

2 Physical Optics

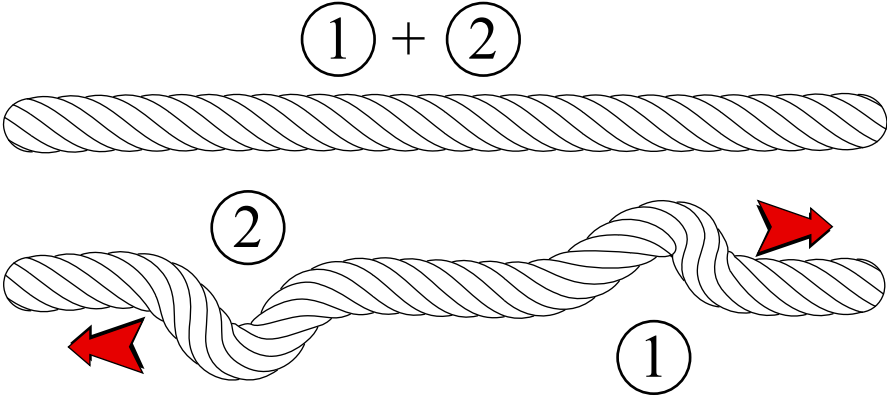
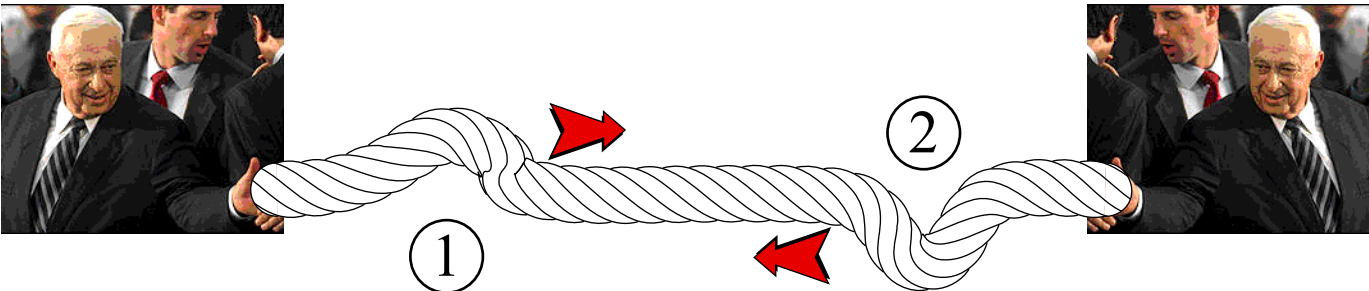
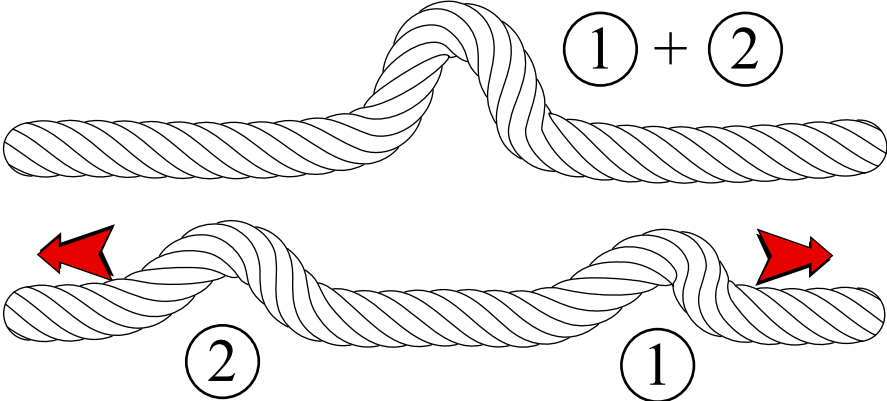
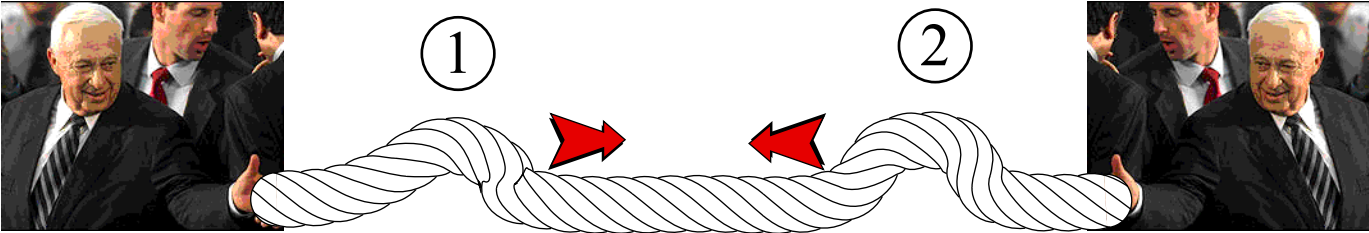
We'll concentrate on **wave aspects of light**, but there are also **particle aspects** to light, which derive from the quantum-mechanical concept of the *photon*, i.e. the smallest possible 'amount' of light.

