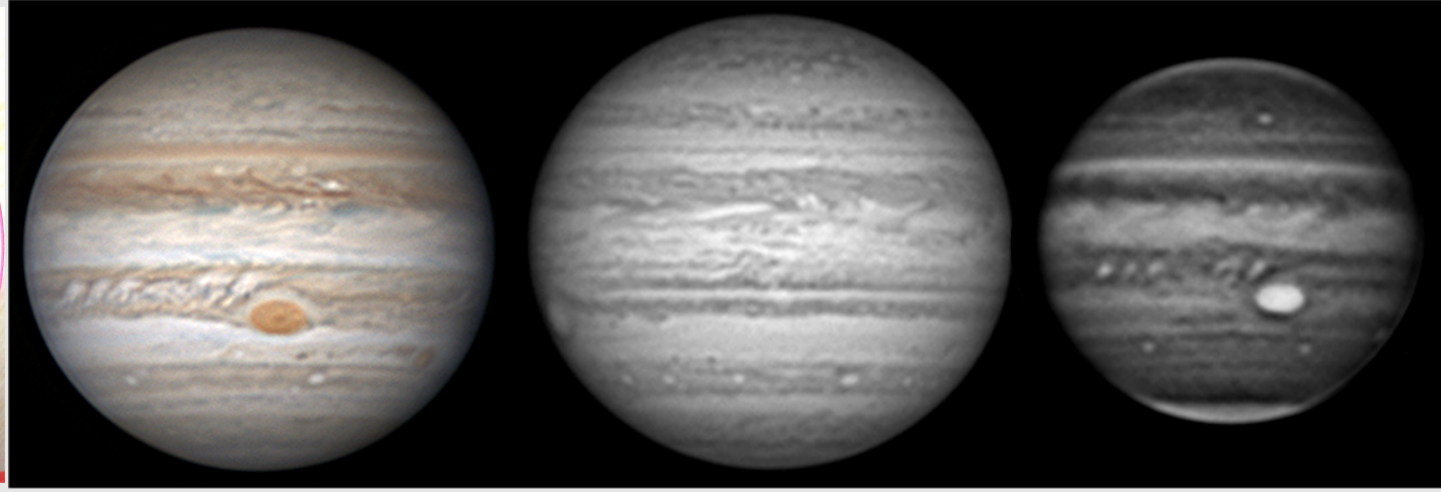
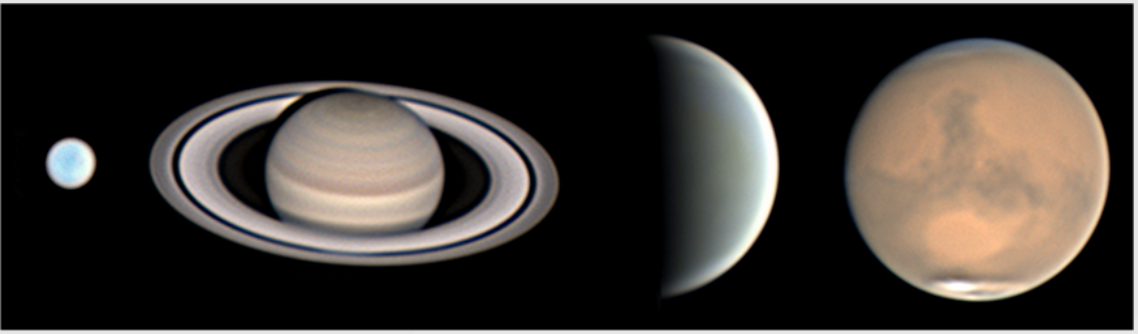
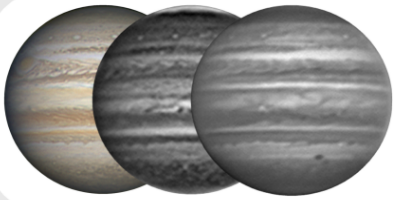


PLANETARY IMAGING WITH A COLOUR CAMERA



COLOUR AND INFRARED IMAGES

FIRECAPTURE SETTINGS

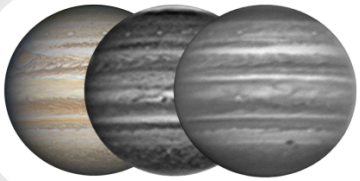


PLANETARY ASTRONOMY

A website by Christophe Pellier

"Planetary imaging with a colour camera"

Is a free guide offered to the readers of the blog



PLANETARY ASTRONOMY

A website by Christophe Pellier

SUMMARY

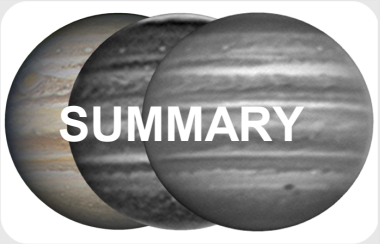
WHY CHOOSE A COLOUR CAMERA ?

For imaging planets we can choose between "colour" sensors and "black and white" ones. Usually we consider two points to decide between the two :

- The colour camera will image planets with less constraints and with a more simple processing

- But the b&w camera could deliver better results, assuming more complex proceedings of acquisition and image processing. It is then often adviced as a better choice, because it is more sensitive.

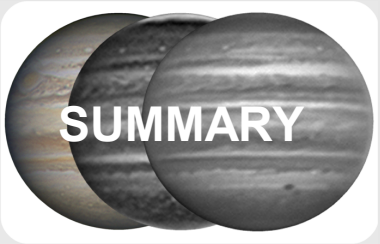
Moreover, b&w sensors give access to other types of observations like infrared, methane or ultraviolet imaging. It is regarded as the favourite tool for the advanced amateur...



WHY CHOOSE A COLOUR CAMERA ?

If the previous remains valuable, at least one parameter of the equation has recently changed: the difference in sensitivity of the sensor that was once always in favour of the b&w camera. Today some of the colour cameras present a very high sensitivity and a weak read out noise, and produce excellent results. This change comes largely from the CMOS revolution. Once a poorer technology than CCD, CMOS has now surpassed it.

