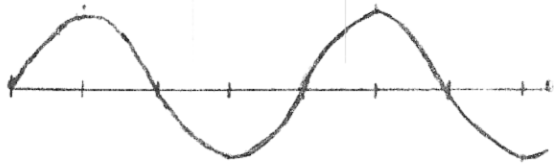
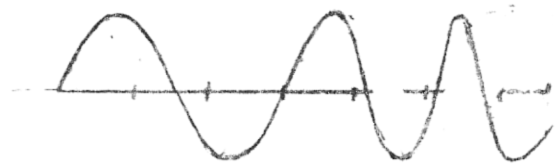
COHERENCE

Light coming out of a laser is both spatially and temporally coherent. Temporal coherence means that all the waves coming out of the laser have the same wavelength-the spacing between crests does not change with time.

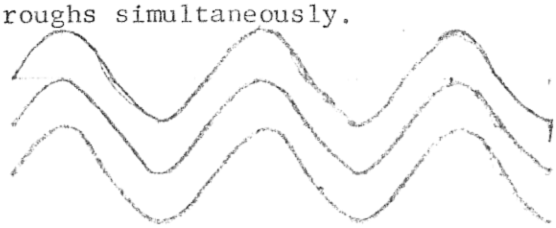


TEMPORALLY COHERENT WAVE

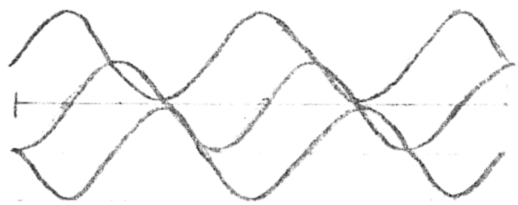


NOT A TEMPORALLY COHERENT WAVE

There is more than one wave of light coming out of the laser and these waves are all in step as they exit the port. They can be thought of as originating at the totally reflective mirror opposite the exit mirror, even though they make many round trips between the mirrors in the resonating cavity before leaving it. This is spatial coherence; all the waves make their crests and troughs simultaneously.

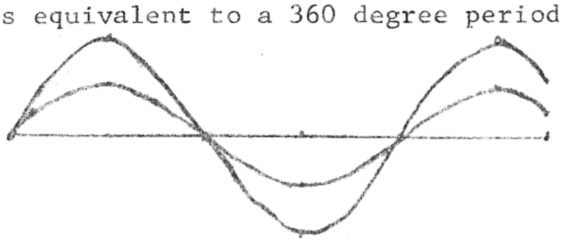


TEMPORALLY AND SPATIALLY COHERENT

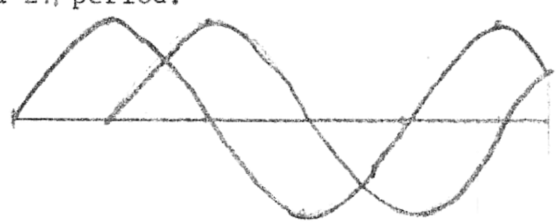


TEMPORALLY BUT NOT SPATIALLY COHERENT

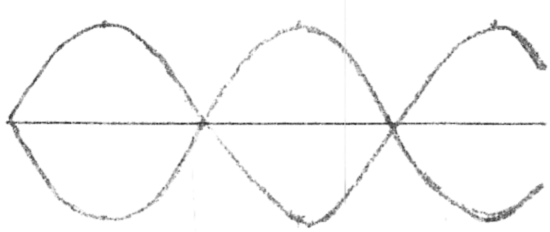
When temporally coherent waves are not spatially coherent, they are "out of phase" with each other. Crests do not match up, troughs don't match up, and neither do points in between. One way to indicate the amount that two waves are out of phase with each other would be to use fractions of a wavelength. Since these wave forms are based on the trigonometric sine curve we can also use degree measure or radian measure, assuming that every wavelength is equivalent to a 360 degree period or a 2π period.



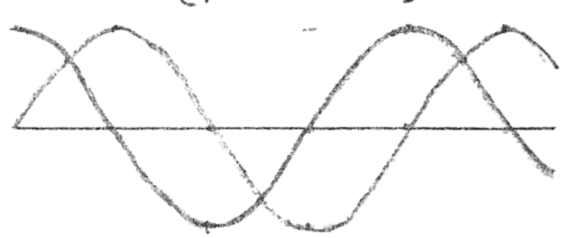
WAVES ARE IN PHASE



WAVES ARE { 1/4 WAVELENGTH / 90 DEGREES / $\pi/2$ RADIANS } OUT OF PHASE



WAVES ARE { 1/2 WAVELENGTH / 180 DEGREES / π RADIANS } OUT OF PHASE



WAVES ARE { 3/4 WAVELENGTH / 270 DEGREES / $3\pi/2$ RADIANS } OUT OF PHASE

It's absolutely essential that the waves used to form a hologram be spatially and temporally coherent to form the constructive and destructive interference fringes.[1] If the wavelength of the interfering beams vary (lack of temporal coherence) the interference will not become a standing wave pattern and will be constantly changing its shape, leaving nothing but a blur on the holographic plate. The reference beam must have all its waves cresting and troughing at the same time to provide a non-random base of reference. The light reflected off the object loses its spatial coherence, but this modulation of the object beam is exactly the information we would like to record.

A phase hologram is recorded on a transparent medium that introduces phase differences in the reconstructing beam by optical path variations. For instance, in a bleached silver halide emulsion, light travels through gelatin, then through transparent silver halide whidh has a different index of refraction from the gelatin, so the light gets slowed down and bent, introducing a phase difference, then through several more gelatin and silver interfaces until when it finally exits it has reconstructed the phase differences between reference and object beams recorded in the hologram. Phase holograms have been recorded on dichromated gelatin, photo-resest, thermoplastics, and photopolymer. Bleached silver halide emulsions are the most popular type of phase hologram because the materials are readily available from commercial manufacturers and relatively easier to handle. Phase holograms are much brighter than absorption holograms since they pass much more light

I. Holograms can be made with any type of wave sound, radio, maybe x-rays, and of course, light.