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P3_8 The Other Schumacher

J. Bettles, I. Clarke, M. Perry, N. Pilkington

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

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Abstract

This paper looked at how much younger than a hypothetical identical twin Michael Schumacher would be due to the relativistic effects of spending a large amount of time travelling at higher velocities. Using a simplified model of Schumacher's illustrious career, it was found that he would be 21.8 nanoseconds younger than his twin.

Introduction

Einstein's special theory of relativity states that if two clocks are moving relative to each other, an observer moving with one clock will see the other clock ticking slower. The twin paradox is a thought experiment in which a twin makes a journey into space in a high-speed rocket and returns home to find he has aged less than his identical twin who stayed on Earth. This result appears puzzling because each twin, from their own reference frame, sees the other twin as travelling; so according to a naive application of time dilation, each should paradoxically find the other to have aged more slowly. In fact, the result is not a paradox since the ship undergoes acceleration to turn around so the journeys are asymmetrical.

In Michael Schumacher's career, he has finished 225 races [1]. A single race in formula one should add up to a distance of approximately 305km [2]. This equates to a total distance raced *d* of 68,625km.

For the purposes of this paper, it was assumed that each race was a straight line and that in each race Schumacher was able to accelerate instantaneously to his maximum velocity, which then remained constant throughout the race. This velocity was estimated by dividing the distance of a race (305km) by the average time over all of Schumacher's 91 wins [3]. The average time was calculated as 1:34:04.301 which equates to 5344.301s. This gave a velocity *v* of 57.07m/s, or 1.904×10^{-7} times the speed of light *c*.

To calculate the total age difference between Schumacher and his twin from all the races, we modelled his career as one continuous race going half the total distance in one direction; turning round and returning to the starting point.

Theory

Schumacher's hypothetical twin stayed stationary relative to the Earth throughout the race, so measured the total time for the race as $t = d/v =$ 1.202×10^{6}s, or 334.15 hours.

The formula for determining time dilation in special relativity is

$$\Delta t' = \gamma \Delta t, \tag{1}$$

where Δt is the proper time, i.e. the time interval between two co-local events for an observer in some inertial frame, $\Delta t'$ is the time interval between those same events, as measured by another observer moving with velocity *v* with respect to the former observer, and γ is the Lorentz factor, given by

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}. \tag{2}$$

Having measured Δt and knowing *v*, the twin could calculate the time that Schumacher would measure from the moving reference frame of the formula 1 car for the stationary twin during the race using equation (1). The difference in ages of the twins was then found by calculating *Δt′* - *Δt*, which was found to be 2.18×10^{-8}s. So after his career long race, Michael Schumacher was 21.8 nanoseconds younger than his identical twin.

To check this, the time was calculated again from Michael's point of view. In his reference frame, the track was moving with a velocity *v*. Special relativity states that the track would contract by an amount given by equation (3),

$$L' = \frac{L}{\gamma}, \tag{3}$$

where *L'* is the length observed by an observer in relative motion (the length of the track from Schumacher's point of view), and *L* is the proper length as measured in the track' s rest frame. So the length of the track in Schumacher's reference frame was 1.24×10^{-6}m shorter than in the twin's reference frame.

Using the contracted length to calculate the total race time at velocity *v*, the difference from the time measured by the twin was again found to see how much older the twin would be from Michael's perspective. The time taken to complete the race in the reference frame of the race car was found to be 2.18×10^{-8}s less than that measured by the twin. So in both cases, each observer confirmed that Michael Schumacher would be 21.8 nanoseconds younger than his twin.

Conclusion

A simple model was created for Michael Schumacher's career. We assumed that he was able to accelerate instantaneously to maximum velocity. This velocity estimated by looking at the times of all his 91 wins. To find the total age difference over his whole career, it was modelled as one continuous race; half the distance in a straight line in one direction, then the rest of the way in a straight line back to the starting point.

It was found that after spending a large portion of time travelling at higher than average velocities, Michael Schumacher would be 21.8 nanoseconds younger than his twin. This result was the same when calculated for both the twin observing in a reference frame at rest with respect to the track and also for Schumacher observing in a reference frame at rest with respect to the car.

Although the model used was greatly simplified compared to reality, because the speeds involved are much smaller than the speed of light the results would not be greatly affected by using a more complex model.

References

[1] *Michael Schumacher races*, 4mula1, 2008, accessed 11/11/11.
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