermal expansion). Now, let Ω represent the moon volume and $\Delta\Omega$ the volume increase. The volume fractional change can then be modeled by [1, p. 403]

$$\frac{\Delta\Omega}{\Omega} \stackrel{\circ}{=} \alpha_{\text{vol}} \Delta\theta \,,$$

where α_{vol} represents the volume coefficient of thermal expansion and $\Delta\theta$ the temperature change to produce the volume increase.

Finally, solve for $\Delta\theta$ to have

$$\Delta\theta = \frac{\Delta\Omega}{\Omega} \frac{1}{\alpha_{\text{vol}}} \,. \qquad \text{eq:moonthermalexpmodel} \tag{1}$$

The last formula models the temperature change required to increase the moon volume.

1.3 MOON DATA

The next step is to gather some information about the moon and its composition:

- supermoon size (wiki): 20% « bigger » than full moon;
- moon main component (Apollo 11 lunar samples): basalt and
- basalt linear coefficient of thermal expansion (encyclopedia britannica): $\alpha_{\text{lin}}/^{\circ}\text{C}^{-1} \sim 10^{-5}$.

1.4 CALCULATION

Replace the gathered numerical values into eq. (1) to find:

$$\Delta\theta \sim 1.20 \frac{1}{3 \cdot 10^{-5}\,^{\circ}\text{C}^{-1}} \sim 4 \cdot 10^{5}\,^{\circ}\text{C} \,,$$

where we have assumed that basalt volume coefficient of thermal expansion is three times its linear coefficient.

1.5 DISCUSSION

For the moon to thermally expand to supermoon, we estimated that a temperature change of 10^5 °C is required; *i.e.*, the moon temperature should be *at least* 10^5 °C. Since the moon main component is basalt and since basalt melts at $\sim 10^3$ °C, thus a supermoon would have a melted surface.

On the other hand, the temperature of the sun's corona is $6 \cdot 10^3$ °C. If we further assume basalt being a black body, then, a supermoon would be as bright as the sun.

1.6 CONCLUSION

Using the math model, eq. (1), and moon data, we estimated that a supermoon would have a surface temperature of at least $\sim 10^5$ °C. Since this temperature value is unlikely to be true, we thus reject hypothesis – the idea of the « moon getting bigger because of thermal expansion ».

biblio

REFERENCES

Standing on the shoulder of giants

— NEWTON, [2]

[1] J. H. L. IV and J. H. L. V, *A Heat Transfer Textbook*, fourth edition ed. (Phlogiston Press, 2012).

[2] Wikiquote, "Isaac newton," (2014).

DOCUMENT REVISION HISTORY

sec:docrevhist

The following table describes the changes to « Hypothesis testing ».

VERSION	DATE	NOTES
0.0.1	20/08/2014	First release
0.0.2	21/08/2014	Changes in text organization. Typo corrections
0.0.3	22/08/2014	Title and subtitle changed
0.0.4	23/08/2014	Math font changed to EulerVM
0.0.5	27/08/2014	Margin notes in sans-serif font
0.0.6	08/09/2014	Show labels in PDFs draft
0.0.7	10/09/2014	Current document compilation