Journal of Interdisciplinary Science Topics

How Much Energy Can Superman Release During a Super Flare?

Osarenkhoe Uwuigbe
The Centre for Interdisciplinary Science, University of Leicester
13/03/2015

Abstract
This paper investigates how much solar energy Superman can store and subsequently release in the form of his new power, a Super Flare. Modelling Superman's cells as tiny solar panels it was calculated that 7.07 x 10^5 J of energy is stored every second by Superman. This figure was adjusted to represent an efficiency which reflected Superman's abilities; a new value of 3.86 x 10^{10} J every second was produced. Assuming that Superman can release the energy as fast as he stores it, then Superman releases 3.86 x 10^{10} J every second during a Super Flare which after an hour would have released more energy than an atomic bomb.

Introduction
Superman is one of the most iconic superheroes within DC Comics fictional universe. He is the last son of his home planet Krypton who was sent, as a baby, to Earth to escape his dying planet [1]. Due to a difference in the type of Star which Earth orbits when compared to Krypton, Superman has a variety of powers on Earth which are fuelled by the solar radiation his body absorbs from the Sun.

In the recent reboot of this universe, called the *New 52*, Superman (also known by his alias Clark Kent) discovers a new power during a fight with Ulysses (a villain within DC Comics). It is found that Superman's heat vision is a precursor to another ability he possessed. Heat vision is the release of Superman's stored solar energy in a controlled beam through his eyes however, the new ability allows Superman to release all the solar energy in every one of his cells (see figure 1) [2]. This creates a solar flare with incredible destructive power; the term "Super Flare" was coined by Batman (another DC Comics superhero) to label this new power. In order to discuss destructive power of the Super Flare this paper will calculate how much energy is stored within Superman's body.

Modelling Superman
For simplicity, Superman's body will be modelled to be human-like and his solar absorption mechanism will be modelled so that each of Superman's cells act as tiny solar panels which are all exposed to the Sun


Figure 1 – A comic illustration of Superman's new power, the Super Flare [2].

and are situated perpendicular to the Sun at sea level. Therefore the power within a single cell is equal to:

$$P_{cell} = I_{solar} \times \varepsilon \times A_{cell} \qquad (1)$$

where P_{cell} is power stored in the cell, I_{solar} is solar irradiation at the solar panel, ε is efficiency of the cell as a solar panel and A_{cell} is the average surface area of a human cell.

To find the total power stored within Superman's whole body, P_{cell} is multiplied by the number of cells within the human body which is 3.72 x 10^{13} [3]. This is an estimated value and will change between people of different sizes and thus cell numbers however the magnitude will remain the same making it an appropriate figure to use in the following calculations:

$$P_{body} = P_{cell} \times 3.72 \times 10^{13} \qquad (2)$$

where P_{body} is the power stored in the whole body.

The solar irradiation reaching the Earth's surface and thus experienced by the solar panel is 1kWm^{-2} [4]. The typical efficiency of solar panels is about 12% [4]. As the human body has variety of different cell types the area used in this model will be the area of one of the body's most abundant cells, blood cells. Blood has a diameter of 8μm [5]. Therefore if we assume the blood cells are completely circular, the surface area, A_{cell}, is equal to:

$$A_{cell} = \pi\left(\frac{8 \times 10^{-6}}{2}\right)^2 = 5.03\pi \times 10^{-11} m^2$$

From these values it is possible to calculate P_{cell}:

$$P_{cell} = 1000 \times 0.12 \times 5.03\pi \times 10^{-11}$$
$$P_{cell} = 1.90 \times 10^{-8} W$$

This value can now be substituted into equation [2] to find P_{body}:

$$P_{body} = 1.90 \times 10^{-8} \times 3.72 \times 10^{13}$$
$$P_{body} = 7.07 \times 10^{5} W$$