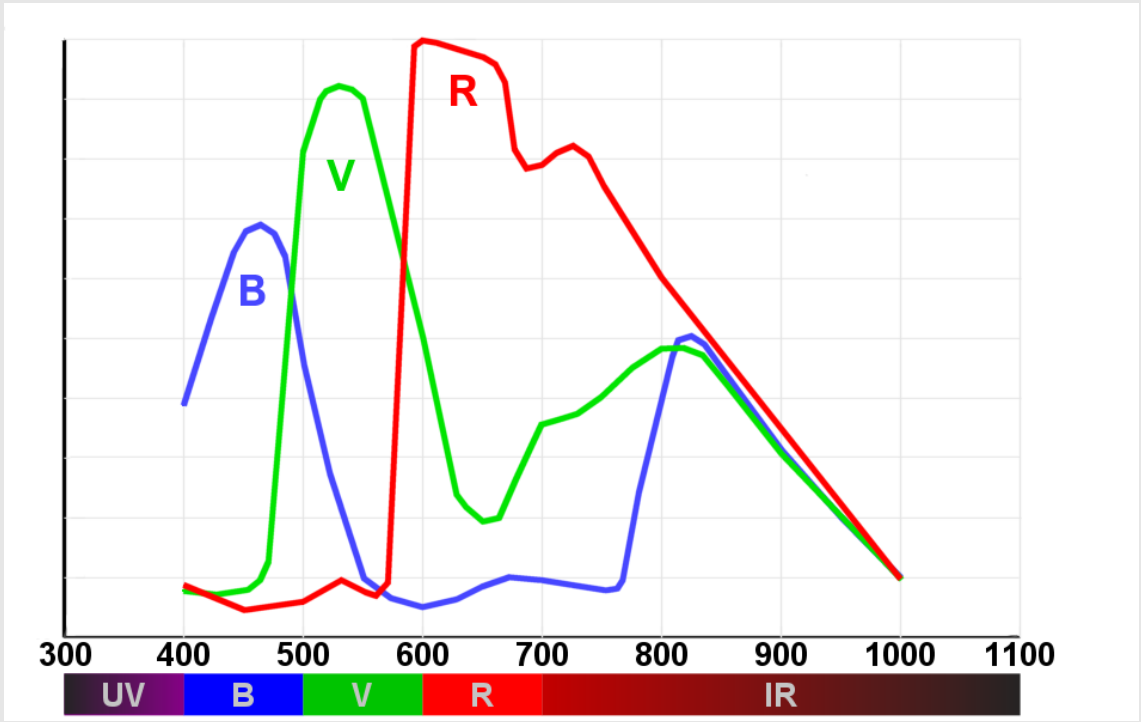
This guide is written following my experience with the IMX224 CMOS sensor from Sony, that equips the ASI224MC model from ZWO. But other models exist, such as the ones using the IMX290, as well as other brands like Altaïr astro or QHY.



1. PRESENTATION OF THE ASI224MC CAMERA

The ASI224MC has a 1304x976 photosites sensor of 3,75 micrometers size (µm).

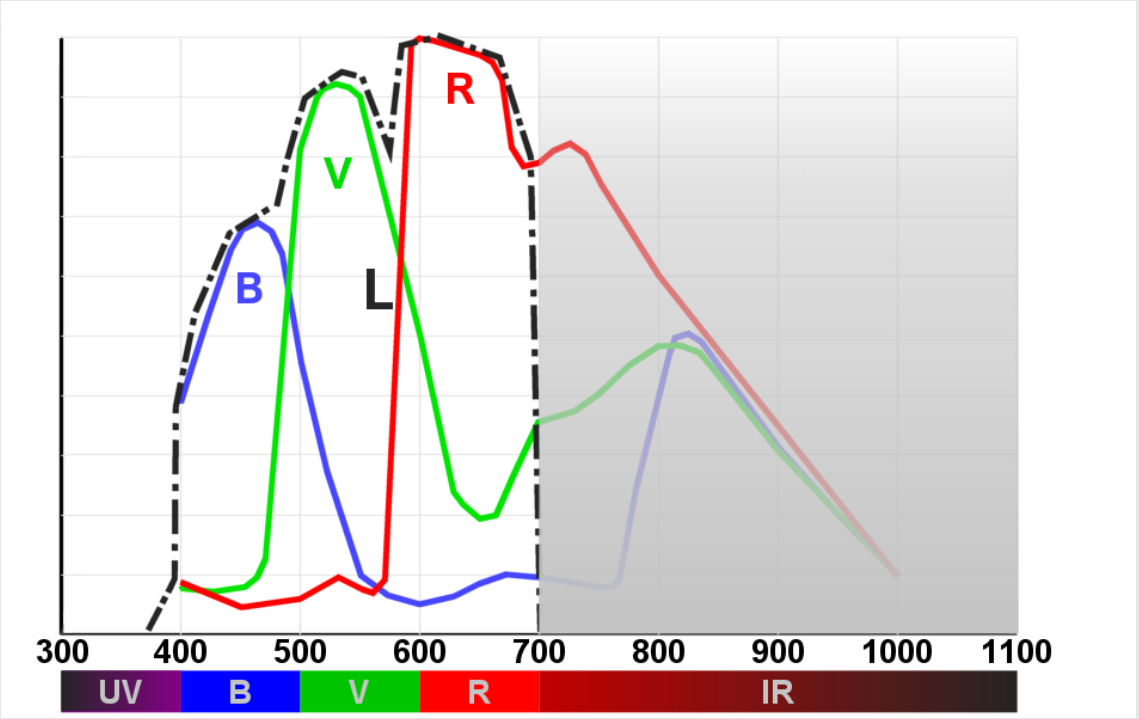
The graph below describes the response of the sensor following the wavelength. Because it is a colour sensor, it comes with an overlaid grid of red, green and blue filters called the *Bayer matrix*. The sensitivity extends beyond 700 nanometers into the near infrared, as it is the case for any camera. This will be exploited for imaging planets (read further "IR imaging with a colour camera").

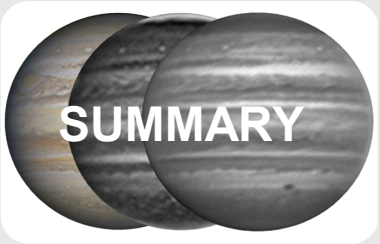


1 – EQUIPMENT OF THE COLOUR CAM : THE IR-CUT FILTER

A Colour camera is to be used along with two essential accessories. The first one and the more important is the presence of a glass filter that is going to block the near-infrared. Some models have a built-in protecting window that already filters infrared and can be used straight on. But the protective glass of other models (like ASI224MC) is transparent to IR and will so require an additional IR-cut filter. Several filters are commercialy available usually at a cheap price. Mine is the former L filter from Astronomik (this brand has recently modified its offer for IR-cut filters, the equivalent would be the "L-2" filter).

This "L" filter eliminates all wavelengths beyond 700 nm.





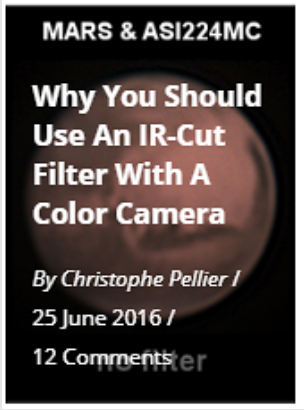
1 – EQUIPMENT OF THE COLOUR CAM : THE IR-CUT FILTER

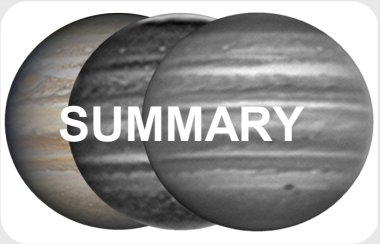
This filter is necessary because the presence of infrared in an image will transform the colour balance by shifting the camera's response towards red wavelengths. A correct colour reproduction must be coherent with our eye vision: and we do not see the infrared !

