Geophysical Research Abstracts
Vol. 19, EGU2017-9660, 2017
EGU General Assembly 2017

Planetary polarisation measurements with small telescopes

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We have developed a method for measuring the linear polarisation of planets which is accessible to experienced amateur astronomers. The method requires a telescope with an aperture of about 20cm or more together with a linear polarising filter and a planetary imaging camera. Many suitable cameras are available and they can record uncompressed video at frame rates of 10 to 60 per second. Typically this rate will depend on the brightness of the source and size of the telescope. An ideal camera will be monochrome and is used with separate colour filters and a polarising filter.

The method is to attach the colour and polarising filters to the camera and record a series of video clips. After recording each video clip the camera and filters are rotated by about 20 degrees until the total rotation is over 180 degrees.

Each video clip is then stacked to produce a single low noise image. Most stacking software can sort the video frames according to quality, so the stack is based on a selected percentage of the best frames. There are several freeware stacking programs available which are primarily used for planetary imaging in general but are very suitable for polarisation. Original videos are mostly 8 bit but noise allows the combined stack to have a higher effective resolution and it is saved in 16 bit format.

The stacked images are currently processed in Matlab, although the algorithms are being incorporated in Winjupos which is freeware. Results so far have been primarily for Jupiter, but we also have some data for Venus. The Matlab code is used to register the stacked frames (removing any camera rotation) and in the case of Jupiter, compensate for rotation of the planet during the video capture process. Accurate image registration is crucial for this method. A disk function is also applied to allow for the changing illumination angle as the planet rotates.

A least squares function calculates the best fit cos squared curve for the variation of light at each point in the image as a function of the angle of the polariser. The coefficients of the multivariate fit are used to calculate the polarisation and its direction (the phase angle of the curve). Statistical analysis of the results gives a one standard deviation confidence interval for the polarisation.

Initial results for Jupiter show the strong polarisation at the poles and variation in the belts and zones. The confidence interval is typically less than 1 percent. Analysis of the results is at an early stage but has the potential to help our understanding of the structure and composition of planetary atmospheres. In addition the involvement of amateur astronomers allows for plenty of available telescope time and the potential for long term monitoring of possible variations in polarisation patterns.