

# The Inverse Square Law of Light

A brief overview of  
a topic which puzzles  
many - needlessly.

**Philip  
Weston**  
LMPA ARPS ASWPP MSA  
MASTER PHOTOGRAPHER - AUTHOR - LECTURER

## Untangling the Inverse Square Law

Aaargh! Not the dreaded Inverse Square Law of Light. Except it's nothing to dread- it's almost ridiculously simple! Honestly. Strange how it is that the moment you mention basic laws of physics, people's eyes glaze over and they assume they won't understand a word.

OK - a little bit of role play and a touch of imagination to start off with. Take three of those little tubs of butter you get in cafés, the ones with 15ml of butter in. Take 1 Ritz cracker, 1 bread bun (cob, plain teacake, bap stottie - whatever you call them in your part of the country) and one French loaf (the 3ft version). Spread the contents of one tub of butter onto each of these items. You now have a buttered Ritz cracker, a buttered teacake and a buttered French loaf - each with the same amount of butter.

But the Ritz has a pile of butter on it, the bread bun an adequate covering while the French loaf has the tiniest smear all over it. What's the difference? The surface area you are covering with butter. Nothing more complicated than that, just the area you are trying to cover.

Let's get rid of the confectionary and substitute subjects and light. You have a fixed amount of light. You can't sort of apply two tubs of light to one subject. It's fixed. Now light coming from a flashgun is emitted in a beam which spreads out. the further away from the source it gets, the more it is spread out. If the subject is close to the flash, you get a great splat of light on it. If the subject is a long way from the source, there's only a smidgeon or smear of light. We have to compensate for this with our aperture control. Fortunately, there are several factors working totally in our favour.

- 1) Light travels in straight lines.
- 2) The further from the source, the more the light spreads out.

With these two factors, it's pretty straightforward to understand that if the light travels double the distance, it spreads out twice as far. But; big, BIG BUT - it doesn't just spread out twice as far on one axis but on two.

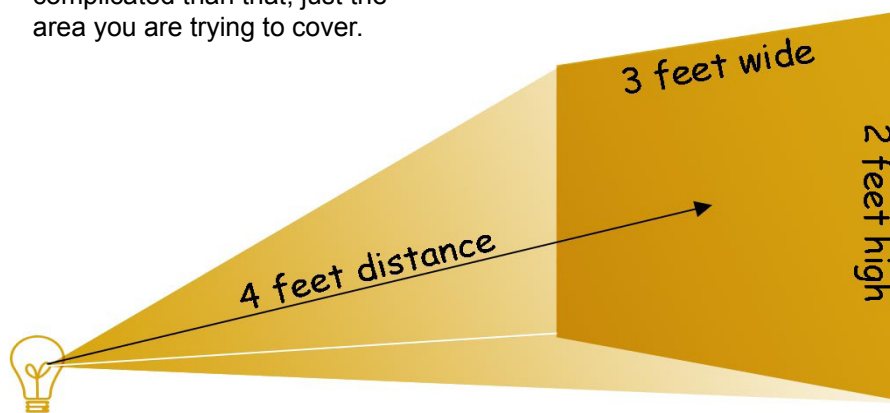
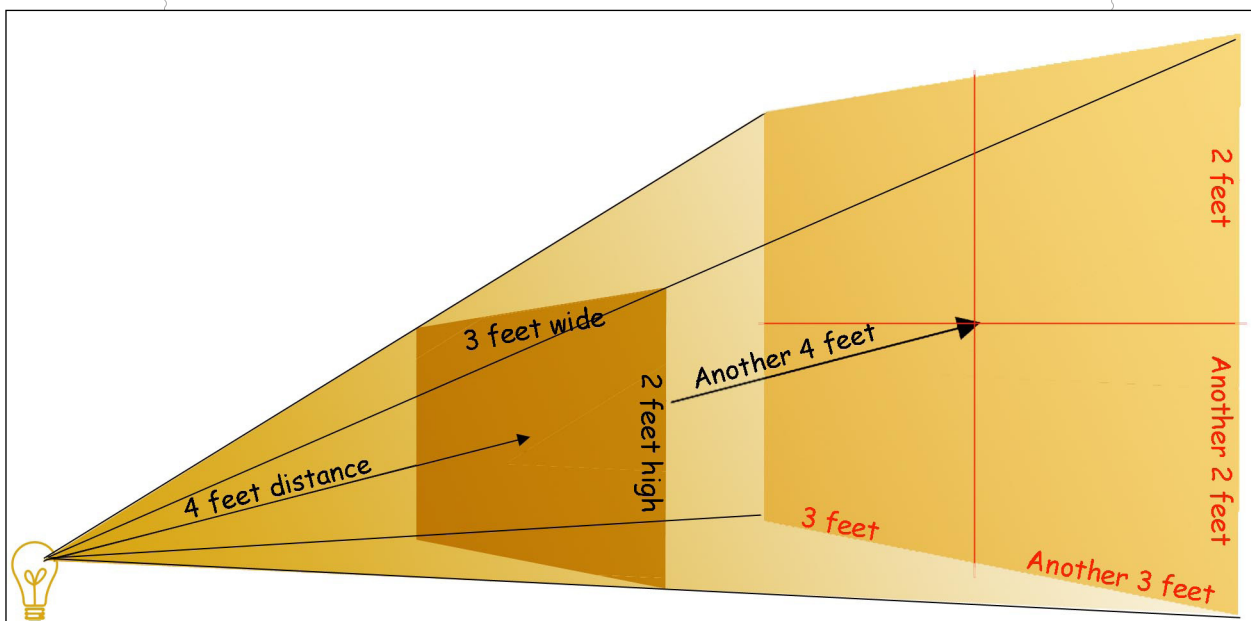


Diagram 1. The light source is 4 feet from the subject and covers an area measuring 3 feet by 2 feet = 6 square feet. The notional exposure for this example is  $f/8$ .