On some planets like Saturn or Jupiter, the lack of an IR-cut filter will result into "washed-out" colors, "colder" than those perceived at the eyepiece. But on a very IR-bright planet like Mars, the shift is so strong that the result will not be a colour image anymore... but an infrared one !

At left : test of the IR-cut filter on Mars. Without filter, the image is extremely close to the IR740.

Read the full article on the blog

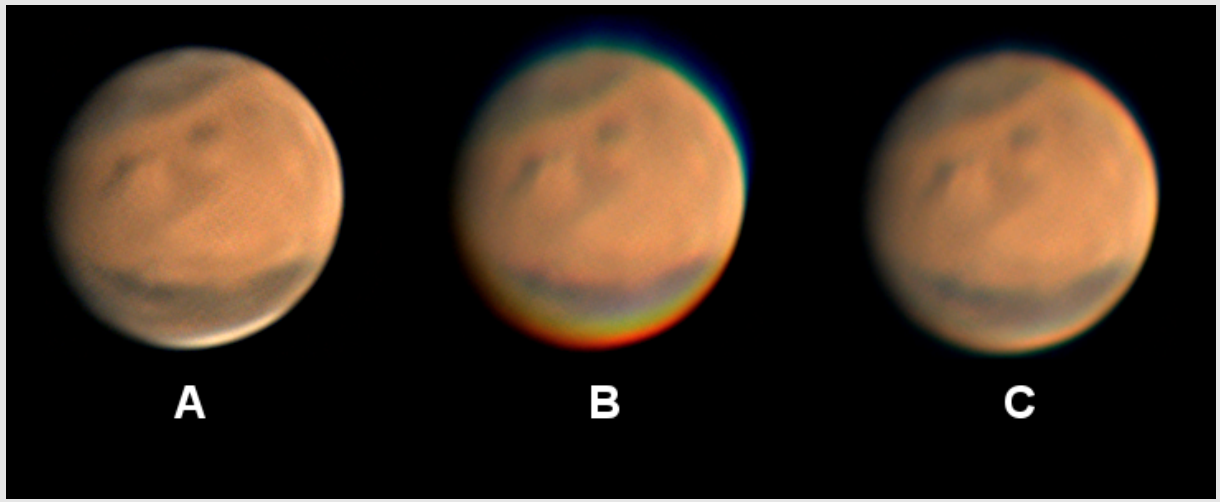




1 – EQUIPMENT OF THE COLOUR CAM : THE ATMOSPHERIC DISPERSION CORRECTOR

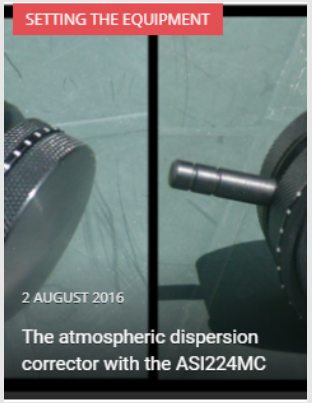
The atmospheric dispersion corrector (ADC) is an optical accessory that corrects the vertical dispersion of colours created by our own atmosphere (blue at top, red at bottom).

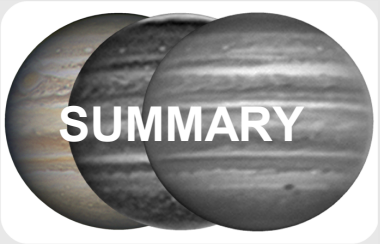
The ADC increases the quality of the image by re-centering every wavelength (and not only the three RGB color bands). Images are sharper and more resolved, especially when planets are very low in the sky.



Mars at an elevation of 20° with ADC (A), without ADC (B) and without ADC with color re-centering (C). Only A is really sharp.

Read the full article on the blog





2 – SETTING THE CAMERA FOR COLOUR IMAGING

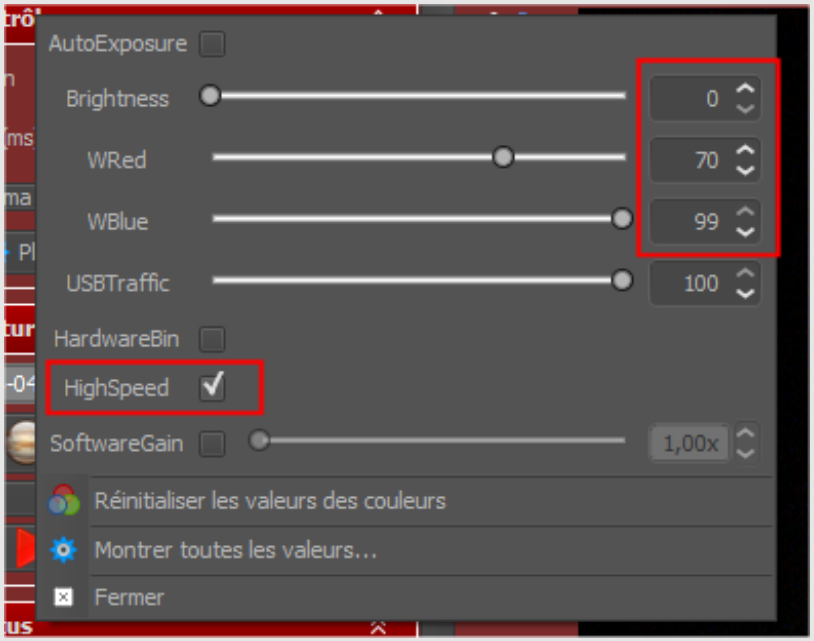
Use of Firecapture : basic settings

Never change these settings :

- Gamma : always unchecked (if not, set it to 50)

- Brightness : always at zero

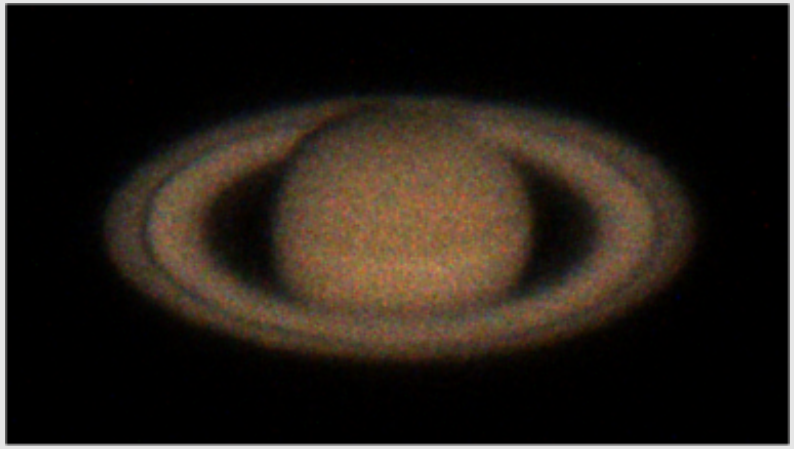
- The HighSpeed box must always remained ticked to avoid abnormal low frame rates.

