Best Possible Astroimaging for the Beginner on the Cheap

Abstract

The main objective of this project is that a novice amateur astronomer could acquire an acceptable proficiency in the practical use of astroimaging techniques, not as a purpose by itself but as a means to allow him the gathering of potentially useful astronomical data. Despite the apparent rudimentary of the equipment at the reach of any ordinary amateur, serious information can still be inferred on condition that it were properly applied.

Given determinate astronomical and imaging equipment operating from a specific site, the properness of its application implies the achievement of the best possible image for the considered target. In this project, several and well different targets will be imaged by means of both film and CCD techniques, and theirs respective appropriateness will be evaluated by comparing the correctness of derived scientific data.

Science Description

Film and CCD imaging intrinsically achieve very different characteristics regarding linearity, dynamic range, spectral sensitivity, efficiency, etc. Being both techniques nowadays equally accessible to any amateur astronomer, the plain knowledge of their theoretical potentialities and practical complexities of use becomes the fundamental first step if serious field work is really pretended to be performed.

In the case of film photography, the selected film speed, the applied exposure time, the optical characteristics of the used lenses, and the application of proper guiding greatly affect the resulting image (Covington, 1999). For CCD photography, such user-variables as exposure time, operating temperature, number of images to be stacked, filters, and correct image processing are directly responsible for the achieved final quality (Wodaski, 2002). *The primary aim of this project is to qualitative analyze, for a given equipment, how different combinations of the involved imaging variables do benefit or degrade the corresponding result.* This will shed light on which particular imaging procedure is the recommended one depending on the considered celestial target.

The scientific information that can be derived from astroimages -by means of applying a suitable software tool- is astrometric and photometric data. In order that the derived data could be reliable, images must represent the real world as truthful as possible. As any imaging system necessarily incorporate inevitable deformation, not only deviations should be qualitatively minimized but quantitatively evaluated as well, if scientific data is going to be extracted from any image. *The secondary aim of this project is to quantitative evaluate the properness of some CCD and film images by analyzing astrometric and photometric data obtained from them*. This will demonstrate the grade of accuracy that data extracted

from the applied imaging gear actually achieves, and hence a definite evaluation about its scientific capability could be objectively stated.

Technical Description

This project will be done by means of relative unsophisticated equipment at the reach of any average amateur astronomer. Specifically, the telescope will be an 8" Schimdt Cassegrain (Meade's LX-90) with no fixed mount, and the imaging gear will include a small sized CCD astronomical camera (Meade's 216XT), a SLR 35-mm film camera (Nikon EM) with several interchangeable lenses, and a CMOS webcamera (Meade's LPI).

No previous practical experience at all, impossibility to obtain any special developing service or stuff other than usual accessories, and suburban skies are the three main restrictions that will frame the execution of this project.

The actual optical and mechanical parameters of the telescope will be appraised, as they certainly impose a practical restriction on the achievable goodness of any image obtained by its support (Berry & Burnell, 2000).

Different imaging procedures will be tried for different targets in order to evaluate their relative properness. Particularly, several film piggyback conditions will be analyzed by using different lenses, different exposures times, different films, with and without guiding, for very different targets (small/large fields, faint/bright objects). Also, film and CCD prime focus imaging will be tried, as well as a CMOS webcam exclusively on the Moon.

The film images will be digitalized by using a standard scanner of 600 dpi. Digital image processing and data extraction will be performed by applying the AIP4WIN software.

The imaging targets have been selected from the brightest objects in each one of the wanted categories -solar system, standard fields, globular clusters, nebulae- (Gupta, 2004), on condition that they would appear particularly high from the observing site. Each expected altitude was found out with the assistance of the Starry Night Pro software.

Particular Tasks to Be Executed

- Analysis of the quality of the telescope tracking
- Determination of the exact focal length of the used telescope
- Assessment of the linear response of the used CCD camera
- Imaging of globular clusters (47 Tuc, M55) and nebulae (Helix, Tarantula, Trifid)
- Digitalization of film images
- Color imaging by the CCD camera (through proper filters)
- Normalization and data reduction of CCD images
- Evaluation of the time variable displacement of Vega for the project period
- Determination of the magnitude limit of each considered image
- Photometric analysis of a standard field image (Landolt SA 113)
- Imaging of the favorable Total Lunar Eclipse of October 28th (UT)

Project Schedule

The overall period to perform this project will span little more than two months from early September, 2004. Taking into account that weather conditions at the observing site are highly variable especially for the considered period, imaging sessions must be properly planned to make the best possible use of the occurrence of favorable nights. Due to private time restrictions, imaging sessions will run from full darkness up to about midnight.

As moonlight spoils the imaging of celestial objects other than bright ones, periods when the Moon appears gibbous well high over the horizon will be useless for this project, except for lunar imaging. This indeed will be the major activity previous to the fortunate event of the total lunar eclipse of October 27th (local time).

Considering moonlight conditions and selected imaging targets, there will be just five favorable imaging periods of different lengths. The following chart shows, for each period, the corresponding dates and length, and a timetable of the targets that should be imaged with their respective average altitudes at the local sky.

Period	***Date***	***Nights***	***Targets to be imaged***
# 1	Saturday Sep 4th to Sunday Sep19th	16	21hs: M 55 (87°), Trifid Neb (64°) 22hs: Landolt SA 113 (55°) 23hs: Saturn Nebula (67°) 24hs: Vesta (70°)
# 2	Friday Oct 1st to Sunday Oct 17th	17	21hs: M 55 (68°), Trifid Neb (47°) 22hs: Landolt SA 113 (56°) 23hs: Vesta (75°), Helix Neb (74°) 24hs: 47 Tucanae & SMC (49°)
# 3	Monday Oct 18th to Tuesday Oct 26th	9	21hs - 23hs: Waxing Moon
# 4	Wednesday Oct 27th	1	21hs - 03hs: Total Lunar Eclipse
# 5	Sunday Oct 31st to Friday Nov 12th	13	22hs: Vesta (69°), Helix Neb (64°) 23hs: 47 Tucanae & SMC (48°) 24hs: NGC 253 & NGC 288 (71°) 01hs: M 42 Orion Nebula (47°) 02hs: Tarantula Neb & LMC (51°)

References

Berry, Richard & Burnell, James (2000): *"The Handbook of Astronomical Image Processing"*, Willmann-Bell Inc.

Covington, Michael A. (1999): *"Astrophotography for the Amateur"*, Cambridge University Press, 2nd ed

Gupta, Rajiv (ed) (2003): *"Observer's Handbook 2004"*, The Royal Astronomical Society of Canada

Wodaski, Ron (2002): *"The New CCD Astronomy"*, New Astronomy Press