ASTROPHOTOGRAPHY

Astrophotography is a specialised type of photography that involves capturing different types of images and the calibration and processing of captured data. With a few exceptions astrophotography uses multiple-time exposure images combined with data processing software.

Images that can be captured in the sky include the solar system, stars and star clusters, galaxies, nebulae, and comets, meteors and meteor showers. 'Nebulae' are enormous clouds of dust and gas in the space between stars that act as a nursery for new stars.

Different types of digital cameras

Different types of digital cameras can be used, including:

- Digital cameras (DSLR) for photographing the solar system, star clusters and deep sky objects.
- Dedicated astronomical CCD cameras together with red, green and blue colour filters, mainly for photographing the solar system, star clusters and deep sky objects. A CCD camera is a camera that contains a charged-coupled device (CCD), a transistorized light sensor on an integrated circuit.
- Smartphones to photograph the Earth's moon and the planets in our solar system.
- Webcams to photograph the planets.

Fitting the cameras

The cameras can be fitted using different adaptors:

- Fixed on a sturdy tripod (DSLR).
- 'Piggyback' when fixed on top of a tracking telescope's tube or fitted onto a separate tracker (DSLR).
- 'A-focal' by connecting to the eyepiece of a telescope (DSLR, smartphones and Webcam).
- On a tracking telescope using 'Prime Focus' by replacing the camera's lens with the telescope's lenses or mirrors (DSLR and CCD).

Capturing the images

Images can be captured in different ways:

Single-shot for relatively bright objects

- Single-shot with suitable time exposures for photographing brighter objects by fixing the camera on a tripod and using a wide-angle lens to capture star trails, the Milky Way and constellations.
- Single-shot with A-focal, piggyback or prime focus for photographing the moon, planets and constellations.

Multiple exposures for capturing images of faint celestial objects:

- **Using light frames**: These are actual exposures, in RAW format, of an object in the sky. A RAW image is the digital equivalent of a film negative. The object signal comes from the photons that have travelled incredible distances across the universe and are recorded by the camera. Longer time exposures, which increase the number of photons that are captured, result in more detail in the final image. Enough frames should be shot to obtain a minimum combined exposure time of twenty minutes.
- Using support frames: These frames are used in suitable software for processing data captured in the light frames by removing undesirable 'noise' signals (introduced by the electronic circuitry in the camera) and correcting problems such as dust shadows on the sensor's glass. There are three kinds of support frames:

› Dark frames are made using RAW format and by covering all camera openings by placing the body cap on and covering the viewfinder eyepiece opening. The same exposure time is used as for light frames at the same ISO (a measure of the camera's sensitivity to light) and temperature, and a minimum of 11 dark frames is shot.

› Bias frames are made exactly like dark frames except that the shortest time exposure on the camera is used.

› Flat-field frames use RAW format and an evenly illuminated, fairly bright light source, such as the twilight sky, with a low ISO setting, infinity focus, and in the aperture value mode setting. A minimum of nine frames is shot.

Calibration and processing of the captured data

Processing involves the application of dedicated astrophotography software, as well as general software such as Photoshop, to process the RAW data captured in the form of light, dark, bias and flat frames. This is done in two phases on a computer.

Pre-processing RAW images using astrophotography algorithms to do the calibration

- Using calibration frames to create Master Dark, Master Bias and Master Flat frames.
- Using master frames to create calibrated light frames by reducing thermal and bias signal noise and removing unwanted modifications from each captured light frame.
- Converting each calibrated light frame to colour.
- Aligning and stacking all colour light frame images to produce one single colour image for post processing.

Post-processing using dedicated or general photo software

This is done by applying various software techniques to normalize the sky background, adjust contrast and brightness, make fine details visible, saturate colours, reduce noise, remove gradients, improve sharpness and improve star colours.