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A4_6 Dark Side Light

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Abstract

We compare the incident power on the surface of Alderaan from the Death Star and the Sith 'supernova' ability from *Star Wars*. We find that overall, the Death Star is more powerful than the supernova and transporting the supernova close enough to overcome this uses more than the supernova's power output.

Introduction

In the *Star Wars* films, the Sith Lords Darth Sidious and Darth Vader repeatedly try to destroy planets using superweapon 'Death Stars'. These take an extraordinary amount of resources to build and have vulnerabilities resulting in their frequent destruction by rebels. The *Tales of the Jedi* comic books, however, show that Sith were capable of moving stars and causing supernovae roughly 4,000 years beforehand[1] using The Force.

In light of this power, we investigate the relative energy it and the Death Star deal to the planet Alderaan — a planet destroyed by the first death star in the films. To do so, we use methods from the paper *That's No Moon*[2] and information about supernovae to calculate several things: the Death Star's incident power; the incident power of the sun and supernova as a function of distance; and the power needed to move the sun/supernova closer.

Theory

Death Star

From *That's No Moon*, we have the equation

for binding energy:

$$E_b = \frac{3GM_p^2}{5R_p}, \quad (1)$$

where G is the gravitational constant, $R_p = 6250$ km [3] is the radius of the planet Alderaan and $M_p = \rho V = 5.64 \times 10^{24}$ kg is the mass of the planet (assumed an Earth-like uniform sphere of density ρ and volume V). Substituting these values in, the binding energy — and thus the Death Star's incident energy — equals 2.04×10^{32} J. As this takes place over approximately 0.25 s[4], the incident power is 8.16×10^{32} W.

Sun

As Alderaan is an Earth-like planet[3], with similar living conditions, we assume that it orbits a star almost identical to our own, at a similar distance (although we know the orbital period in local days to calculate this, we do not know the length of a local day). The power produced by our Sun $P_{sun} = 3.8 \times 10^{26}$ W[5], so we use this for Alderaan's sun.

Supernova

We assume that the nature of the Sith ability is to create or act as the required local conditions for a supernova. We will only consider the power

released by the 'smallest' possible explosion, a Type Ia supernova. This power value $P_{sup} = 1.92 \times 10^{36}$ W[6].

Transport

The power required to move the star is simply a matter of calculating the following:

$$P_{trans} = \frac{M_{sun}v^2}{t} = \frac{M_{sun}c^3}{R_{orbit}}, \quad (2)$$

where we assume that the Sith are capable of moving the star at the speed of light. $M_{sun} = 1.99 \times 10^{30}$ kg and $R_{orbit} = 150 \times 10^9$ m[7] (we vary the distance up to this value).

We calculate the power incident on Alderaan by using the inverse square law to find intensity (for both sun and supernova scenarios), then multiplying by half the surface area of the planet. Since both use the surface area of a sphere, the terms cancel to:

$$P_i = \frac{PR_p^2}{R_{orbit}^2} \quad (3)$$

Discussion

We model this situation and achieve the following graph:

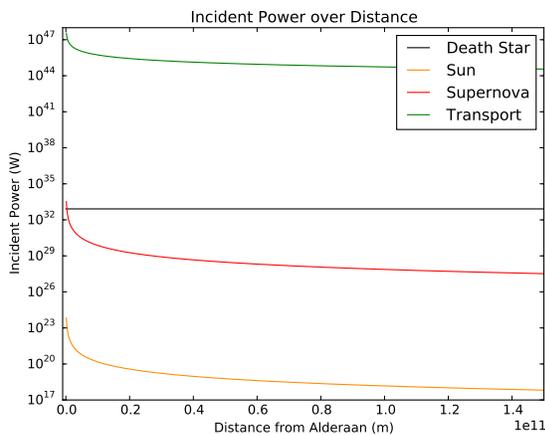


Figure 1: Comparison of the incident power from the Death Star, sun and supernova over distance. The Death Star remains fixed in the position from the film (displayed only for comparison) and the 'transport' power required to move the sun is shown in green.

From this, we can see that for most cases, the Death Star is the most powerful weapon to use against Alderaan. Only when the sun is moved very near to the planet will the power of the supernova exceed that of the Death Star — and if work must be done to move the star there, this power will be effectively cancelled out.

Conclusion

The results we obtained indicate that using the Death Star to destroy Alderaan is the most viable approach. It is likely that the radiation from a supernova explosion would kill all life in the solar system anyway (a possibility that could be investigated further), but this would not have the 'shock and awe' factor of complete planetary destruction.

We still imagine that using the supernova ability as a Death Star alternative would save Darth Sidious and Darth Vader time, resources and employees' lives. The fact the comics suggest a special ship is needed to use the ability[1] would also make it a smaller, more defensible target than the Death Star.

References

- [1] Anderson, Carrasco and Heike, *Tales of the Jedi: The Sith War #4* (p.21-24) and *The Fall of the Sith Empire #5* (p.18, 19) (Marvel, New York, 1995-97).
- [2] D Boulderstone, C Meredith and S Clapton, *A2.8 That's No Moon*, PST 9, (2011).
- [3] <http://starwars.wikia.com/wiki/Alderaan/Legends> accessed on 31/10/2016.
- [4] https://www.youtube.com/watch?v=_onwa25RuEo accessed on 31/10/2016.
- [5] http://helios.gsfc.nasa.gov/qa_sun.html#power accessed on 31/10/2016.
- [6] https://en.wikipedia.org/wiki/Type_Ia_supernova accessed on 08/11/2016.
- [7] <http://nssdc.gsfc.nasa.gov/planetary/planetfact.html> accessed on 31/10/2016.