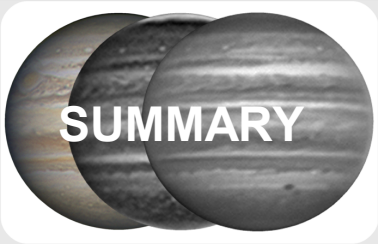


Colour balancing is done with only two cursors, one for red (WRed) and the other for blue (WBlue). Unfortunately there is none for the green.

The idea is only to get an approximative colour balance (fine tuning will be kept for the final processing stage)

Always keep the blue at maximum and balance the image with red adjusting only. The correct value will depend from conditions (elevation and sky transparency) but is usually around 60/70.





2 – SETTING THE CAMERA FOR COLOUR IMAGING

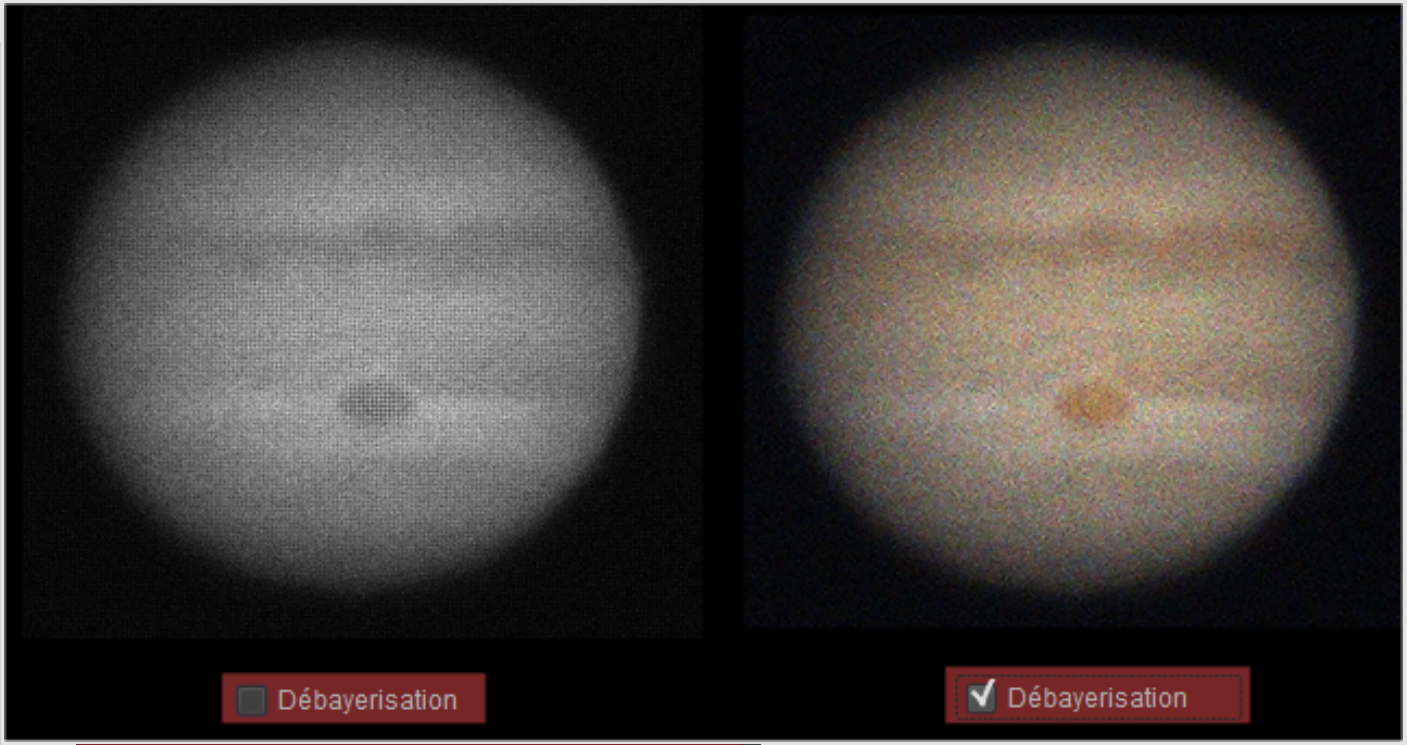
Use of Firecapture : basic settings

Setting the video capture :

- Always use the SER format, much lightweight than AVI, uncompressed, and fully compatible with astronomical processing softwares

- Always record in RAW, i.e. with the "Debayer" box <u>unticked</u>. Image is displayed in b&w and lets guess the grid of the Bayer matrix.

Raw files will occupy less space on the disk and will allow faster frame rates.



The Debayer box is found in options at bottom left.

