5.2: Introduction

Although the model of geometrical optics helps us to design optical systems and explains many phenomena, there are also phenomena that require a more elaborate model. For example, interference fringes observed in Young's double-slit experiment or the Arago spot indicate that light is more accurately modelled as a wave. From a previous course you may remember that the condition for interference maxima in the double-slit experiment is that the difference in path lengths to the slits is an integer multiple of the wavelength:

$$d \sin \theta = m\lambda,$$

where d is the distance between the two slits, θ is the angle of the propagation direction of the light, m is an integer, and λ is the wavelength of the light. For sufficiently narrow slits, the Huygens-Fresnel principle says that each slit acts as a point source which radiates spherical waves.

In this chapter we will find more results that follow from the wave model of light. It will be shown that the extent to which light can show interference depends on a property called coherence. In the largest part of the discussion we will assume that all light has the same polarisation, so that we can treat the fields as scalars. In the last part we will look at how polarisation affects interference, as is described by the Fresnel-Arago laws.

It is very much worth noting that the concepts of interference and coherence are not just restricted to optics. Since quantum mechanics dictates that particles have a wave-like nature, interference and coherence also play a role in e.g. solid state physics and quantum information.

External sources in recommended order

- KhanAcademy - Interference of light waves: Playlist on wave interference at secondary school level.
- Yale Courses - 18. Wave Theory of Light