For those who are interested: some important effects that demonstrate the particle nature of light are the photoelectric effect (this is what Einstein won his Nobel Prize for, not Relativity!) and atomic radiation spectra (Benson chapter 40, in particular 40.2, 40.4-6).

2.1 Harmonic waves

2.1.1 Principle of superposition

Benson 16.2





(more accurately: *linear* waves add up)

examples for *linear* waves:

- low-amplitude waves on a string or rope,
- ripples on water (NOT ocean breakers!),
- electromagnetic waves**

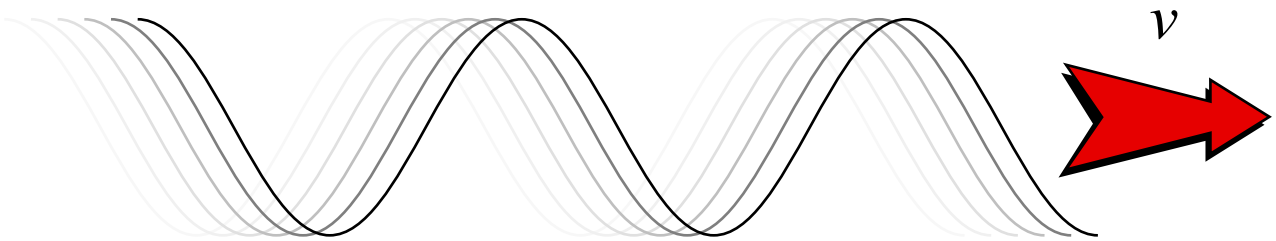
conversely:

- waves can be broken down into parts;
- one particularly useful set of parts that *any* wave
- can be broken down into is the family of the
- harmonic waves**