2 – SETTING THE CAMERA FOR COLOUR IMAGING

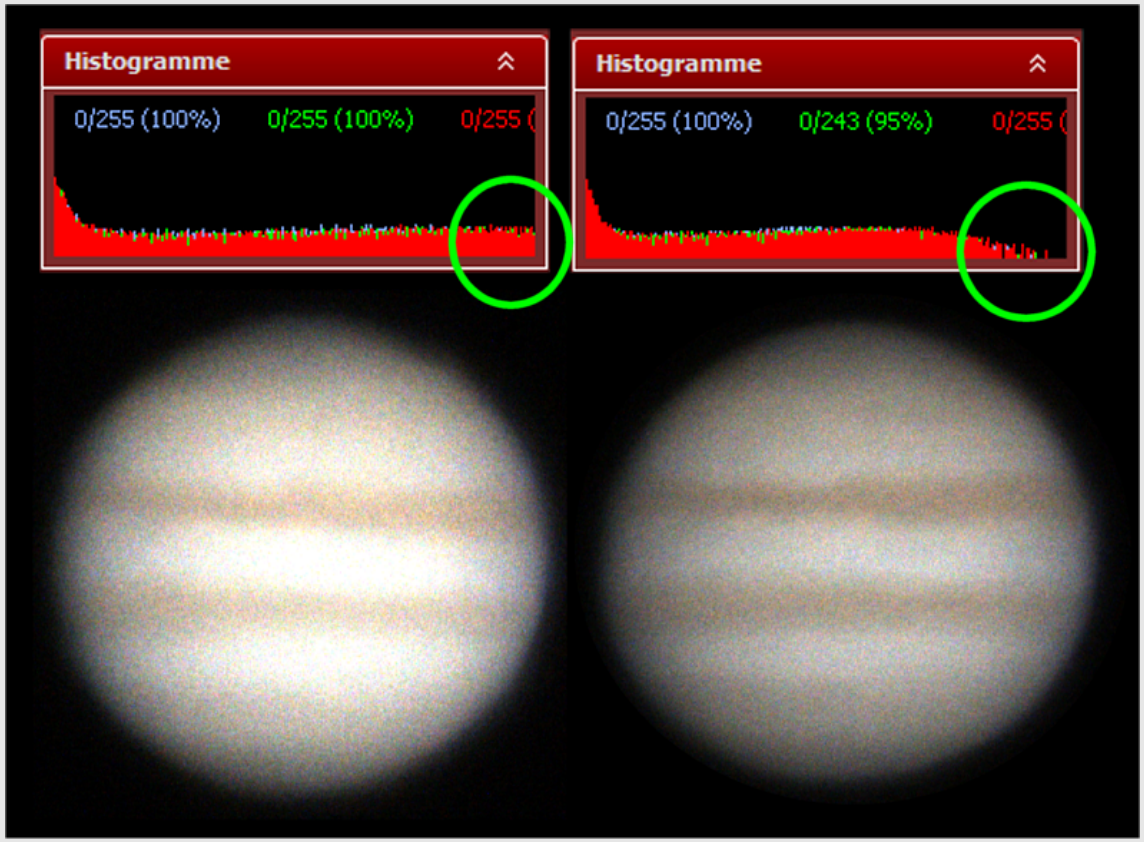
Use of Firecapture : basic settings

Settings of video recording :

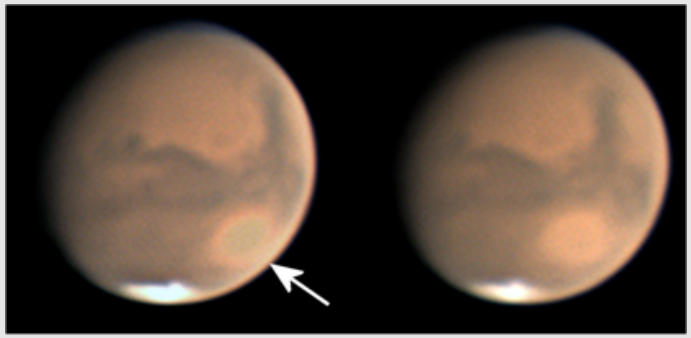
A key setting is adjusting the histogram.

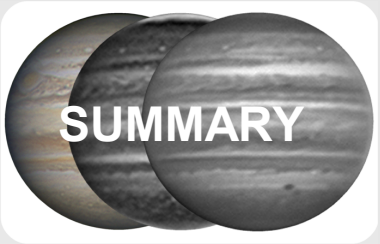
- Too bright, and the image will saturate during recording. Check the right end of the histogram (see at left on the image). Saturated potosites will lose data definitely.

- Too dark, and noise will be more difficult to eliminate during processing. The curve must fall to zero before the right end of histogram.

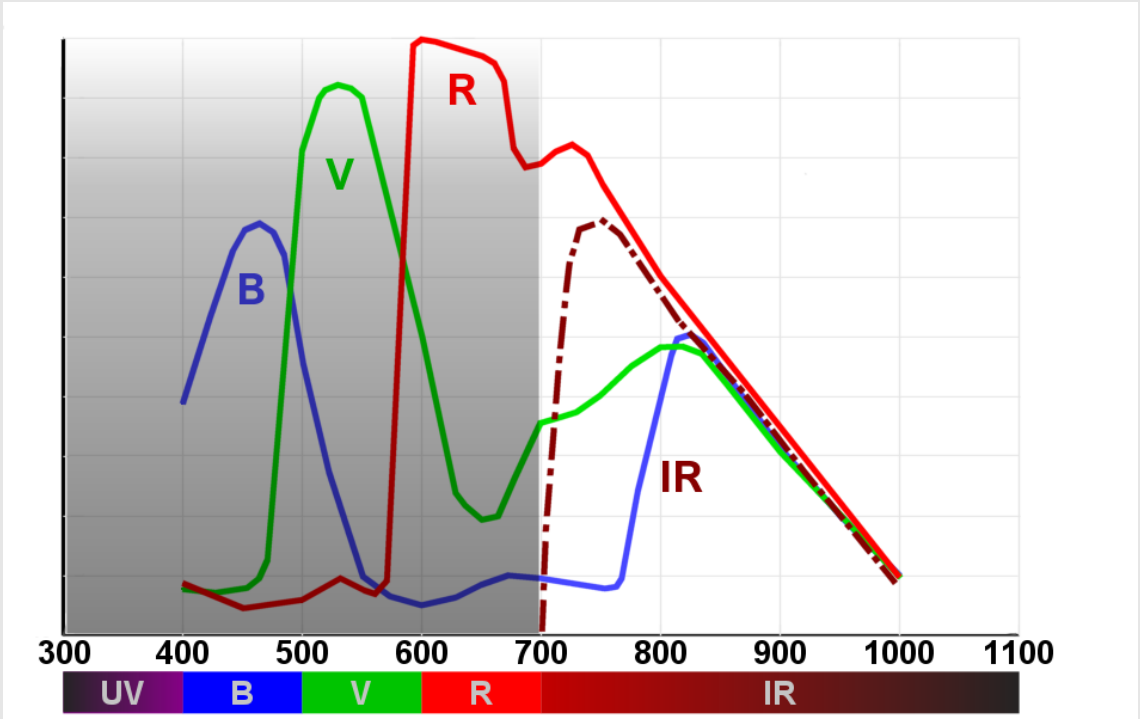


Here is what a saturated image looks like (see the Hellas basin arrowed). At right is an image correctly exposed.





3 – INFRARED IMAGING WITH A COLOUR CAMERA



The ASI224MC is highly sensitive in infrared and can be used along with an IR-pass filter (do not confound with IR-cut for colour imaging).

