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A1_2 One Punch Man - Speed Test

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Abstract

Saitama, the hero of "One Punch Man" has seemingly immeasurable strength and speed. We attempt to quantify his speed from a scene in which he jumps from the Moon to the Earth. We calculated Saitama's velocity during this action as 6.7% of the speed of light, and that his collision with the Earth would create a crater of 570m in diameter. This is comparable to a Near-Earth Object impact of 8 on the Torino Scale.

Introduction

Saitama, the protagonist of the parody series "One Punch Man", is a hero with seemingly immeasurable strength and speed, and unknown limits [1]. In "The Strongest Hero", Lord Boros, tries to defeat Saitama by punching him to the Moon. Saitama, unfazed by this, takes a look around before jumping back to Earth. From this action, we can find the velocity at which Saitama travels, the energy expended to make this jump and the crater size that he would create on the Earth's surface. This will be compared to previous large scale destructive events.

Theory

In the reference frame of the observer, Saitama completes the Moon-Earth jump in 19 seconds [2]. Assuming he jumps the average Earth-Moon distance, he travels 384,400km. Using this, we will calculate his velocity. Since his velocity is enormously high, relativistic effects must be considered. To find the Lorentz factor, γ, we use the equation

$$\gamma = \frac{1}{\sqrt{(1-\beta^2)}}, \quad (1)$$

where $\beta = v/c$ and v is Saitama's velocity and c is the speed of light. We can calculate the relativistic kinetic energy, E, to make this jump,

$$E = (\gamma - 1)m_0c^2, \quad (2)$$

where m_0 is the proper mass of Saitama.

Assuming conservation of kinetic energy, this is also the energy Saitama has as he lands on the Earth. To give this energy a scale, we can express it in the equivalent megatons of TNT, a unit of energy used in the comparison of the destructiveness of events. 1 megaton of TNT is equivalent to 4.184 petajoules [3]. It can also be assessed using the Torino Scale [4], which categorises impacts by Near-Earth Objects.

We can calculate the diameter of the impact crater Saitama's impact would create by considering the equation for the diameter, D, of a meteorite impact crater [5]

$$D \approx 2\rho_i^{0.11}\rho_t^{-0.33}g_t^{-0.22}R^{0.12}E^{0.22}(sin\theta)^{0.5}, \quad (3)$$

where ρ_i is the density of the impactor, a human of density 1062kgm^{-3} [6] , ρ_t is the density of the target, where the density of Earth's crust is 2700kgm^{-3} [7] , g_t is the gravitational acceleration of the target, in this case at Earth's surface, 9.81ms^{-2}, R is the radius of the impactor, assumed to be 0.2m for a human, E is the kinetic energy of the impactor, and θ is the angle of the impactor, assumed to be 90°.

Results

To travel the distance from the Moon to the Earth within the time shown in the anime, Saitama must be travelling at a velocity of $2.02\text{x}10^7\text{ms}^{-1}$. At such a velocity, he would experience serious effects from high speed atmospheric re-entry, however we will not calculate this at this stage. Since this is 6.7% of the speed of light, it can be assumed that Saitama will experience some relativistic effects.

To calculate the Lorentz factor associated with this speed, equation (1) was used in conjunction with the calculated velocity. This gives β to be 0.067 and a Lorentz factor, γ, of 1.002. To calculate the relativistic kinetic energy, equation (2) was used. Using m_0=70kg [1], we find that E is $1.44\text{x}10^{16}$J.

The energy associated with Saitama's jump is equivalent to 3.44 megatons of TNT. His energy is comparable to approximately 215 "Little Boy" nuclear bombs dropped on Hiroshima or 0.07 Tsar bombs, the most powerful nuclear bomb ever created [2].

On the Torino Scale, Saitama's impact with the Earth from his jump could fall within group 8, since his collision with Earth is certain. NASA states that group 8 impacts are "capable of causing localized destruction for an impact over land or possibly a tsunami if close offshore" [3]. By comparison, the 1908 Tunguska meteroite impact event was rated 8, and the 2013 Chelyabinsk meteorite impact event was rated 0 [8].

From equation (3) we calculated that Saitama's impact with Earth would create a crater of 570m in diameter.

For comparison, the Chicxulub crater, created by the asteroid which caused the mass extinction around 66 million years ago, is more than 180km in diameter [9]. Although Saitama's impact would cause widespread destruction, such as flattening a city, it would be nowhere near as catastrophic as this impact event.

Discussion

We made many assumptions in these calculations, including that Saitama would not die as a result of the high velocity travel through space and the Earth's atmosphere, being in a vacuum, and through the impact with the Earth. We also assumed that all kinetic energy was conserved and that Saitama had a head-on impact with Earth.

Whilst we considered the effect of heating and drag on the hero during atmospheric re-entry, we recommend that further work is done to fully quantify this and investigate the material his hero suit would have to be made of to survive re-entry.

Saitama's jump back to Earth would have truly disastrous consequences for any area he landed on. From this work, we can give a number to Saitama's supposedly immeasurable speed, although his true power limit may be vastly greater, if he even has a limit at all.

References

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