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Experimental color analysis of Jupiter's clouds

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Abstract

Jupiter is a planet which is currently well followed by amateurs from the ground, with high resolution images taken in color, or in non-visible wavelengths such as UV, IR, CH4. Such images participate to the knowledge of the planet, along with professionnal data and space orbiters like the JUNO probe. Other technics of observation like spectroscopy and photometry, while being widely used among amateurs to study stars, remain largely ignored for planetary studies, and would deserve to be more investigated.

1. Introduction

Describing the variations of colors on planetary disks has always been a part of the following of planets. This topic is interesting because color changes are a manifestation of some meterological and chemical changes. On Jupiter, many short or long-term color changes can be identified. Some of them have been linked to a scientific explanation, like the recurrent episodes of strong coloration in the equatorial zone [1]. Some others remain, however, unexplained.

While the colors of the planet can be easily revealed by the modern high quality and high resolution images, evaluating them on those images remain partially a subjective work. In the professional world, it is possible to use high-resolution spectroscopy or absolute reflectivity on disk images [2]. But these technics can prove hard to use for amateurs.

Because this topic participates to the long-term knowledge of Jupiter, I will experiment some more basic methods, accessible to amateurs, for a more objective way to evaluate the colors of the jovian clouds.

2. Low resolution spectroscopy of belts and clouds

By using a simple grating of R=100, but modified in order to work with a slit, it is possible to extract low resolution spectra of the main belts and zones. By taking the spectrum of a nearby solar-like star, it will then be possible to produce reflectance spectra of those belts and zones.

3. Reflectance photometry of the jovian details

The concept of reflectance spectrum, which implies the simple division of planet's spectrum by a solar star spectrum, could be extrapolated for filter photometry. Images of Jupiter and the reference star will be taken with BVRI photometric filters and the first series divided by the second. While the resolution of such a reflectance "spectrum" will drop to only 150 nanometers (the mean transmission of a filter), it will be in return possible to extract reflectance photometry from details other than belts and zones, like the Great red spot (GRS).

4. Photometric color index of the jovian details

The final experimentation will be to calculate the photometric magnitudes of Jupiter, possibly in all UBVRI bands, or only some of them. This will be done by using the method of differential photometry, starting from nearby reference stars of different color index (B-V). Then, on photometrically calibrated jovian disks images, it will be possible to extract color index of the main details, either belts and zones, or smaller areas like the GRS.

5. References

[1] Arrate,A., Fletcher,L., Orton,G., Melin,H., Rogers,J., Harrington,J., Donnelly,P., Rowe-Gurney,N., . Blake,J. (2018), “Infrared Characterization of Jupiter's Equatorial Disturbance Cycle”, Geophysical Research Letters, vol.45 Issue 20, 10987-10995.

[2] Mendikoa, I., Sanchez-Lavega,A., Pérez-Hoyos,S., Hueso,R., Rojas, J-F., Lopez-Santiago,J., "Temporal and spatial variations of the absolute reflectivity of Jupiter and Saturn from 0,38 to 1,7 μm with PlanetCam-UPV/EHU", Astronomy and Astrophysics, vol.607, november 2017.