

Basic Concepts Guide

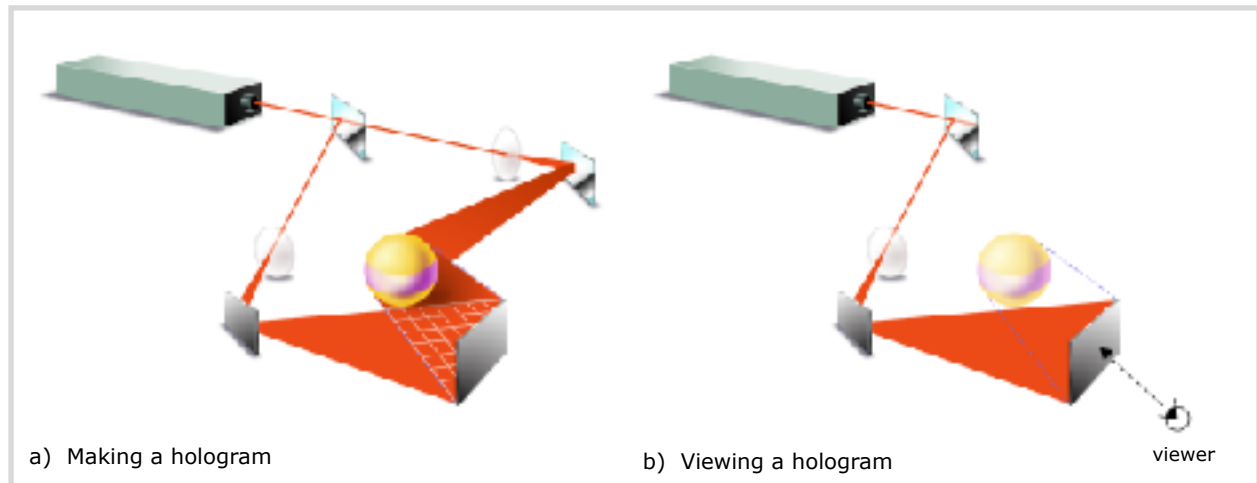
Holograms

For most of us, a hologram is a three-dimensional image that looks like a real object because the image has depth. However, a hologram is not required to be 3D, and some 3D images are not holograms at all.

In technical terms, a hologram is the captured intensity and phase information produced by the interference of two or more beams of light. Not exactly easy to understand, is it?

We all know that a regular two-dimensional picture has no depth, and is simply a recording of intensities of an image, or the shades of brights and darks in an image. A hologram is unique because it records not only the intensity of the light, but also the direction that the light was traveling when it hit the film. It is this extra information of direction that allows you to see the images in 3D, or to "look around" the objects as if they were really there. A hologram captures the intensity and direction information by recording the interference pattern of the light that hits the film.

A simple layout for making a hologram is shown in the image below. The laser beam exits the laser and is divided into two beams by a beamsplitter. One beam is expanded and then reflects off of the object, with the reflected light scattering onto the film. This is often called the "object beam." The second beam is also expanded, but goes directly to the film, and is called the "reference beam." The object beam (light scattered from the object) and the reference beam create an interference pattern on the film, which is the hologram. To view the hologram, the film is developed (in the case of Litiholo "Instant Hologram" Film, there is no developing), placed back in its original position, and illuminated with only the reference beam. When the viewer looks through the film (from the side opposite the object) a holographic three-dimensional image can be seen where the object was originally located.



The layout for the Litiholo Hologram Kit is a little different from this image. The hologram kit uses only one beam of laser light, with part of the beam hitting the object and the other part hitting the film directly. This layout allows the hologram to be more resistant to vibrations, which means you can make holograms even on your kitchen table.

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"Instant Hologram" Film

Well, you may not know it, but making holograms was not always this easy. Usually, after creating your hologram with the laser, you still had one of the hardest parts ahead of you: the developing. For years and years, holograms have typically been made on silver-halide emulsion film, very much like a higher resolution version of the film in traditional cameras. Developing these holograms involved a complex process of several different chemical baths, all in the dark, of course. Before that, some holograms were made on DCG, or Dichromate Gelatin, the development for which included dipping the holograms into boiling alcohol.

But not you! You are now a member of an elite generation that can make holograms instantly. With Litiholo "Instant Hologram" Film, the hologram forms and develops at the same time, allowing your images to be viewed immediately. No waiting. No chemicals.

Laser Light

Almost all holograms are made with laser light, because it is a convenient source of highly ordered and controlled light. You probably already know that all light is made up of waves (and particles called "photons," of course). The distance between the peaks of the waves is called the "wavelength" of the light, and this determines the different colors of the light we see, with red being a longer wavelength, blue being a shorter wavelength, and green in between. So what's the difference between laser light and regular light? A nice mental picture is to think of a parade. Regular lights, like the ones in your home, are like a wild parade with people running in all directions, lots of noise, and lots of party favors being thrown everywhere. So regular light still has waves, but there are lots of different wavelengths (colors) going in lots of different directions, all at the same time. Laser light, on the other hand, is like a military parade with everyone marching in the same direction, stepping perfectly together to the music. Laser light only has one wavelength (color), and all of the waves come out of the laser with the waves lined up in step with each other. This highly ordered light makes it much easier to create an interference pattern with the light, which is what we need to make a hologram.

Interference Pattern

A hologram is really an interference pattern of light that is captured on film. Enough said, right?

Okay, maybe a little more would be helpful. When two waves come together, such as two waves from two beams of laser light, they combine to make one wave pattern. If the peak of one wave combines with the peak of another wave, you get a wave twice as big (this is an example of "constructive interference"). If the peak of one wave combines with the valley of another wave, you get no wave at all (and this is an example of "destructive interference"). The combination of all of the constructive and destructive interference creates a microscopic pattern of bright (constructive) and dark (destructive) lines on the film that are about 50 times smaller than the thickness of one piece of hair. All of these microscopic bright and dark lines make up an interference pattern, which is the information of your hologram.

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Diffraction

If you've ever seen the rainbow on the bottom of a CD or DVD, you've seen diffraction. Diffraction is when light bends from passing through (or bouncing off of) very closely spaced lines. In the case of a CD or DVD, the closely spaced lines are the tracks on the disc and the space between each of the tracks. The light diffracts off of this pattern bending the light into a rainbow, since each of the colors (or wavelengths) bends a different amount.

When a hologram is made, it records a microscopic pattern of bright and dark lines in the film due to the interference of the light beams that created the hologram. To see the hologram, light is passed through the hologram again, and now the light diffracts off the captured pattern, bending the light to look like the original object is still there.

Vibration

The enemy of holograms is vibration. Not just vibrations from airplanes passing over your head or loud music from a car. But also the vibrations made every time you step on the floor. Or the vibrations created from air currents passing through the room coming from the air conditioner. A pretty good example is the fact that you cannot make holograms of plants with this kit, because the plant will actually grow too much during the making of the hologram, causing movement.

Remember, holograms are made from interference patterns, with bright and dark lines that are about 50 times smaller than the thickness of one hair. Even the smallest of vibrations can destroy this pattern. And this is not like a photograph, where movement makes the picture a little blurry. If vibrations happen during the time that the hologram is being made, the tiny interference pattern is wiped out, leaving you with a completely blank hologram.