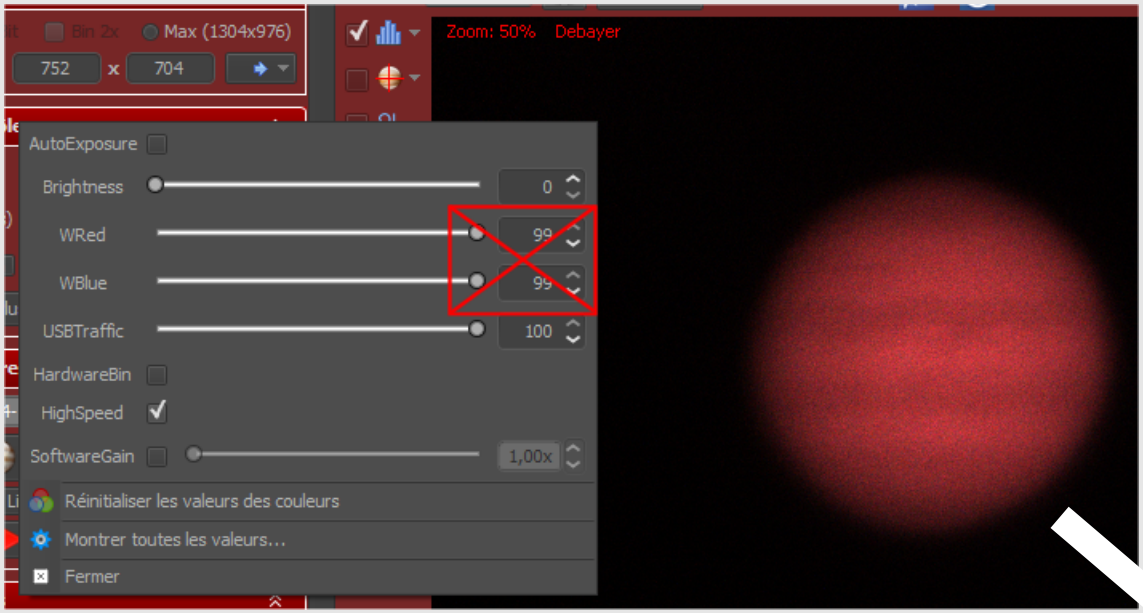
This will allow the camera to make images in this very interesting band.

If your colour camera has a built-in IR blocking protective window, you must remove it and change for on that hasn't one (ask the manufacturer)

Any available IR-pass filter can be chosen, uses are the same as with a b&w camera

Read full article on the blog

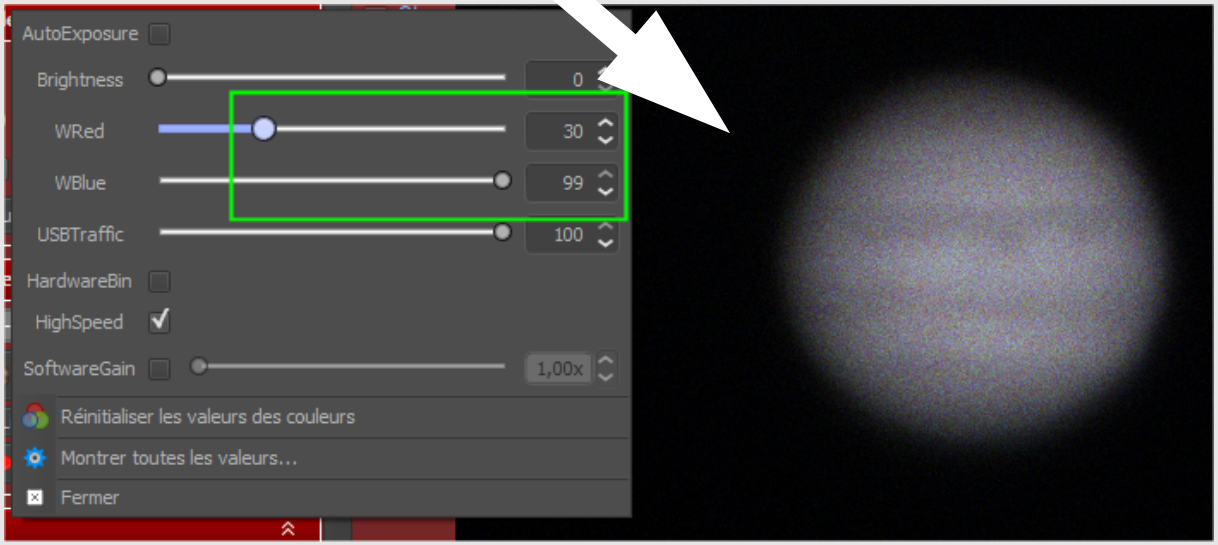
3 – SETTING THE CAMERA FOR INFRARED IMAGING

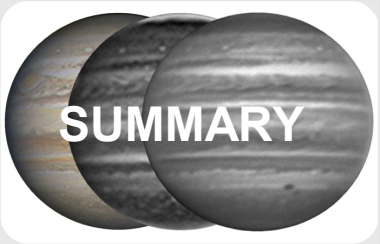


Colour balancing the image in infrared is a key setting. The camera "sees" a very red image if the filter transmits wavelengths before 800 nm, because the red photosites of the Bayer matrix are more sensitive.

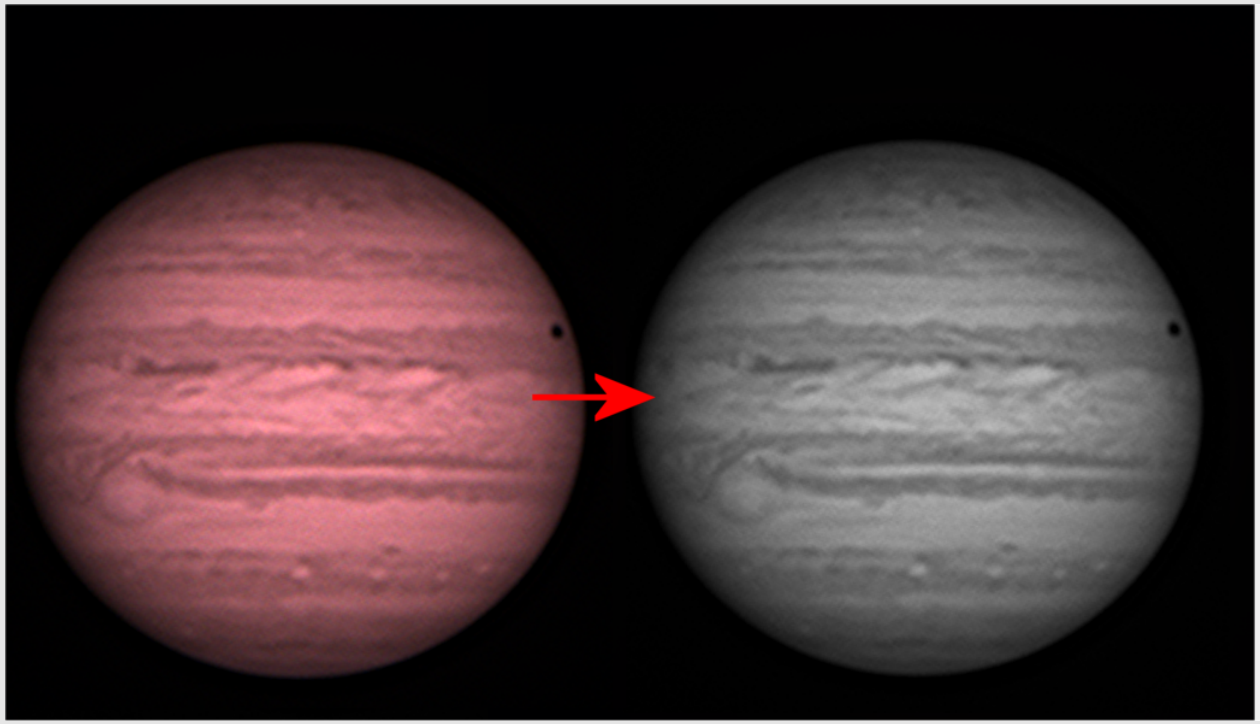
The good practice is to <u>lower the WRed value</u> so as to obtain an image that will more or less be in black and white. Do not search for a perfect grey-level appearance because this adjustment is also losing true signal. Just be careful that the image is not strongly red.

