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P5_5 Troublesome Tribbles in Power

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Abstract

In this paper, we discussed the population growth of Tribbles and their energy output by thermal transfer. We then calculated the time it would take for the Tribbles to power the warp drive for 1 second, the time being 5.16 days.

Introduction

A Tribble is a small alien in the Star Trek universe that is known for being soft, furry, and pleasing to most humanoids types. Tribbles are asexual and born pregnant. They will only give birth if they consume a sufficient amount of food, however, they can not give birth in cold temperatures [1].

Theory

In the Star Trek episode "The Trouble with Tribbles", we are introduced to the first time the Federation encounter tribbles. They are on board from stardate 4523.3 to slightly after stardate 4525.6 [2], which is roughly a period of 3 Earth days [3].

Based on the words of Mr. Spock [4] during the episode, we can work out the growth rate of Tribbles under the correct breeding requirements. He states that a Tribble has a litter of around 10 Tribbles every 12 hours. Thus, the total number of Tribbles N_T is given by:

$$N_T = 11^{t/t_r}, \tag{1}$$

where t is the time spent breeding and t_r is the time it takes to breed. Therefore, there were 1771561 Tribbles aboard the Enterprise after only 3 days, shown graphically in Figure 1.

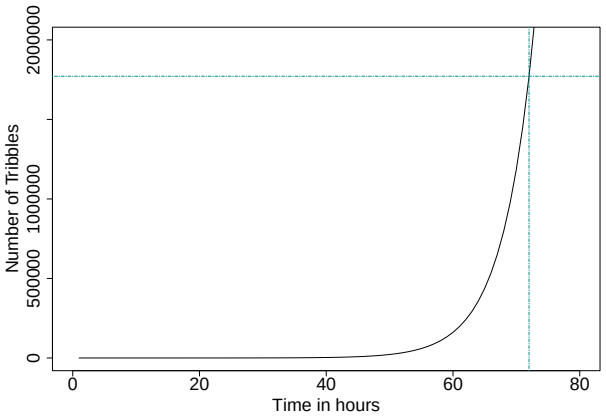

Figure 1: Tribble Growth Rate over Time

The writer of the episode used Tribbles to interpret the rabbit population explosion in Australia [5], therefore we will assume that Tribbles have similar properties as rabbits.

Experiment

We found that rabbits have a body temperature, T_t, of 39 °C [6] and their fur conductivity, κ is around 69 mW/(m.K) [7].

We took rough measurements of the to-scale

model Tribble that we own and we assumed it was spherical for simplicity. We found a diameter of 18 cm, making the surface area, A, 0.1 m^2, and the thickness of a Tribbles fur, d, is 1 cm. The equation [8] to work out the thermal energy released by one Tribble after time dt is:

$$dQ = \frac{\kappa A \Delta T}{d} dt \tag{2}$$

with $\Delta T = T_r - T_e$, where T_e is the temperature of the Enterprise (21 °C). We combined and integrated equations 1 and 2 to obtain the total energy produced by the Tribbles given in equation 3,

$$Q_{TOT} = \frac{\kappa A \Delta T}{d \ln(11)} t_r (11^{t/t_r} - 1) \tag{3}$$

We use $t = 3$ days and we get a total energy output of 4.0×10^{14} J. As before, this can be seen graphically in Figure 2.

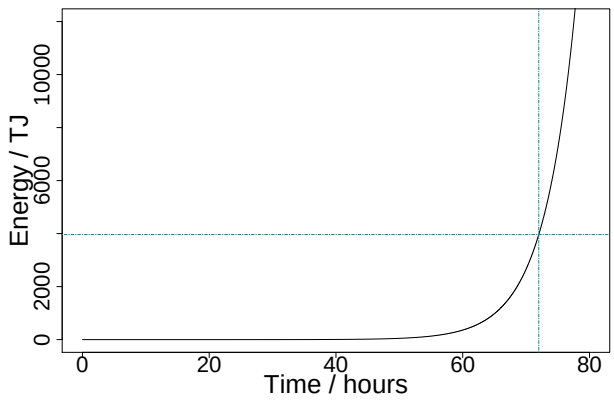

Figure 2: The energy that Tribbles produce as their population grows over time

As the Tribbles produce such a high amount of energy, we decided to see how long it would take them to produce the same amount of energy as the warp drive of the USS Enterprise NCC-1701-D (the ship in the Next Generation Series) would in 1 second. The warp engine generates a power of 12.75×10^{18} W [9]. Hence, by rearranging equation 3, we found that it would take the Tribbles 5.16 days to power the warp drive for 1 second.

Conclusion

We conclude that Tribbles' exponential population growth yields an exponential increase in the energy produced by thermal transfer. This is to due the difference in the Tribble's internal energy and its surroundings. From our research, we learnt that extremely large amounts of energy can be produced due to the rapid population growth over a short amount of time. Though our paper focuses on a fictional scenario, further research can be done to understand what effects Tribbles could have in the real world.

References

[1] `http://www.startrek.com/database_article/tribble` [Accessed 7 November 2018]

[2] `http://memory-alpha.wikia.com/wiki/The_Trouble_with_Tribbles_(episode)` [Accessed 7 November 2018]

[3] `http://mentalfloss.com/article/68741/how-do-star-trek-stardates-work` [Accessed 7 November 2018]

[4] Star Trek The Original Series, (1967), S2Ep15. [TV programme] NBC.

[5] `http://memory-alpha.wikia.com/wiki/Tribble` [Accessed 7 November 2018]

[6] `http://rabbitresource.org/body-temp/` [Accessed 7 November 2018]

[7] `https://thermtest.com/applications/fur-thermal-conductivity-hfm` [Accessed 7 November 2018]

[8] Tipler, P. and Mosca, G. (2008). Physics for scientists and engineers. New York: Freeman.

[9] Star Trek The Next Generation, (1992), S6Ep6. [TV programme] NBC.