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Investigating the Force Fields in the 75th Hunger Games

Nickolas Goncharenko & Katie Maloney
Honours Integrated Science Program, McMaster University
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Abstract
In the popular Hunger Games trilogy, young adults called tributes compete against each other in a televised battle to the death to become the victor. This paper will examine the force field that surrounds the arena where the games take place and is frequently shown throughout the books and movies. The health implications of interacting with the field and its physical feasibility are examined.

Introduction
The 75th Hunger Games takes place during the second novel in the trilogy by Suzanne Collins, Catching Fire, in a futuristic dystopia called Panem [1]. This country is the remains of North American and is divided into 12 districts that support the capital. The story continues with victors from the 74th Hunger Games, Katnsis Everdeen and Peeta Mellark who discover on their victory tour that they will be forced to return to the area to celebrate the 75th Hunger Games. During these games, it is mentioned by district 3 tributes, Beetee and Wiress that the force fields are electromagnetic. Observations throughout the trilogy confirm that the only force that can make these fields would be electromagnetic.

Health Hazards Associated with the Force Field
During the games, two tributes Blight and Peeta come into contact with the force field. Blight, a tribute from district 7 is the first to touch the force field. He is immediately thrown backward and his heart stops, resulting in his death. When Peeta comes into contact with the force field his heart also stops, but he is revived by another tribute preforming Cardiopulmonary resuscitation (CPR).

It is believed that Peeta experienced a phenomenon analogous to electric shock due to direct current (DC). Alternating current (AC) has a greater tendency to cause fibrillation, but DC is known to induce muscle tetanus and make the heart stand still [2]. The majority of electrical devices operate on DC current making it very likely that Blight and Peeta were shocked by direct current [3]. Another important factor to consider is a heart that has stopped is more likely to regain a normal heartbeat pattern after the shock than a fibrillating heart, which can continue to display a rapid and arrhythmic heartbeat after the victim is no longer in contact with the current [4].

When the direct current experiences resistance, it will generate heat, which can result in burns and is likely the culprit of the singed hair smell that was described by Katniss after Peeta touches the force field [2]. There are also differences in electrical resistance within the body that result in current travelling preferentially along blood vessels and nerves, making the heart the most susceptible to damage from electric shock. [2].

An important point of information, concerning the nature of the field is that both people who came into contact with the force field were thrown back. This is particularly interesting because a small amount of current can result in the victim being unable to break circuit or let go of the object that is providing the current [5]. At low voltages and currents of less that 600 V and 22 mA, respectively more than 99% of typical adults would not be able to let go of a conducting material due to muscle tetanus [4]. This usually does not occur with DC current because there is only a feeling of shock when the circuit is made or

broken. If the circuit is high voltage (>600 V) a person can be thrown from the point of contact within 100 milliseconds [4]. The accepted value for the level of current needed to sense pain is 10 mA and severe muscle contractions is at 100 mA, which also represents the threshold for electrocution [5]. This further proves that the shocks that the characters experience are due to DC current and was likely a high voltage circuit.

The Nature of the Force Field

It is both stated explicitly and implicitly that the force field in the Hunger Games could repel any material object. Though this would be possible if only incoming electromagnetic radiation could be reflected [7], most other objects would either be attracted due to an induced dipole effect or remain unaffected. Any repelling effect of the field would be over whelmed by this induced dipole effect.

Force Field Strength

To estimate the strength of the force field, data from Peeta's electrocution can be used to estimate charge density. A formula for the surface of the material creating the force field is:

$$\eta = \frac{It}{A}$$

Where η is the surface charge density, I the strength of the current supplying the electric field, *t* the time in contact with the charged surface, and *A* the surface area of contact. Given that in the previous analysis we assume a maximum current of 300 mA (the maximum current that can cause Peeta's symptoms without death) is received for 100 ms by a surface of 540 cm^2 (the average surface area of a hand) [8]. Based on these estimates the surface charge is 555.6 mC m^{-2}. To determine field strength we assume that any object (such as an arrow or a bullet) is small enough compared to the size of surface generating the field that we can assume features such as curvature or distance is irrelevant. Therefore the field generated by the charged surface is the same as an infinite plane of charge. Because of the size of the surface in our model the effect of magnetic field is negligible compared to the electric field (the size of the surface makes the current act like a static charge). The equation representing electric field strength in this model is:

$$E_{plane} = \frac{\eta}{2\varepsilon_o}$$

Where ε_o is the permittivity of free space. Given these parameters, the strength of the electric field is 3.1×10^{10} NC^{-1}. Maintaining an electric field of this strength is not practical as the field strength exceeds the dielectric strength of air causing arcing near the surface [3]. Fields seen in the Hunger Games trilogy must therefore be activated by a mechanism on contact, rather than always on. They would otherwise be a lethal hazard to their operators.

Conclusion

The nature of the force fields in the Hunger Games would be very different in the real world. The electric field strength has been estimated to be 3.1×10^{10} NC^{-1}. At best they function as powerful electric fences and would not be capable of repelling any physical object. Metals and other materials with induced or permanent dipoles would be attracted to the field.

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