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P4_5 Can You Catch 'em All?

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Abstract

The storage process of Pokémon is investigated using a system based on that shown in the animé. It is found that only Pokémon under 6.5kg could be contained, however the temperature would quickly break the Pokéball.

Introduction

The popular 90's animé Pokémon (and preceding games) revolved around people called trainers who would catch and train wild Pokémon, a fictional animal species, for battle with other trainers. The Pokémon were captured with devices called Pokéballs, roughly 10cm wide spheres that capture and store a Pokémon inside [1].

In the animé the process of storing and recalling a Pokémon from a Pokéball is visualised by converting the Pokémon into a beam of red light that is sent into or ejected from the ball, as shown in Fig. 1. In this paper the possible physics behind this process is investigated.

Figure 1. A Pokémon being captured in a Pokéballs as depicted in the animé [1].

Theory

In the original games there are 151 possible Pokémon to collect; however in subsequent games more were added and there are currently 649 different Pokémon. To work out if it's possible to contain a Pokémon in energy form a Pokémon's rest-mass energy will be calculated. As all Pokémon can be captured by a standard Pokéball I will use the heaviest Pokémon in my calculations to establish an upper limit. The heaviest recorded Pokémon is Groudon with a mass of 950kg [2]. We can use this to work out its rest-mass energy via

$$E = mc^2. \quad (1)$$

As shown in Fig. 1 the Pokémon is converted into what is assumed to be standard red light comprising 700nm photons. The amount of energy in a photon can be calculated from

$$E = \frac{hc}{\lambda}, \quad (2)$$

so the number of photons our Pokémon will be converted into can be calculated by dividing Eq. 1 by Eq. 2. In order to contain the Pokémon without any loss of energy or information we will assume the insides of the Pokéball are perfectly reflective. Each photon will have a momentum given by h/λ so the momentum transferred to the Pokéball will be twice this (because of perfect reflection) times by the total number of photons. This comes out as

$$\frac{mc^2\lambda}{hc} \times \frac{2h}{\lambda} = 2mc. \quad (3)$$

Putting in the mass of Groudon we get a momentum of 5.7×10^{11} kg m s^{-1}. This means the amount of force every second is 5.7×10^{11} N.

If we assume a Pokéball is a 10cm diameter sphere of negligible thickness we find that the surface area on the inside of the Pokéball is 0.03m^2. From this we can calculate the pressure on the inside of the Pokéball which comes out as 1.9×10^{13} Pa. The largest tensile strength is that of graphene which has a value of 1.3×10^{11} Pa [3]; this value is not

nearly large enough to contain the amount of momentum that would be imparted by all the photons. We can reverse Eqn. 3 and work out the largest Pokémon that can be contained by a graphene Pokéball which turns out to be 6.5 kg. Of the 649 Pokémon only 115 have a mass of 6.5 kg or lower.

So far the temperature of the energy has been neglected. Taking the 6.5 kg limit the temperature equivalent of the rest-mass energy would be 4.24×10^{40} K. By assuming the interior of the Pokéball is perfectly reflective, and containing only the photons of the Pokémon, none of the energy would be absorbed by the Pokéball and so the temperature would be contained. Perfect reflectivity however is physically impossible [4] meaning some of the energy would leak to the graphene quickly causing it to break open releasing the Pokémon's energy: the same amount of energy as two Tsar bombs, the largest nuclear weapon ever detonated [5].

Conclusion

Storing a Pokémon by converting it to photons is highly impractical. Most Pokémon have masses that would produce a force on the Pokéball greater than the tensile strength of any known material, and as it is impossible to keep the Pokéball from absorbing some of the energy it would quickly fail, releasing an amazingly destructive amount of energy.

References

[1] *Pokémon, I Choose You: Pokémon The Original Series*, 1997, television program, Pioneer Entertainment.

[2] http://www.pokemon.com/us/pokedex/ Viewed on 10/02/2011 at 11:05

[3] Lee, C. *et al,* 2008, *Measurement of the Elastic Properties and Intrinsic Strength of Monolayer Graphene* Science **321** (5887): 385

[4] Dr S. Gurman, University of Leicester (private communication).

[5]http://www.nuclearweaponarchive.org/Russia/TsarBomba.html Viewed on 15/02/2011 at 12:29