Construct, Conduct & Comprehend Physics Experiments

LEOK-3-29 Record and Reconstruct Holograms

- *Complete set*
- *Cost effective solution*
- *Detailed instructional manual*
- *Easy alignment*

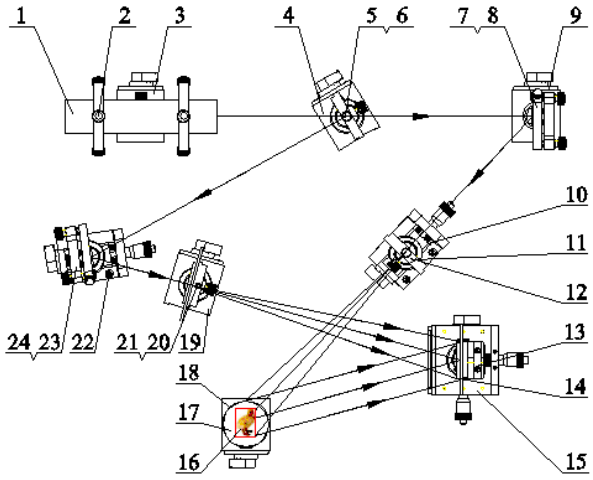

Figure 29-1 Schematic of experiment setup

1: He-Ne Laser (LLL-2)
2: Laser Holder (SZ-42)
3,9,18: Magnetic Base (SZ-04)
4,19: Z-adjustable Stage (SZ-03)
5: Beam Splitter (7:3)
6,12: Lens Holder (SZ-08)
7,24: Kinematic Holder (SZ-07)
8: Flat Mirror M_1
10,22: Two-Axis Stage (SZ-02)
11: Beam Expander Lens L_1 (f' = 4.5 mm)
13: Plate Holder (SZ-12)
14: Holographic Plate (or white plate)
15: Three-axis Stage (SZ-01)
16: Small Object
17: Sample Stage (SZ-20)
20: Beam Expander Lens L_2 (f' = 6.2 mm)
21: Rotary Lens Holder (SZ-06A)
23: Flat Mirror M_2

Theory

Light is a transverse electromagnetic wave, so a ray of monochromatic light can be written as

$$x = A\cos(\omega t + \varphi - \frac{2\pi}{\lambda} r) \qquad (29\text{-}1)$$

where A is the amplitude, ω is the circular frequency, λ is the wavelength, and φ is the initial phase.

Generally speaking, a camera can only record the amplitude of the light reflected from an object. So the photo taken by a camera is a planar picture. By contrast, holography can record both the phase and amplitude of the light, thus the image is three-dimensional. Even if a hologram is broken or cut up, each small portion still contains the information of the whole object.

There are two steps in making a hologram. The first step is to record all the information of the light reflected from the object on a holographic plate. The second step is to illuminate the hologram and reconstruct the light wave reflected by the object.

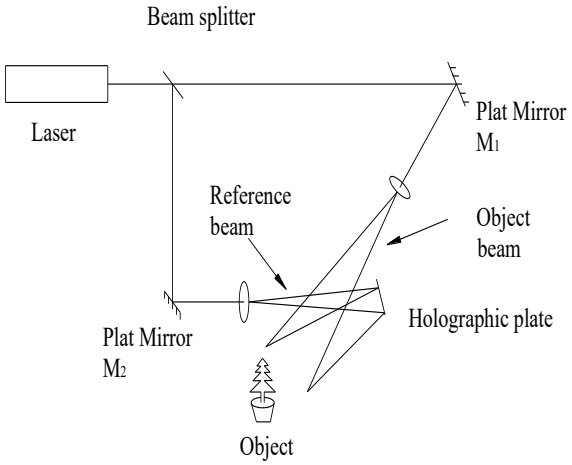

Figure 29-2 Schematic of hologram recording

In fact, holography is a process of interference. As shown in Figure 29-2, a laser beam is split into two beams: one beam, called the reference beam, is directed toward a holographic plate; another beam, called the object beam, is reflected off an object. The object beam contains such information as location, size, shape and texture of the object. Then the two beams produce an interference pattern on the holographic plate, which is recorded in the light sensitive emulsion. As a result, the holograms of the object are obtained. To reconstruct a hologram, a laser beam is used to illuminate on the holographic plate at the same direction as the reference beam. Then the three-dimensional image of the object can be observed.

Experiment Procedures

Note: The hologram recording experiment is recommended to be carried out on a vibration isolated optical table.

1. Refer to Figure 29-1, align all components in same height, let the primary plane of the system parallel to the table, remove L_1 and L_2 from optical path at this moment;
2. Set approximately equal optical path length for object beam and reference beam, and let their intersection angle about 30° to 40°; let the object close to the holographic plate;
3. Adjust M_1, let object beam illuminate on the central portion of the object;
4. Adjust M_2, let reference beam illuminate on the central portion of the holographic plate (use a white plate or a paper plate of a similar size for setting up);
5. Insert L_1 and L_2 back to the optical path, adjust them so that the object beam and reference beam are still at their original centers;
6. Move L_2 back and forth to change the illuminating intensity of the reference beam on the white plate; let the intensity ratio between reference beam and object beam about 5:1 to 10:1;
7. Fix all components, turn off indoors light, replace the white plate with a holographic plate and expose the holographic plate with He-Ne laser for 20 to 30 seconds;
8. Develop and fix the hologram;
9. Put back the hologram at its original location, remove object and block object beam, observe the reconstructed object.

Note: for correctly using the beam splitter, please set the front surface of the beam splitter to face to the incident light and let the light reflected from the front surface.