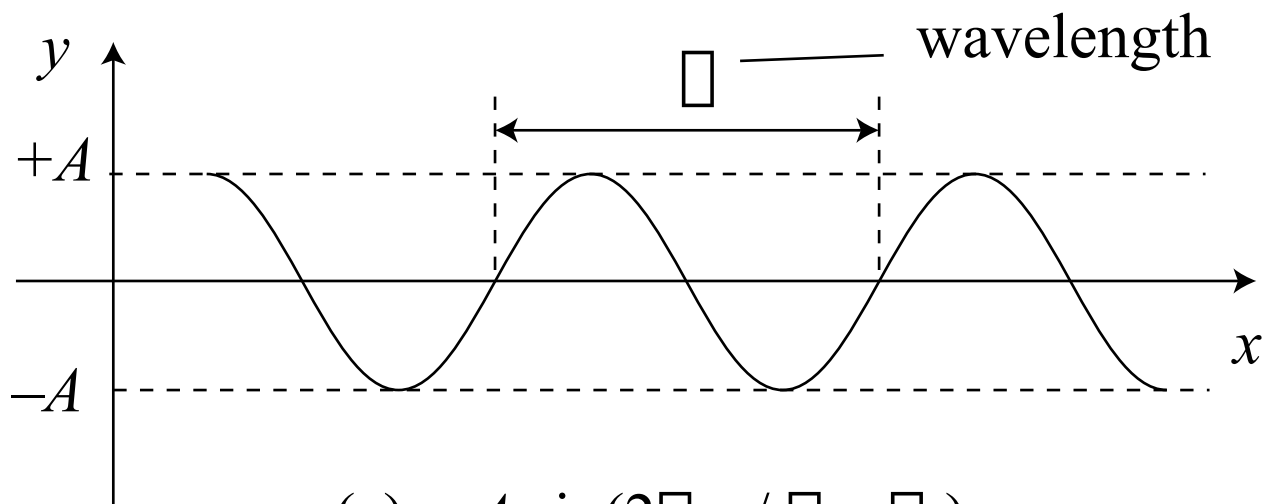
2.1.2 Harmonic travelling waves

Benson 15.1

infinitely long sinusoidal "displacement"
moving at speed v



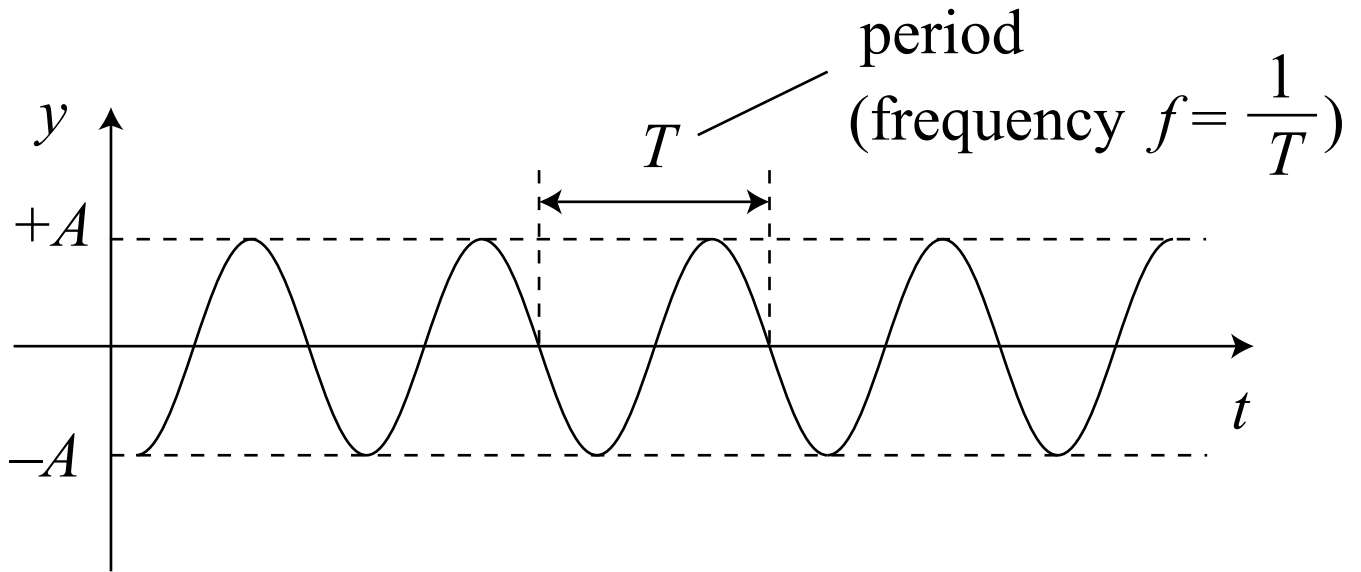
snapshot of the "displacement" y at one instant in time:



$$y(x) = A \sin(2\pi x / \lambda + \phi_1)$$

at different times the wave might be moved
sideways; this is represented in the additional
phase constant ϕ_1

time dependence of y at one point in space:
 "simple harmonic oscillation"



$$y(t) = A \sin(-2\pi t / T + \phi_2)$$

/
 phase constant

space and time dependence of y :

