SIERRA COLLEGE OBSERVATIONAL ASTRONOMY LABORATORY EXERCISE		
NUMBER II.C.	**TITLE: Astronomical Imaging**	
DATE- **DAY-** **LOCATION**	**PRINT NAME/S AND INITIAL BELOW:**	**GROUP** ☐

PURPOSE:

To learn how cameras may be used to collect images of celestial objects.
To make measurements of astronomical photographs.
To determine plate scale by formula and observation.
To get an introduction to digital imaging devices such as CCDs.

DESCRIPTION:

Much information about the universe has been gathered using imaging devices, especially film and digital cameras. This exercise will address astronomical imaging, especially with an introduction to CCDs (Charged Coupled Devices).

PROCEDURE:

The instructor will demonstrate various ways of attaching a standard 35mm camera to a telescope to make both wide field and long focal length prime focus photographs. The concept of f/ratio will be presented. An application of an electronic (CCD) camera will also be demonstrated.

The instructor will derive the formulae below and explain their use in this exercise.

$F = \frac{57.3^{o} \times S}{A^{o}}$	$F = \frac{3438' \times S}{A'}$	$F = \frac{206265'' \times S}{A''}$	**(Eq. 1)**
$f/ratio = F/D$			**(Eq. 2)**

F = the focal length of the camera lens or objective (mm).
S = the image size or measured dimension on the image (mm).
A = the angular space between two points on the sky, or the size of the celestial object (degrees, or arcminutes, or arcseconds)
D = the diameter of the camera lens or objective (mm).

MEASUREMENTS/OBSERVATIONS:

1. Determine the exposure time (minutes) for each of the 3 star trail photographs. Given the actual exposure times, calculate the percent discrepancies for your results. Enter the results in Table A.

TABLE A

Photo #	Trail Angle	Measured Exposure Time	Actual Exposure Time	% Discrepancy
1			**12 min**	
2			**6 min**	
3			**24 min**	

2. Measure the diameter of the Moon on the lunar images.
   a. On the 35 mm slide made at the prime focus of Meade or C-8.
   b. On the photograph made at the prime focus of Markowitz Dual Rate Camera (MDRC).

   Using the angular size of Moon as given in Table E, determine the focal lengths of both systems (use Eq. 1). Enter data in Table B.

TABLE B

	Diameter of Image	Computed Focal Length	Actual Focal Length	% Discrepancy
Meade or C-8 slide of Moon			**2000 mm**	
MDRC image of Moon			**4200 mm**	

3. Measure the size of Jupiter on the slide provided. Using your measured image size and the given telescope focal length, calculate the angular size of the planet (solve Eq. 1 for ***A***). Enter results in Table C. Using the actual angular diameter of Jupiter at the time of observations (in Table E), calculate the discrepancy in your computed value.

TABLE C

Jupiter image diameter	F_o	Computed angular diameter of Jupiter	Actual angular diameter of Jupiter	% Discrepancy
	17600 mm			

4. Calculate the field of view (width and height) of the CCD camera used in the observatory at the Nevada County Campus. Use Eq. 1, solved for ***A*** in arcminutes.

TABLE D

Telescope Focal Length	**CCD Chip Size**	**Computed Angular Field of CCD Chip**
2800mm	**13.3 mm x 13.3 mm**	**x**

QUESTIONS/CONCLUSIONS:

1. What is the **f/ratio** of a Meade telescope?

   Is this telescope 'faster' or 'slower' than an f/11 optical system?

2. If the moon were photographed on various nights with the same camera, would its image size change? Explain.

3. Give some possible reasons for discrepancies in Tables A-C.

4. Rewrite the three versions of Equation 1, below, having solved them for the field of view A:

   A^{o} =

   A' =

   A" =

5. Using your equations from question #4, calculate the angular field that would fit on a single frame of 35 mm film at the prime focus of a 50 mm focal length lens.

   Short dimension (S= 24 mm) A = _____ degrees

   Long dimension (S= 35 mm) A = _____degrees

6. Calculate the angular field along the short dimension of a 35mm frame at the prime focus of a Meade telescope. Give your answer in arcminutes.

7. At the top of Table E, write the field of view of a 50 mm lens camera along the 24 mm short dimension (from Question 5) in the top row, column 1. Also, write the field of view from the Meade telescope (from Question 6) in column 2. Finally, write the field of view of a CCD chip (from Table D) in column 3.

8. Place checks in columns 1, 2, 3 of Table E, for each object that would fit in the field of view for that optical system.

TABLE E

Celestial Object	Angular size	Column 1: 50 mm lens	Column 2: Meade	Column 3: CCD
Lyra (constellation)	8°			
Orion (constellation)	15°			
Large sky view for meteor shower	90°			
All-sky Milky Way panorama	180°			
Sun	32’			
Moon	31’			
Jupiter	40”			
Saturn with rings	42”			
Venus	20”			
Mars	8”			
M-1 Crab Nebula	6’			
M-8 Lagoon Nebula	1.5°			
M-13 Hercules Globular Cluster	12’			
M-27 Dumbbell Nebula	8’			
M-31 Andromeda Galaxy	160’			
M-42 Orion Nebula	1°			
M-44 Beehive Cluster	1.5°			
M-45 Pleiades (7 Sisters)	2°			
M-57 Ring Nebula	90”			
M-51 Whirlpool Galaxy	12’			