Based on this model, the solar energy Superman could possibly store per second is 707000 J (as watts is equal to joules per second). Comparing this energy with the energy released during an actual solar flare from the Sun (10^{27} ergs s^{-1} = 10^{20} Js^{-1} [6]), it can be seen that the calculated figure is 10^{15} orders of magnitude out. However, a previous paper has calculated that Superman disobeys the law of conservation of energy and operates at solar cell efficiency of not 12% but 656000% [7]. Taking this efficiency into account P_{body} is then:

$$P_{body} = 1000 \times 6560 \times 5.03\pi \times 10^{-11} \times 3.72 \times 10^{13}$$
$$P_{body} = 3.86 \times 10^{10} W$$

Adjusting for Superman's efficiency when modelled as a solar cell, the solar energy Superman could store per second is 3.86 x 10^{10} J which although is magnitude of 10^{10} away from an actual solar flare, it is still an immense about of energy to be able to store per second. Assuming Superman can release the energy as quickly as he stores it, to produce a more powerful blast all he would need to do is absorb solar energy for a longer period of time. The limits of how much solar energy Superman can store has never been stated so theoretically Superman is able to perform a Super Flare of any magnitude and thus is not only capable of releasing energy comparable to an actual solar flare but is also capable of releasing energy much greater than that of a solar flare.

To put Superman's new power into perspective. An hour of absorbing solar energy will store more energy than the Little Boy Atomic Bomb which was dropped on Hiroshima in World War 2:

$$E_{stored} = 3600 \times 3.86 \times 10^{10} = 1.39 \times 10^{14} J$$

Limitations

A limitation to this model is the idea of spreading Superman's cells across so they act like a giant solar panel, in practice only a small portion of the cells which make up his body will be exposed to sunlight as Superman is a complex organism. This causes the value for the energy stored by Superman to be a gross overestimate. However it could be argued that although Superman's inner cells are not exposed to sunlight, he is an alien being and so it is not unreasonable to believe that he may possess a highly optimised transport system which transmits solar energy stored at the surface of his body to the innermost parts of his body.

For simplicity, only the area of blood cells were used in this model, however more accurate figures could be produced if P_{cell} was found for all the different cell types, multiplied by their respective proportions of the body they account for, then added together.

Furthermore the energy released from Superman during a Super Flare should only be released by the surface cells and not the inner cells to minimise damage to himself. Therefore the energy stored should be higher than the energy released.

Conclusion

Superman's new ability the Super Flare has incredible destructive power. At the efficiency of a typical solar panel, Superman can release 7.07 x 10^{5} Js^{-1} whereas at a previously calculated efficiency for Superman , he can release 3.86 x 10^{10} Js^{-1} which after an hour Superman would have released more energy than an atomic bomb.

References

[1] DC Comics (2015). *Superman*. Available at: http://www.dccomics.com/characters/superman [Accessed 06/02/2015]

[2] IGN (2015). *Superman's New Super Flare Power and Costume Revealed.* Available at: http://uk.ign.com/articles/2015/02/04/supermans-new-super-flare-power-and-costume-revealed [Accessed 06/02/2015]

[3] Bianconi, E., Piovesan, A., Facchin, F., Beraudi, A., Casadei, R., Frabetti, F., Vitale, L., Pelleri, MC., Tassani, S., Piva, F., Perez-Amodio, S., Strippoli, P. & Canaider, S. (2013) *An estimation of the number of cells in the human body.* Annals of Human Biology. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23829164 [Accessed 6th February 2015]

[4] Tipler, P.A., Mosca, G. (2008) *Physics for Scientist and Engineers. 6th ed*. W.H. Freeman. pp 237

[5] Wadsworth Center, (n.d.). *Through the Microscope: Blood Cells – Life's Blood.* Available at: http://www.wadsworth.org/chemheme/heme/microscope/rbc.htm [Accessed 06/02/2015]

[6] Holman, G. (n.d.). Available at: http://hesperia.gsfc.nasa.gov/sftheory/frame1.htm [Accessed 06/02/2015]

[7] Szczykulska, M., Watson, J.J., Garratt-Smithson, L. & Muir, A.W. (2013) *P4_4 The Solar Cell Efficiency of Superman.* Available at: http://physics.le.ac.uk/journals/index.php/pst/article/view/647/472 [Accessed 06/02/2015]