If your flash is pointing horizontally, the light spreads both horizontally and vertically. So if the flash emits 8 units of light measured at 4 feet from the source, when you step back to 8 feet the light has spread out. You may think “double the distance so the light has spread out twice as much - that means that subject will be half as bright”.

Wrong! The light has spread twice as far in the horizontal plane AND twice as far in the vertical plane so there is actually only a QUARTER the brightness at 8 feet as there was at 4 feet. The difference in exposure terms is actually 2 f/stops and not the 1 f/stop you would imagine. Why? Because the light has spread twice as far vertically at



*Diagram 2. The light has now travelled double the distance (8 feet) and has spread out twice as far both horizontally and vertically. It now covers an area 6 feet by 4 feet or 24 square feet. The same volume of light has now to illuminate 4 times the area -  $\frac{1}{4}$  the illumination or two f/stops dimmer. To compensate for this, we need to open the aperture by 2 f/stops. With the figures from diagram 1, the exposure would be  $f/4$ .*

the same time as it was spreading twice as far horizontally. That old pat of butter has been spread out more thinly because the bread is a bigger area.

So, in photographic terms, the difference when you double the light-subject distance is 2 f/stops. Double it again? Another 2 f/stops. Let's say you start off with your flash 2ft from the subject and the correct exposure is  $f/16$ . Move the flash to 4ft and the correct exposure becomes  $f/8$ . Move

the flash to 8ft and the correct exposure becomes  $f/4$ . Move the flash to 16ft and the correct exposure becomes  $f/2$ .

Familiar numbers? 2, 4, 8, 16. Seen those anywhere before? Of course, you've just used them in reverse as f/stop settings to get the correct exposure. What about those other funny f/stop numbers in between? You know -  $f/2.8$ ,  $f/5.6$ ,  $f/11$ . Guess what - it works with them too! Move your flash from 2ft to 2.8ft from the subject and that

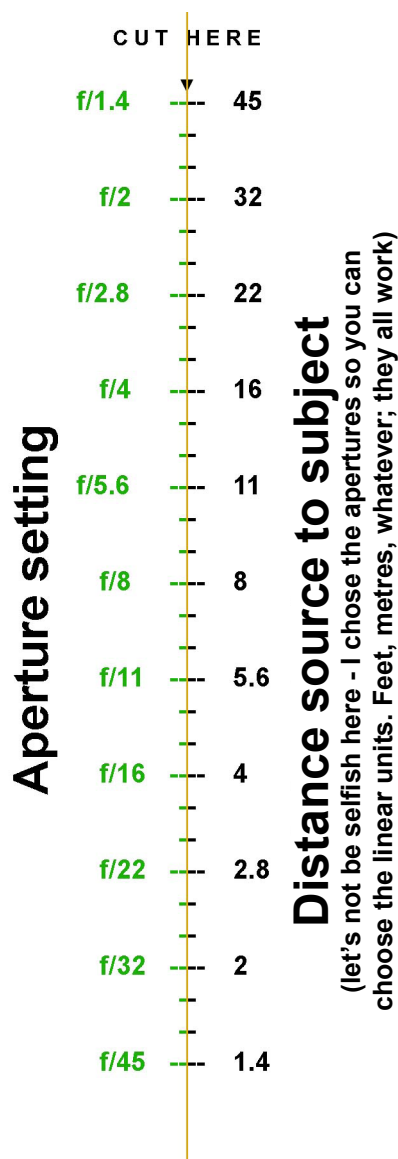


Diagram 3. Cut down the yellow line then align your current source/subject distance against your current correct aperture. The distance against any other aperture is the correct one for that aperture setting - as long as you don't change anything else.

aperture setting has to be changed from f/16 to f/11 because of the spread of light. Move the flash from 2.8ft to 5.6ft and you need to change the aperture by 2 f/stops to compensate because that old light has spread out over 4 times the area. So your aperture has to be set to f/5.6, two f/stops wider than it was before.

Let's look at that full sequence. 2, 2.8, 4, 5.6, 8, 11, 16. You've seen those numbers on your lens. They represent, left to right, a halving of the amount of light passing through the lens. But they also represent, in the same order, a doubling of the AREA of the spread of light. NOT a doubling of the distance but of the area. No matter whether these numbers represent f/stops, metres, feet, nanometres or whatever, everything works on a factor of two. Each step in that sequence means either half or double the amount of light. One directly offsets the other.

So, that's the Inverse Square Law of Light - double the distance, quarter the brightness; half the distance, four times the brightness.

Now, will someone be kind enough to pass the marmalade please?

**Philip Weston**  
LMPA ARPS ABWFF MSA  
MASTER PHOTOGRAPHER - AUTHOR - LECTURER

email: [tutoratwestonphoto.plus.com](mailto:tutoratwestonphoto.plus.com)

(Please manually change the **at** to the normal symbol **@** - this helps me to get **your** email instead of the spammers' rubbish)

[www.photo-tutor.co.uk](http://www.photo-tutor.co.uk)