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A3_4 Jamie Vardy: The Time Traveller

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Abstract

In the 2015/16 season, Jamie Vardy was crowned one of the fastest players in the Barclays Premier League. As Vardy approaches his top speed of 9.84 ms^{-1}, time slows down for him due to special relativity. In this paper, we find that relative to a stationary reference frame of a spectator, Vardy's time slows down by 0.34 $\pm$ 0.15 picoseconds (10^{-12}s) per match. We also calculated the number of Premier League seasons Vardy would have to play in order to have a time dilation that is more significant in the macroscopic world (seconds).

Introduction

In 1905, Albert Einstein developed the theory of special relativity. According to this theory, relative to a stationary reference frame, time slows down for a fast moving body [1].

This is also known as time dilation. This phenomenon is more effective on bodies travelling at relativistic speeds. However, the law is applicable to any non-relativistic moving reference frames. In this paper, we calculated the time dilation of Leicester City's striker and winger, Jamie Vardy.

In 2015, Vardy, with a top speed of 9.84 ms^{-1}, was crowned the fastest player in the Barclays Premier League [2]. On average, a football player sprints around 125 $\pm$ 25 times each lasting 5 $\pm$ 2 seconds [3]. We further calculated the total time an average football player sprints to be 625 $\pm$ 279.51 seconds. We assume that Vardy sprints for this amount of time in his reference frame. According to special relativity, in the stationary reference frame of the audience, Vardy's time would slow down.

Theory

Vardy achieved a top speed of 9.84 ms^{-1}. We call Vardy's reference frame S' and the audience's reference frame S. This is shown schematically in Figure 1.

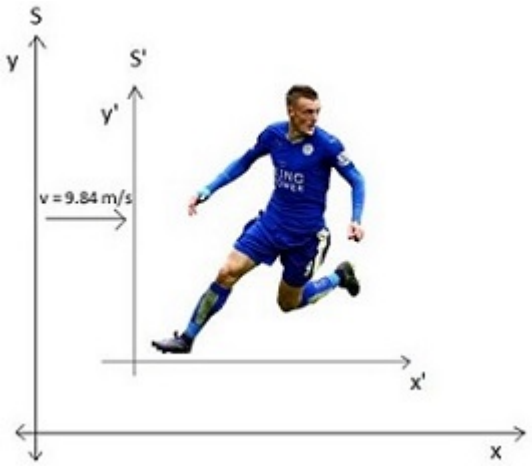

Figure 1: A schematic showing the reference frames of Vardy. S' is Vardy's reference frame in which he is stationary and S is the stationary reference frame of the audience.

In special relativity, the time of a moving object changes by a factor called the Lorentz factor which can be found using Equation 1.

$$\gamma = \frac{1}{\sqrt{1 - (\frac{v}{c})^2}} \tag{1}$$

where, γ is the Lorentz factor, v is Vardy's speed and c is the speed of light. Using $v = 9.84$ ms^{-1}, the Lorentz factor for Vardy was calculated and then we substituted this into the time dilation equation.

$$t = \gamma t' \tag{2}$$

where, t' is called proper time and is the time in Vardy's stationary frame, S' and t is the time in audience frame, S. Using the Lorentz factor calculated from Equation 1, the time in the S frame was calculated. The time dilation can be calculated by finding the difference between t and t'. This time difference was 0.34 ± 0.15 picoseconds. Making the assumption that on average this remains the same for all the matches and that Vardy plays the 38 matches in the Premier League, the total time dilation Vardy is subjected to per season comes out to be 12.92 ± 5.7 picoseconds. We assume a linear relation between the number of seasons and the cumulative time dilation, T.

$$T = kN \tag{3}$$

where N is the number of seasons and k is the proportionality constant. We use this equation to calculate the number of seasons Vardy must play in order to go through a time dilation that can be measured in the macroscopic world (seconds). This can be seen in Figure 2.

Discussion

For mathematical simplicity, we assume that Vardy accelerates to his top speed instantaneously and that Vardy runs at his top speed for 625 ± 279.51 seconds per match. However in real life, this would vary according to the nature of the game. It can be seen that Vardy suffers a time dilation of 0.34 ± 0.15 picoseconds.

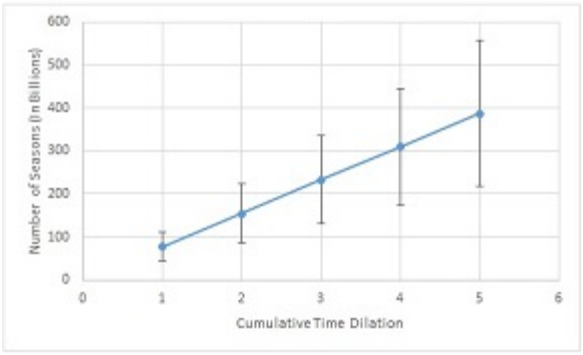

Figure 2: A plot showing the assumed linear relation between cumulative time dilation in seconds and number of season in billions.

This means that after a match, if measured in the audience's reference frame, the clock would be 0.34 ± 0.15 picoseconds ahead of Vardy's clock. As this is incredibly small in the macroscopic world, a high error of 0.15 picoseconds is expected. Laser light bursts and their interaction with matter are some of the shortest events that can be measured in a laboratory [4]. These usually range from femtoseconds (10^{-15}s) to attoseconds (10^{-18}s). However, in the macroscopic world, a picosecond is a negligible quantity. Therefore, we calculated the number of seasons Vardy would have to play in order to go through a time dilation of seconds. For example for a time dilation of 1 second, Vardy would have to play 77.4 billion seasons (Figure 2).

References

[1] Tipler and Mosca,'Physics for Scientists and Engineers', Chapter R, p.1

[2] https://goo.gl/4Q0DQI accessed on 01/11/2016

[3] http://article.sapub.org/10.5923.s.sports.201401.09.html accessed on 15/11/2016

[4] https://goo.gl/wNPPBn accessed on 02/11/2016