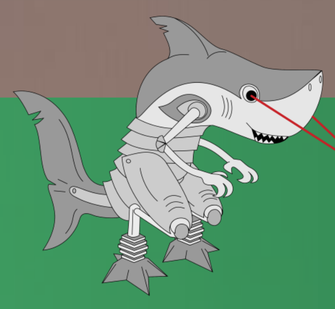
Diffraction

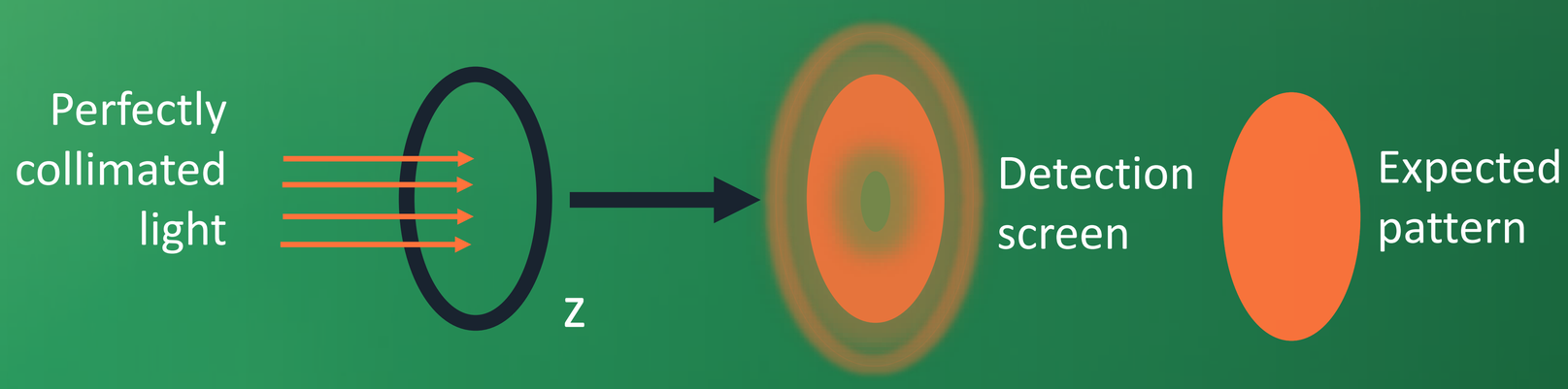


OPTICA Student Chapter at the University of Kent Canterbury, UK

A way to explain how light moves through space

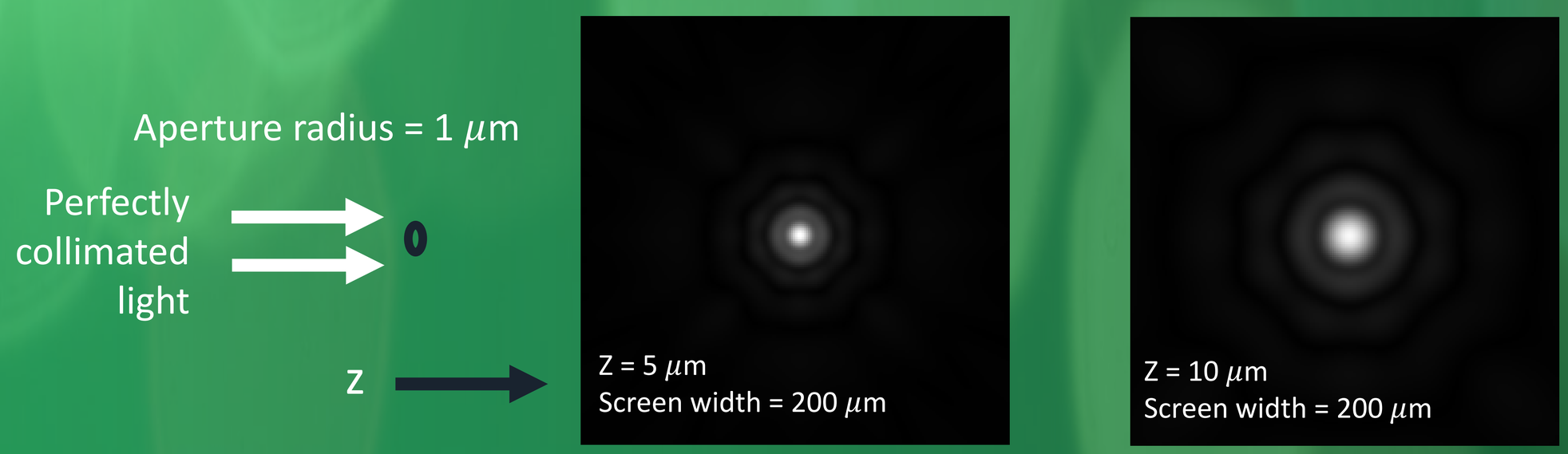
Reflection describes how light bounces off an interface, and refraction describes how light propagates through a medium. Both consider light a ray and work without the assumption that light is a wave. Diffraction is anything which isn't reflection or refraction, it considers the wave nature of light and the interference effects that result, whereas treating light as rays doesn't lead to interference.

It's useful to know how light spreads from an aperture especially for imaging. An easy way to look at diffraction is to consider a *circular aperture*, basically a circle punched into a piece of card, and to examine the patterns a distance away on a detection screen. It's then possible to move the detection screen to get an idea of how light has spread at different z distances. If the light is not coming in at an angle (collimated), we wouldn't expect rings, blur or a spot in the center of the pattern. Yet those things can be observed in experiments, this motivated the development of a theory to account for this behaviour.



The theoretical formulation ties together two seemingly unrelated concepts *spherical isotropic emitters* and *circular apertures*. Like the sun, a *spherical isotropic emitter* is a sphere that emits uniformly, and in all directions. This is useful because we know the field at any distance away. The groundbreaking step was developed by Christiaan Huygens around 1650. The step was to consider the circular aperture as being comprised of many spherical emitters, emitting not just on axis, but in all directions. A common calculus trick was then employed: assume there are a large number of emitters, and the intensity of each emitter is inversely proportional to the number of emitters. Then since we know the contribution of each emitter exactly, add up the individual contributions of each emitter on the detection screen.

With the benefit of computer's it's computationally expensive but conceptually simple to develop the computer simulations below*. They show how light propagates from a circular aperture and form the basis of any image formation system, such as camera's and microscopes.



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