LABORATORY TECHNIQUES

COLLIMATION OF LIGHT

I. OBJECTIVE

To convert a diverging spherical wave into a plane wave for optical processing systems.

II. BACKGROUND

Collimating lenses are used for two purposes: (a) collimating a diverging light beam, and (b) focusing a collimated light beam to a point. These lenses are usually achromatic, i.e. consist of two or more elements, and are highly directional: to minimize aberrations they must be aligned with the optical axis of the system and the correct side must face the collimated beam; the side with the greatest curvature usually should face the collimated beam.

There are two basic methods for collimation: (a) using an optical flat, and (b) using a mirror and an iris. An optical flat is an optical component with very flat (λ/20) surfaces, which are usually parallel to each other. When this flat is placed at an angle with respect to the optical axis of an incident beam, reflections from the two surfaces will interfere with each other, as shown in Fig. 1. When the beam is collimated, i.e. a plane wave, the interference pattern will have a large uniform central area since the two reflected plane waves are traveling parallel to each other.

Fig. 1. Beam collimation using an optical flat.
Some flats have surfaces that are at a slight angle to each other, forming a *wedged flat*. In this case the interference pattern will be alternating bright and dark fringes that are spaced as far apart as possible since the two reflected plane waves will be interfering at a slight angle. This kind of optical flat lends itself to a form of "calibration": by rotating the wedged flat in a suitable mount, the fringe pattern due to a previously collimated beam can be set to be either horizontal or vertical. Thus, any incident beam can be easily collimated by adjusting the collimating lens until the appropriate set fringe pattern is achieved. The setup for collimating using a mirror and an iris is shown in Fig. 2.

![Fig. 2. Beam collimation using a mirror and an iris.](image)

III. PROCEDURE

**Collimating with an optical flat:**

1. Place the collimating lens approximately one focal length away from the diverging source (usually the output of a spatial filter). This will give you an output beam which is almost collimated.
2. Insert the optical flat after the lens and observe the reflection on a white card. Rotate the flat to get an interference pattern visible on the card.
3. Adjust the position of the collimating lens until the desired interference pattern is obtained: a large uniform central area (bright or dark “fringe”) for parallel flat or the largest fringe pattern for wedged flat.

**Collimating with a mirror and an iris:**

1. Place the collimating lens approximately one focal length away from the diverging source to get an almost collimated beam.
2. Insert an iris right at the output of the lens, center it on the beam, and adjust its size to allow about 80% of the light passing through.
3. Place a mirror at the far end of the optical bench and tilt it until the reflected beam is centered on the iris.
4. Adjust the position of the collimating lens until the reflected beam size is the same as the forward beam passing through the iris.