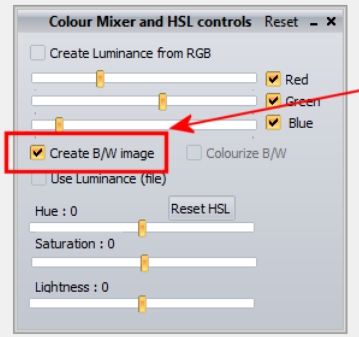
Any other setting remains unchanged in comparison with the usual colour imaging.

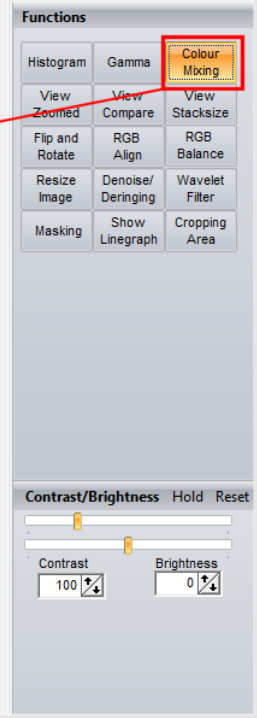




3 – SETTING THE CAMERA FOR INFRARED IMAGING



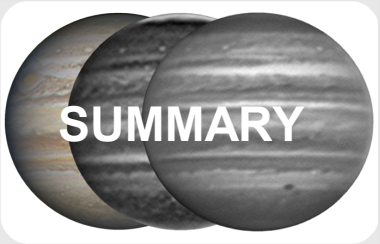




Video processing is performed just like if it was in colour : choose the "RGGB" algorithm to debayer the video (usually the softwares automatically make the conversion).

The notion of colour beeing meaningless in infrared, the image is to be transformed into black and white. This can be done with any photo processing software but there is a nice setting under Registax6 that will do it well. Under the wavelengths tab., look at the upper right parameters and choose "Colour mixing" then click on "Create B/W image".

Above is a Jupiter image taken with ASI224MC and a Baader IR 685 filter. The colour balance from the start was not completely grey (see preceding slide) because the filter has a large passband before 800 nm.

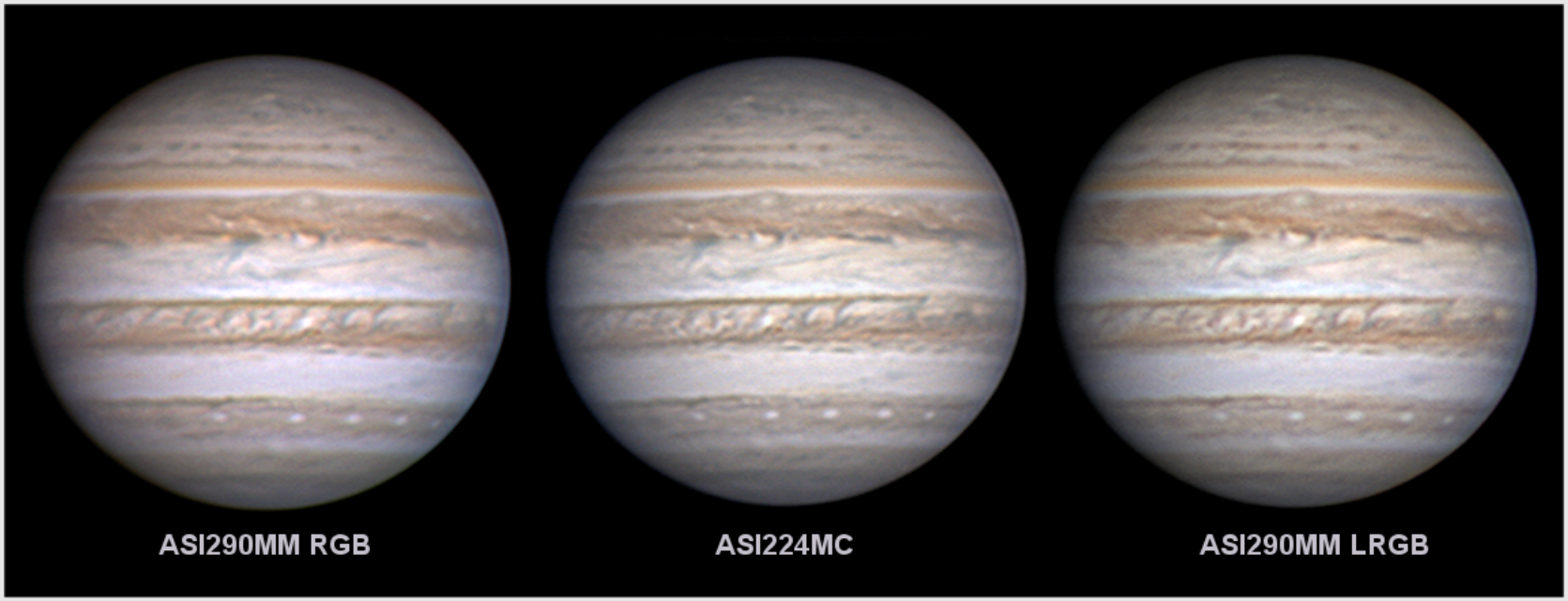


4 – A WORD ABOUT COLOUR RENDERING

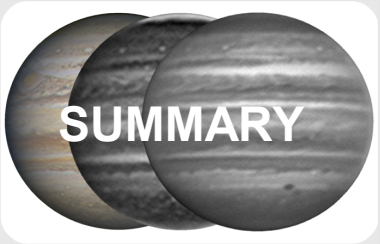
With a highly sensitive sensor like IMX224, the results are excellent and will rival or surpass any b&w camera.

A performing colour camera is really more simple to use.

