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A1 7 Blinded at the Angel Dispatch Centre

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Abstract

In this study, the show Wizards of Waverly Place is reviewed. The impact of the bright light emitted from the Guardian Angel Dispatch Centre is considered, and it is determined that without eye protection, the photochemical limit is exceeded, likely causing retinal damage to the characters.

Introduction

This paper investigates the Guardian Angel Dispatch Centre (GADC) portrayed in Season 4, Episode 9 of Wizards of Waverly Place titled “Wizards & Angels” [1]. The entrance into the GADC is a bright, glowing light. Tina, a guardian angel in training, suggests to Alex that the best approach to entering the GADC is to “squint and run”, which Alex replies with “no, I don’t run.” as she places sunglasses on her face and saunters through the entrance.

This paper investigates the impact on the retina that the holy light at the GADC’s entrance has on both Alex and Tina’s eyes. To allow us to investigate if the longer exposure time of the light, Alex is exposed to has adverse effects, or whether the sunglasses blocked enough light to allow Alex’s vision to go unimpeded.

Theory

To determine the retinal damage, the irradiance on the retina, I_{retina} , must be considered initially. Where I_{retina} is defined as:

$$I_{\text{retina}} = I_{\text{cornea}} \tau \frac{A_{\text{pupil}}}{A_{\text{retina}}} \quad (1)$$

where I_{cornea} is the corneal irradiance, τ is the transmittance, A_{pupil} is the area of the charac-

ter’s pupil, and A_{retina} is the area of the character’s retina [2]. The corneal irradiance in this scenario would be equivalent to the irradiance of the light emitting from the entryway of the GADC. To determine how damaging the light is to the character’s eyes, the energy per unit area of the retina, H_{retina} , must be calculated. The energy per unit area in terms of time, t , is given by:

$$H_{\text{retina}} = I_{\text{retina}} t \quad (2)$$

where permanent retinal injury will occur if

$$H_{\text{retina}} \geq H_{\text{threshold}}$$

where $H_{\text{threshold}}$ is the threshold energy per unit area. The threshold value is dependent on the mechanism that damages the retina. In this paper, we will review both photochemical damage and thermal damage. Photochemical damage can be defined as retinal injury due to absorption of UV photons, triggering chemical reactions in retinal pigments. And thermal damage can be defined as retinal injury caused by heating due to intense optical power [3].

Results

Initially, considering Tina, who wears no protection from the bright light ($\tau = 1$), but runs

through the entrance towards the GADC. We assume that the diameter of Tina’s pupil is 3 mm due to its contraction from the bright light [4], and that she runs through the light for approximately 4 s. It is also assumed that both girls have a retina of area 1090 mm² [5] and that their pupils are circular. If we consider the bright light to have an equivalent irradiance to the Sun, the corneal irradiance can be assumed to be 1360 W m⁻² [6]. Equation 1 gives a value of 35.2 W m⁻² for Tina’s retinal irradiance, and substituting this value into Equation 2 suggests that Tina’s retina has an energy per unit area of 141 J m⁻².

Now, considering Alex, who walks through the entrance and we assume to wear sunglasses that offers a medium reduction of visual light with a mean transmittance of 30.5% [7]. We assume that Alex’s pupils have a diameter of 6 mm [4], this is due to the sunglasses being darker, her pupils will be more dilated than Tina, and that she takes 20 s to saunter into the GADC. Using Equation 1 gives her retinal irradiance to be 2.68 W m⁻², and substituting into Equation 2 gives her retina’s energy per unit area to be 53.6 J m⁻².

Discussion

To determine if either of the characters exceed the thermal threshold, the following equation is used:

$$H_{\text{threshold}} = 28 \times 10^4 \alpha^{-1} \Omega t \quad (3)$$

where α is the source size in radians and Ω is the solid angle. The source is assumed to fill both characters’ field of view ($\Omega = 2\pi$), when $\alpha \geq 100$ mrad the effective radiance limit is constant [2]. Utilising Equation 3, Tina’s thermal threshold is 7.04×10^7 J m⁻², and Alex’s thermal threshold is 3.52×10^8 J m⁻². Therefore, although both characters utilise different methods to enter the GADC, neither of them exceeds the thermal limit, suggesting neither character receives retinal injury due to heating.

The photochemical limit for both characters in this situation is 100 J m⁻² [2]. When considering the scenario where corneal irradiance is equiva-

lent to solar irradiance, Tina’s character exceeds the photochemical limit, as shown in Figure 1. Due to Tina’s character exceeding the photochemical limit, it is likely that at a minimum, she will experience eye fatigue and blurred vision for a few hours, and at an extreme level, a permanent minor loss of vision.

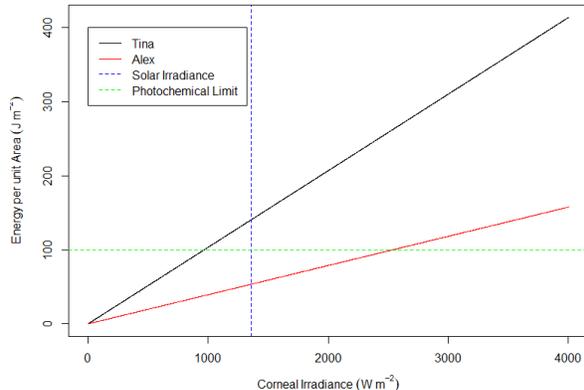


Figure 1: Graph of energy per unit area against corneal irradiance for the scenario.

According to Figure 1, Alex will only exceed the photochemical limit if the light that is emitted from the GADC has an irradiance of approximately 2550 W m⁻², which would likely cause similar symptoms to those described for Tina. However, at this level, Tina would likely experience more extreme symptoms and vision loss.

Conclusions

This paper investigates the show Wizards of Waverly Place, when the characters Alex and Tina enter the GADC, where the entryway is portrayed as a tunnel emitting a bright light. Both girls utilise different methods to enter the GADC, with Alex walking in while wearing sunglasses and Tina running in with no eye protection. It is determined that the energy per unit area on Tina’s retinas exceed the photochemical limit, but neither of the characters exceeds the thermal limit.

References

- [1] Greenwald, T. (writer) and Gonzalez, V. (director) 2011, Wizards vs. Angels, Wizards of Waverly Place, season 4, episode 9, Disney Channel (2011).
- [2] ICNIRP (International Commission on Non-Ionizing Radiation Protection), ICNIRP guidelines on limits of exposure to incoherent visible and infrared radiation, Health Physics, vol. 105, no. 1, pp. 74–96 (2013).
- [3] van Norren D, Vos JJ. Light damage to the retina: an historical approach. Eye (Lond). 30(2):169-72 (2016).
- [4] Spector RH. The Pupils. In: Walker HK, Hall WD, Hurst JW, editors. Clinical Methods: The History, Physical, and Laboratory Examinations. 3rd edition. Boston: Butterworths. Chapter 58 (1990).
- [5] Kolb H. Facts and Figures Concerning the Human Retina. In: Kolb H, Fernandez E, Jones B, et al., editors. Webvision: The Organization of the Retina and Visual System. Salt Lake City (UT): University of Utah Health Sciences Center (2007).
- [6] <https://earth.gsfc.nasa.gov/climate/projects/solar-irradiance/science>
[Accessed 3 November 2025]
- [7] <https://www.lip-sunglasses.com/what-is-visible-light-transmission-in>
[Accessed 2 November 2025]