Astronomy A305 - Modern Observational Techniques
Lab Assignment 5

CCD Imaging of Sunrise and Sunset

Goal: The goal of this lab assignment is to learn to determine the basic characteristics of the CCD camera and to learn to measure seeing and sky brightness from CCD observations

What to hand in: Submit a complete (see the general lab instructions) lab report describing your observations in detail, including a log of your observations. Assess the quality of your observations (depth, focus, guiding, seeing). Describe your measurements of the plate scale, the properties of the CCD (bias and saturation levels, and the dark current rate), and the sky brightness and seeing that characterize your observations. An appropriate length would be about three typed page, single spaced, 12-point font, with 1” margins, plus any figures or tables. You should also have one of the lab instructors certify that you were able to complete the requirements of the lab by signing below.

Requirements:
• Obtain B and V filter observations of a star field containing stars with well determined coordinates.
• Obtain bias frames, dark frames, and sky flat frames to calibrate your astronomical images.
• Determine the plate scale, orientation, and field of view of the CCD imager from your date.
• Determine the bias level, dark current, and gain of the CCD.
• Determine the seeing and sky brightness during the time of your observations in both B and V

Certification: ___________________________ has completed the assignment and successfully located four objects with Sunrise or Sunset. The student has also demonstrated an ability to operate the telescope successfully in a safe and appropriate manner.

Signed: _______________________________________________________
Lab Instructor
Observations

Star field or star cluster: For your observations of a star field or cluster, you may choose any field that contains several stars for which you can find accurate coordinates. The Hipparcos catalog, the HST guide star catalog, and the 2MASS All Sky Survey are good sources of coordinates. The open cluster M11 is a good choice.

Obtain both short and relatively deep images of the selected field using the B and V filters. It is recommended that you obtain 3 exposures in each filter. Use the guider for long exposures.

Calibrations: Take 3 sky flats in each filter using the twilight sky, plus 5 bias frames and 3 dark frames with exposure times similar to your flat field frames. Use the shortest possible integration time (0.11 seconds) for bias exposures. Also acquire an overexposed image of a bright star.

Observing Log: Maintain an observing log including the time, date, exposure time, filter, airmass, the temperature of the CCD, and the sky conditions for each observation taken, both calibration and object exposures. Include comments as appropriate (e.g. "elongated images" or "out of focus" or "integration time too short" or "stars saturated," etc.)

Determining CCD and Sky Properties:

Plate scale. Determine and list the center pixel coordinates in declination for two pairs of stars that are widely separated (in declination and/or right ascension) on a CCD exposure. Use the stellar declination and RA of these stars to calculate four values of the plate scale in arc seconds per pixel. Is the plate scale the same using the B and V filters?

CCD Properties.
- Determine empirically the bias level and the saturation level in DN (digitized numbers). Use the shortest possible exposure (0.11 sec) Dark Frame for bias. You can either sample a few pixels and take the mean, or use the Histogram function from the View menu.
- Determine the saturation level using an exposure of a bright star with an exposure time long enough reach the maximum pixel value for the center of the saturated star image.
- Determine the dark current rate at the temperature of the CCD during your observations. Dark current is described as DN per second. Be sure to subtract the bias level before determining the dark current rate. How long can you integrate before dark current accumulates to one-half of the saturation DN?

Seeing. From the plate scale and from star images in your exposure, determine the FWHM of the star images for short and long exposures.
Sky brightness. From your observations, determine the brightness of the sky in DN s\(^{-1}\) in each filter. Be sure to subtract off bias and dark current. This can be done in one step by using the automatic dark frame subtraction feature in CCDSoft. How long could you integrate before the sky signal accumulates to one-half of the saturation level? The zenith sky brightness depends on the lunar location and phase, as well as the sky condition. Therefore carefully note the lunar and sky conditions under which you made your sky brightness determination. Compare the B and V sky brightness determinations.