Journal of Physics Special Topics
An undergraduate physics journal

P1_6 Red TARDIS

L. Reed, H. Mahon, P. Vanderpump and A. Fitzpatrick

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

December 2, 2022

Abstract

In this paper we investigated the relativistic effect the speed of the TARDIS from the the BBC television programme Doctor Who would have on its colour. We aimed to calculate the speed at which the TARDIS would have to travel in order to appear red rather than its iconic blue colour. We found that the TARDIS would have to be travelling at 1.0 x 10^8 m/s (2 s.f) away from an observer to appear red. We felt this was a reasonable speed for the spaceship to be travelling at due to it's advanced time and space travelling capabilities.

Introduction

In this paper we investigated the speed required for the TARDIS, from the TV show 'Doctor Who', to entirely change colour from the point of view of an observer. The TARDIS first appeared in Doctor Who in 1963, appearing as a 1960s style police box [1] and is the transport of the titular character, The Doctor. TARDIS stands for Time and Relative Dimensions in Space. As suggested by this name the space ship has the ability to travel in both time, likely using a series of wormholes, and space, the ability this paper will focus on. When stationary the TARDIS appears to the observer to be a shade of dark blue (Pantone 2955 C [2]), and in the TV show the TARDIS remains this shade of blue while in motion.

Theory

Using the relativistic Doppler effect we found the speed at which the TARDIS would change colour entirely to red to an observer on Earth as it is travelling away from Earth. The Doppler Effect can be defined as the apparent change in frequency of the light seen, due to the relative motion between the source of light and the observer [3].

It occurs with any wave phenomena, including visible light. This effect is often used in astronomy to measure the speed which stars and galaxies are moving towards or away from us, causing blueshift or redshift respectively. In this case, the TARDIS is moving away from the observer on Earth, so the wavelength is stretched out. This results in the TARDIS experiencing redshift.

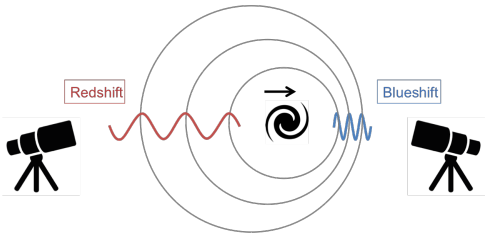

Figure 1: Diagram of an object experiencing the relativistic Doppler Effect [3]

Results

The Relativistic Doppler Effect can be expressed by,

$$\lambda_o = \lambda_s \sqrt{\frac{1 - v/c}{1 + v/c}}, \tag{1}$$

Rearranging this for velocity gives,

$$v = c \left(\frac{1 - (\lambda_s/\lambda_o)^2}{1 + (\lambda_s/\lambda_o)^2} \right), \tag{2}$$

where λ_s is the rest wavelength of the object, λ_o is the wavelength observed by a stationary observer, v is velocity of the object and c is the speed of light (taken to be 3.0 x 10^8 m/s (2 s.f) for our calculations).

The TARDIS's colour as of 2016 was confirmed to be Pantone 2955 C [2] . This is equivalent to a wavelength of 480 nm (2 s.f) [4] which will be taken as our source wavelength. The central wavelength of the red section of the spectrum is 690 nm (2 s.f) [5] and so we have chosen this to be our observed wavelength. Substituting these values into equation 2 yields a velocity of -1.0 x 10^8 m/s (2 s.f), where the negative sign indicates the object is moving away from the observer.

Discussion

In Doctor Who, the TARDIS does not ordinarily travel in the way we have discussed above, 'flying' through space. Instead, it often utilises an infinite series of wormholes and traverses the time vortex. There is little literature containing the exact speeds the TARDIS is capable of flying at when not travelling through the vortex. However due to its ability to travel through wormholes it can be assumed that the TARDIS is capable of travelling at half the speed of light. Future work could focus on exploring how wormholes affect the TARDIS's travel and finding at which speeds the TARDIS would have to travel to appear each colour on the visible light spectrum.

Conclusion

In this paper, we found that the TARDIS would have to be travelling at 1.0 x 10^8 m/s (2 s.f) away from an observer to appear entirely red, instead of its iconic blue colour. This is a result of the relativistic Doppler effect. This result relies on the TARDIS to be flying through space and not the time vortex.

References

[1] Dr Who: The Complete History Issue 57 (Ainsworth, 2018)

[2] https://www.inverse.com/article/38286-doctor-who-13th-doctor-tardis-season-11#:text=The%20Color,by%20BBC%20as%20Pantone%202955C [Accessed 21 October 2022].

[3] http://voyages.sdss.org/preflight/light/redshift/ [Accessed 24th October 2022]

[4] https://encycolorpedia.com/003865 [Accessed 8th November 2022]

[5] https://joovv.com/blogs/joovv-blog/red-light-wavelength [Accessed 24 October 2022].