Journal of Physics Special Topics
An undergraduate physics journal

P4_4 Lord Farquaad's Little Problem

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December 14, 2020

Abstract

The film *Shrek* introduces the diminutive human called Lord Farquaad as the antagonist to the title character of Shrek, who is an ogre. A solution to Lord Farquaad's height problems is considered using special relativistic effects. Using Shrek's height as a basis, we found that Lord Farquaad would need to accelerate Shrek to a velocity of $0.75c$ to reduce Shrek's height to his own, we then consider the pitfalls associated with this speed such as Shrek being blue-shifted outside of the visible spectrum.

Introduction

In the 2001 Dreamworks film *Shrek*, the audience are introduced to the title character Shrek, who is an ogre. This fact means that Shrek, at 206cm [1], is taller then the average human, this highly contrasts with the main antagonist of the film, Lord Farquaad, who only stands at a height of 137cm [2]. This being much smaller then the average adult male height of 175cm [3]. The film also suggests that Farquaad wishes to be seen as taller then he really is due to his use of stilts and stools. This has led to the idea of reversing the process, instead of making him taller, he could utilise certain effects of special relativity in order to change the apparent size of others, such as Shrek.

Theory

For this we set up a situation in which Lord Farquaad accelerates Shrek, uniformly along his body, while he is orientated on his side. Using the concept of length contraction, equation (1) [4], we can calculate the velocity at which Shrek would have to be propelled in order for him to appear as the same height as Lord Farquaad.

$$L = L_0\sqrt{1 - \frac{v^2}{c^2}}, \tag{1}$$

where L is the apparent length, L_0 is the length in the rest frame, v is the required velocity and c is the speed of light in vacuum. Equation (1) can be rearranged for v and calculated using Shrek's height for L_0 and Lord Farquaad's height for L.

While this would be a novel way for Lord Farquaad to resolve the difference between him and Shrek, there would be serious problems to consider. The first problem would be the energy needed to reach the relativistic velocity, the total energy can be calculated using equation (2) [4],

$$E = \frac{m_0c^2}{\sqrt{1 - \frac{v^2}{c^2}}}, \tag{2}$$

where m_0 is Shrek's rest mass. However, if Lord Farquaad was able to propel Shrek at such speeds then there would be the problem of the relativis-

tic Doppler effect. Given by equation (3) [4].

$$\frac{\lambda_{obs}}{\lambda_0} = \sqrt{\frac{1-\frac{v}{c}}{1+\frac{v}{c}}}, \tag{3}$$

where λ_{obs} is the observed wavelength in the rest frame and λ_0 is the wavelength emitted.

Results and Discussion

The calculation for the velocity gave a value of approximately $0.75c$. This is a significant speed to achieve and it is currently unknown how Lord Farquaad might achieve this, especially when we consider the energy requirements of this speed. The total energy approaching c can be shown as in figure (1). From this we can see that Shrek

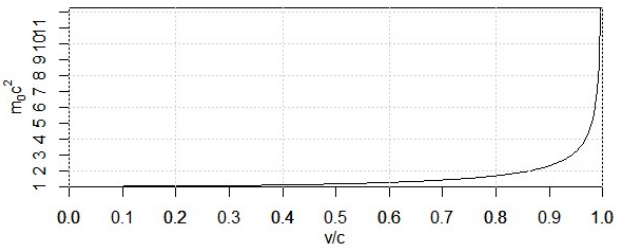

Figure 1: As $\frac{v}{c}$ approaches 1, the energy increases asymptotically. Produced using the R language and Rstudio software.

would have 1.5 times his rest mass energy of m_0c^2. At 161kg [1], this equates to a total energy of approximately 2.2×10^{19}J.

Since Lord Farquaad's aim would be to have Shrek appear as short as himself to those around him, it may be more concerning for him to consider whether, at this speed, anyone could see Shrek. This is due to the Doppler effects at relativistic speeds, where the wavelength of the emitted radiation is changed according to equation (3). The range of light visible to a human is 380nm to 700nm [5]. Inputting both extremes of the visible light range into equation (3) produces approximately 144nm and 266nm, the wavelength is reduced as we assumed that Shrek is travelling towards Lord Farquaad. This is outside of the previously stated range for visible light and so he would be blue-shifted out of anyone's visibility.

Conclusion

We have suggested a possible use of special relativistic effects for the fictional character Lord Farquaad to use instead of his more traditional methods. We calculated that he would need to accelerate Shrek to $0.75c$ in order to decrease Shrek's apparent height to be equal to his own. Such a large fraction of the speed of light means that other effects of special relativity would render the method impractical. The energy involved would be very high and, if he could come up with a method of propelling Shrek at this speed then, the Doppler shift would mean that no human would be able to see the actual decrease. To find this we assumed a situation where Lord Farquaad used some unknown method of propelling Shrek so that he was travelling on his side towards Lord Farquaad. Future research could examine ways in which this might be achieved in the Shrek Universe, as well as examining any further effects.

References

[1] `https://muc.fandom.com/wiki/Shrek` [Accessed 18 October 2020]

[2] `https://muc.fandom.com/wiki/Lord_Farquaad` [Accessed 18 October 2020]

[3] `https://web.archive.org/web/20160702012345/http://www.hscic.gov.uk/catalogue/PUB13218/HSE2012-Ch10-Adult-BMI.pdf` [Accessed 19 October 2020]

[4] P. A. Tipler, G. Mosca, *Physics For Scientists and Engineers with Modern Physics* (New York, 2008), vol. 6, Ch. 39

[5] `https://science.nasa.gov/ems/09_visiblelight#:~:text=The%20visible%20light%20spectrum%20is,from%20380%20to%20700%20nanometers.` [Accessed 19 October 2020]