$$y(x,t) = A \sin(2\pi (x / \lambda - t / T) + \phi)$$

during one period, T , the wave moves through one wavelength, λ

consequently the speed of the wave is

$$v = \frac{\lambda}{T}$$

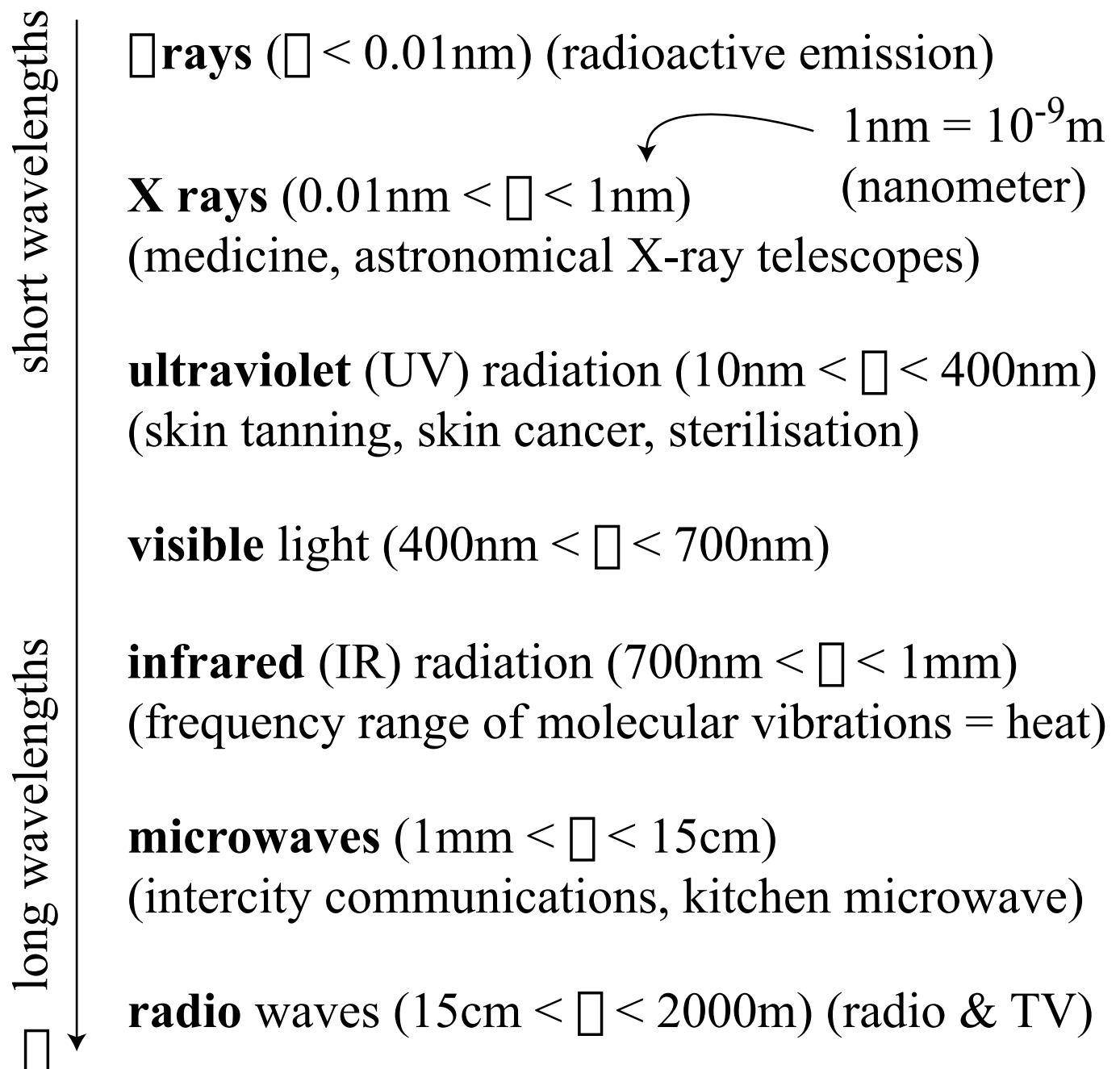
2.1.3 Electromagnetic spectrum

Benson 34.7

displacement: electric and

magnetic field strength

light consists of **electromagnetic harmonic waves** travelling at the speed of light, $c \approx 3 \cdot 10^8$ m/s



2.2 Interference

2.2.1 Addition of two harmonic waves

(Benson, introduction to chapter 37 and 37.1)

