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## P2\_4 The Right Arm of the Imperium

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### Abstract

In this paper we analyse what the true effective range of a lasgun from the tabletop game Warhammer 40,000 would be, and by calculation conclude that it is 53.0 m. This is longer than the range in the game, which when scaled up is 36.5 m. However, we recognise that this range comes from a need for gameplay balance and not realism, and therefore do not believe that the range needs to be changed.

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### Introduction

In the tabletop game Warhammer 40,000, an Imperial Guardsman is equipped with a lasgun, a laser based rifle. When considering any weapons technology, the effective range over which it can be used is a primary concern. The same would be true for laser weapons. In the tabletop game lasguns can be fired over a range of 24 inches [1]. Given that Warhammer miniatures are 1/60 scale [2], this translates to a range of 120 feet. 1 foot is equivalent to 0.305 m, so this range is equivalent to 36.5 m in SI units. By exploring the range over which the light of a laser becomes less coherent, we can assess how realistic this range is.

### Theory

Laser light loses coherence by a factor of  $e = 2.718$  after travelling the coherence length of the laser. We will assume that the power of the laser is sufficiently decreased as to limit its use after the coherence has decreased by a factor of 100. This occurs after 36.8 coherence lengths of travel. We will assume that the coherence and focus of the light is not focused by any optics within the

barrel. The coherence length  $L_{coh}$  is given by

$$L_{coh} = \frac{c}{\Delta\nu_{tot}} \quad (1)$$

where  $\Delta\nu_{tot}$  is the total separation between the excited modes. One mode separation is given by

$$\Delta\nu = \frac{c}{2l} \quad (2)$$

where  $l$  is the cavity length. We will assume that this corresponds to the barrel length of the lasgun, assuming that there are no optical lenses to focus the laser, as above. For a laser with  $n$  excited modes, there will be  $n - 1$  mode separations, so we can combine equations 1 and 2 to give

$$L_{coh} = \frac{c}{\frac{c}{2l} \times (n - 1)} \quad (3)$$

which simplifies to equation (4) below.

$$L_{coh} = \frac{2l}{(n - 1)} \quad (4)$$

As stated above, the maximum range of the laser is assumed to be 36.8 times this length.

## Methodology

Based on equation (4), we can develop a numerical analysis given the length of the laser cavity. The Imperial Infantryman's Handbook states that a standard M-G short pattern lasrifle has a total length of 90 cm[3]. The rifle is shown having a stock which takes up around 20% of the total weapon length, so we shall assume that the barrel length is 72 cm. We can now plot how the range varies with the number of excited modes:

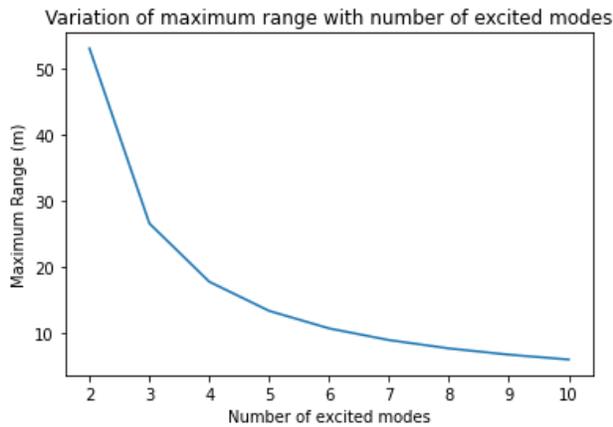


Figure 1: As the number of excited modes increases, the maximum range decreases exponentially. The graph starts with 2 excited modes because only 1 results in an infinite range.

## Discussion

The maximum range found from the calculation is 53.0 m. This is longer than the stated range of 36.5 m. However, the range does decrease if the number of modes is increased. It may be worth considering that for a single operational mode, there are no mode separations, resulting in an infinite maximum range. Given that this degree of precision would be very hard to achieve in the technological decline seen in the universe of Warhammer 40,000, we have omitted this possibility from our conclusions.

## Conclusion

The maximum effective range for a laser of similar design to the Imperial Guard lasgun is 53.0 m, which is longer than the range of this weapon in the tabletop game Warhammer

40,000. As such, it may be appropriate for Games Workshop to increase the range as portrayed on the tabletop. However, this analysis concludes only on the realism of the laser, and does not consider non-physical constraints such as gameplay balance. Further research could look into what power the weapon would have at different ranges, and thereby generate an improved estimate of the maximum range of the lasgun.

## References

- [1] Codex: Astra Militarum, Games Workshop Limited, Nottingham, 2017
- [2] [https://www.dakkadakka.com/wiki/en/Scale\\_Model\\_Kits\\_for\\_40K](https://www.dakkadakka.com/wiki/en/Scale_Model_Kits_for_40K) [Accessed 2/10/22]
- [3] The Imperial Infantryman's Handbook, Games Workshop, Nottingham, 2019, page 115