COHERENCE

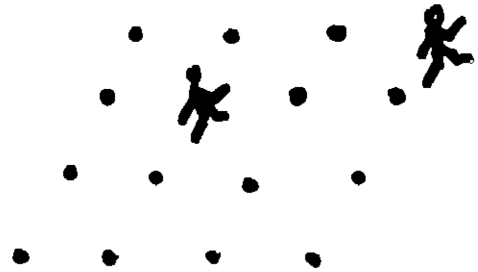
A lightwave is said to exhibit coherence when there is a predictable connection or correlation between the amplitude and phase at one point A on the wave and at any other point B.

correlation in time

has connotation of predictability of one event based on the knowledge of an earlier event

correlation in space

Predictability of the location of an object in a group based on the position of another object



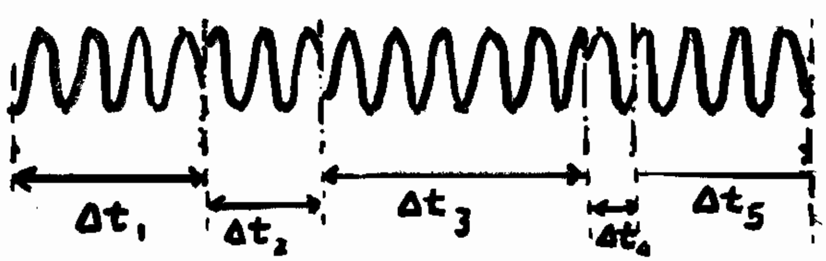
COHERENT GROUP

If we know the location of one marcher, it is highly probable that we shall find another marcher 2 feet forward and 1 foot left.

Light from a source is completely coherent both in space and time if there is complete correlation between
the electric field variations of the light at any one point in space A, and
those electric field variations at any other point B.

Having measured once the electric field variations of the light at both points A and B, one can say with complete certainty at any later time: what the electric field is doing at the second point B simply by measuring the field at the first point A.

However, it does not exist perfectly coherent light. Even "monochromatic" sources emit light that, at best, can be represented as a sequence of harmonic waves trains of finite duration, each separated from the others by a discontinuous change in phase



Light can then be characterized by the average duration of its wavetrains $\Delta t_c = \langle \Delta t_i \rangle$, called its coherence time

After a measurement at a given time, the variation of the wave can be predicted only in the next Δt_c seconds

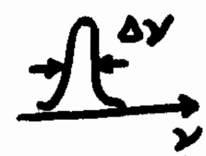
The coherence length of the wavetrain is the length of its coherent pulse

$$l_c = c\,\Delta t_c$$

On the other hand, we also know that a set of waves whose frequencies lie in a limited range $\Delta\nu$ around a given ν, give rise to a well defined pulse of frequency ν and duration

$$\Delta t \sim \frac{1}{\Delta\nu}$$

It is plausible then to think of a real light source as one that emits bursts of light pulses each having a bandwidth $\Delta\nu_i$. When this light passes a spectrum analyzer all the frequency components will be revealed.



and an average $\langle \Delta\nu_i \rangle = \Delta\nu$ can be identified. the associated value $\frac{1}{\Delta\nu}$ can be considered as the coherence time of the light