Optical exercises at the Vacuum Tower Telescope

1. INTRODUCTION

The Vacuum Tower Telescope of the KIS allows direct access to the spectrograph and to many optical components in the optical laboratory. Thus, instead of operating an instrument as a *black box*, where light goes in and some data comes out, students can actually follow and understand the function of the instrument component by component, e.g., see the effect of partial blocking of a pupil image, verify the role of an order-sorting interference filter, etc.

The telescope and the light feed to the spectrograph and the optical lab were set up such that both places receive 50% of the sunlight by using a 50:50 beam splitter. This allowed to conduct 2 experiments simultaneously, with the only restriction that both groups would share the same image (Sun or local target).

2. ACTIVITIES IN THE OPTICAL LABORATORY

Goals

Students use the available optical table and a number of optical components (lenses, polarizers, neutral density glasses, CCD camera to setup simple optical setups to get hands-on experience on simple optical systems, understand the concept of collimating and imaging optics, images of objects, images of entrance pupil.
In a second part, students verify by experiment the effect of crossed polarizers. Placing a 3rd polarizer at different positions relative to the first 2 ones, students learn that order matters, when polarizing optics is concerned.

Exercises

1. Set up a 1:1 transfer optics with 2 identical 1500 mm lenses
    a. Focus image on CCD camera, using a target in F1
    b. Take test data
    c. Put target at F2; check focus position (do not move camera)
    d. Determine image scale on detector (mm/pixel)
    e. Find pupil image between the two lenses
        i. Partly block pupil image: what happens in the focal plane F3?
        ii. Partly block image in focal plane F2. Effect on pupil image?
    f. Put neutral density glass in the beam close to the pupil image. Notice the effect on image quality.
    g. Put same neutral density glass close to the camera. Compare with (f).

2. Demonstrate effect of crossed polarizers in the light beam.
    a. Put 2 polarizers at an angle of 90 degrees in the light beam. Verify extinction at the CCD camera.
    b. Insert a 3rd polarizer at different azimuthal angles relative to the crossed ones. What happens?
    c. Explain your findings

3. EXPERIMENTS WITH THE ECHELLE SPECTROGRAPH

Preparation

The spectrograph was setup without predisperser grating. Thus, we had to use narrowband interference filter to sort out individual diffraction orders. From the available stock, we chose filters for the Ca II H and K lines at 397 and 393 nm, the H I line at 486 nm (H-beta), the two Na D lines at 590 nm, and two Fe I lines at 630 nm, which are accompanied by two terrestrial O_2 lines.

Exercises

1. Use a spectral atlas to find the spectral lines mentioned in the previous section. To change the spectral region, change the angle of the Echelle grating using the handbox.
    a. Verify the spectral region by viewing through the eyepiece (check the color!)
    b. Verify the spectral region by recording the image with a CCD camera
2. Use the crosshairs at the entrance slit to verify or change the focus position of the CCD camera.
3. See (and explain) the differences between solar spectral lines and lines produced in the Earth atmosphere (terrestrial lines).
4. Why are there no O_2 lines in the solar atmosphere? (Why are there no Fe I lines in the Earth atmosphere?)