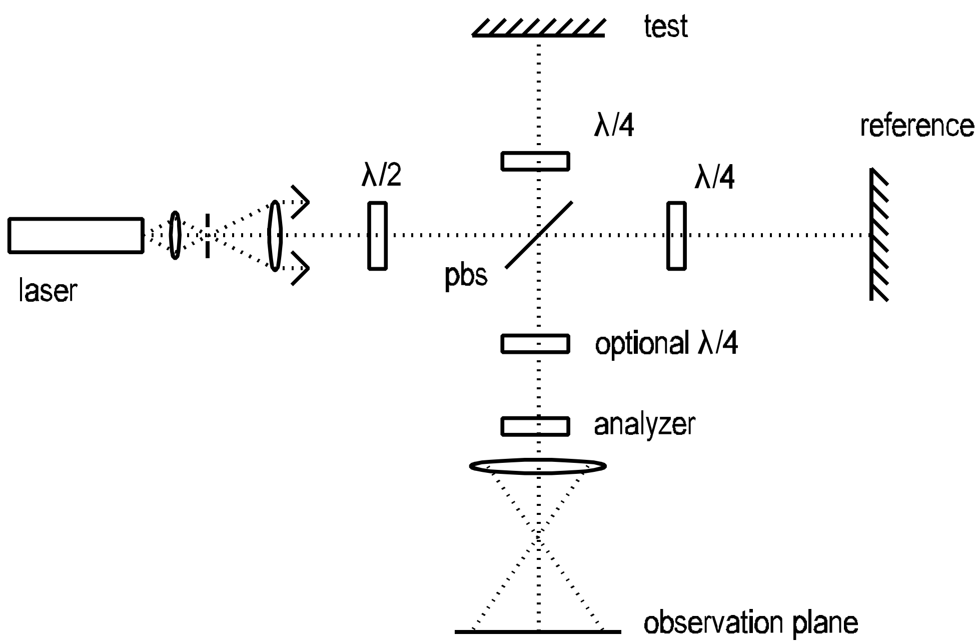
Lab #4 -- Twyman-Green Interferometer with Polarization Intensity Compensation

The purpose of this lab is to become acquainted with the use of a Twyman-Green interferometer and the use of polarization techniques to match beam intensities.

Preparation:

Know the relationships between fringe contrast and the object and test beam intensities. Review the use of polarization components in an interferometer to match beam intensities and improve fringe contrast.



Twyman-Green Interferometer
with Polarization Intensity Compensation

Using the Twyman-Green Interferometer:

1) Sketch the layout of the interferometer and label all components.

2) Place a flat mirror in the test arm. Tilt the test flat until the two spots at the focal plane of the imaging lens are overlapped. Then look in the image plane of the flat. You should see fringes. If not, adjust the 1/2 wave plate before the beamsplitter until both beams have equal intensity. Then adjust the analyzer at the output until the fringe contrast is a maximum. If this still doesn't do it, translate the reference mirror until high contrast fringes are seen.

3) Next, replace the flat with a diverging lens and a concave spherical mirror. The sphere should be positioned so that its center of curvature is at the focus of the diverging lens. This can be done by placing a card with a hole in it at the focus of the diverging lens, and adjusting the position of the test mirror until the reflected beam comes to a focus at the card and goes back through the hole. Make sure the test beam hits the center of the mirror.

4) Once there is a return beam into the interferometer, line up the dots at the focus of the imaging lens. Use the x-y-z adjustments at the bottom of the interferometer until the spots are lined up and the same size. You should be close to having fringes. If not, check the path difference between beams and the analyzer.

5) Try to determine which parts of the mirror are high or low compared to a sphere.

6) Lastly, replace the test mirror with the parabola. Align it the same way as the sphere. Scan through difference "zones" of the mirror. Note the predominant aberrations both on and off axis.

Questions:

1) What is the main advantage of using this type of interferometer when testing widely varying types of samples?

2) What relative position (with respect to path length) of the reference mirror to the test mirror provides the highest fringe contrast?

3) In using polarization techniques to match beam intensities, is there any advantage to adjusting the 1/2 wave plate before the beamsplitter rather than the analyzer after the beamsplitter?

4) What optical components in the interferometer have the most stringent quality requirements?
5) What is your estimate of the total peak-to-valley aberration of the Twyman-Green used in the lab?

6) What is the influence of air currents in the interferometer paths?

7) Does this interferometer need to be on an isolated table? Why?

8) How would you use the Twyman-Green to test windows or lenses in transmission?

9) What is the effect of placing a quarter-wave plate between the analyzer and the beamsplitter? Assume that the quarter-wave plate has its crystal axes at 45° with respect to the beamsplitter eigenstates.

10) What is the effect of rotating the quarter-wave plate in part (9)?