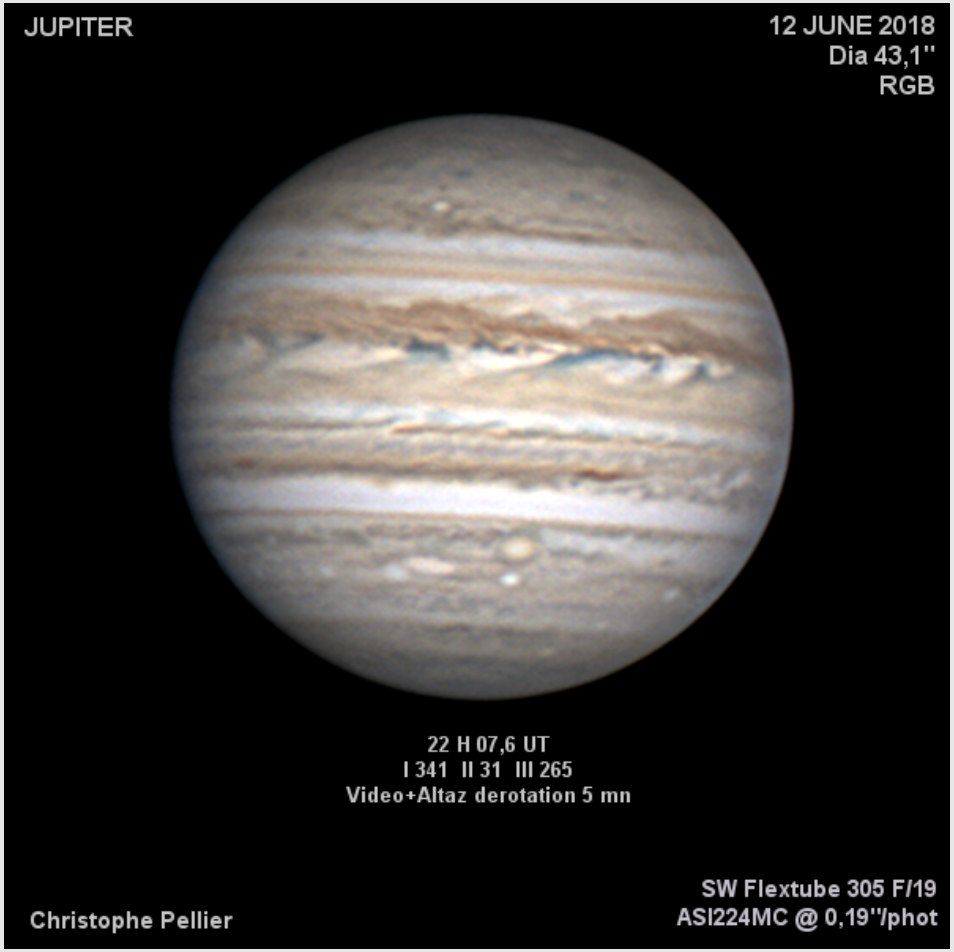
The only drawback is that b&w sensors equipped with RGB or LRGB filter sets will still reach a better colour rendering, with more colour nuances. The problem comes from the passbands of the RGB Bayer photosites that overlap themselves a bit too much (refer to preceding slides).

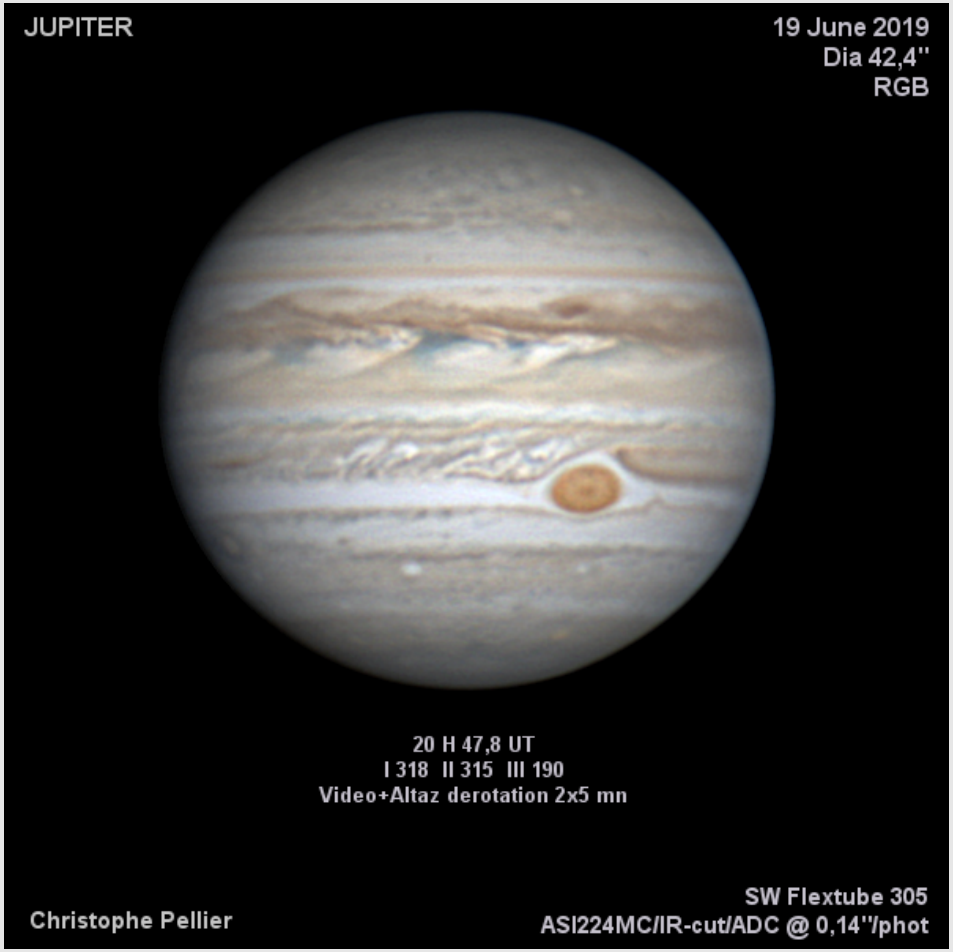


Comparing Jupiter imaging with a colour camera (ASI224MC) and a b&w (ASI290MM) with Astronomik LRGB filters. The resolution of the colour camera is as good, or even slightly better, but the image is more "greyish".

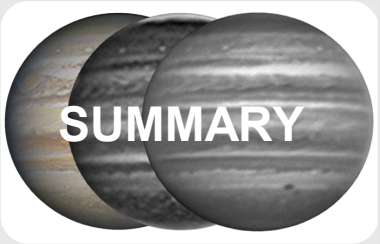


5 – SOME RESULTS : JUPITER

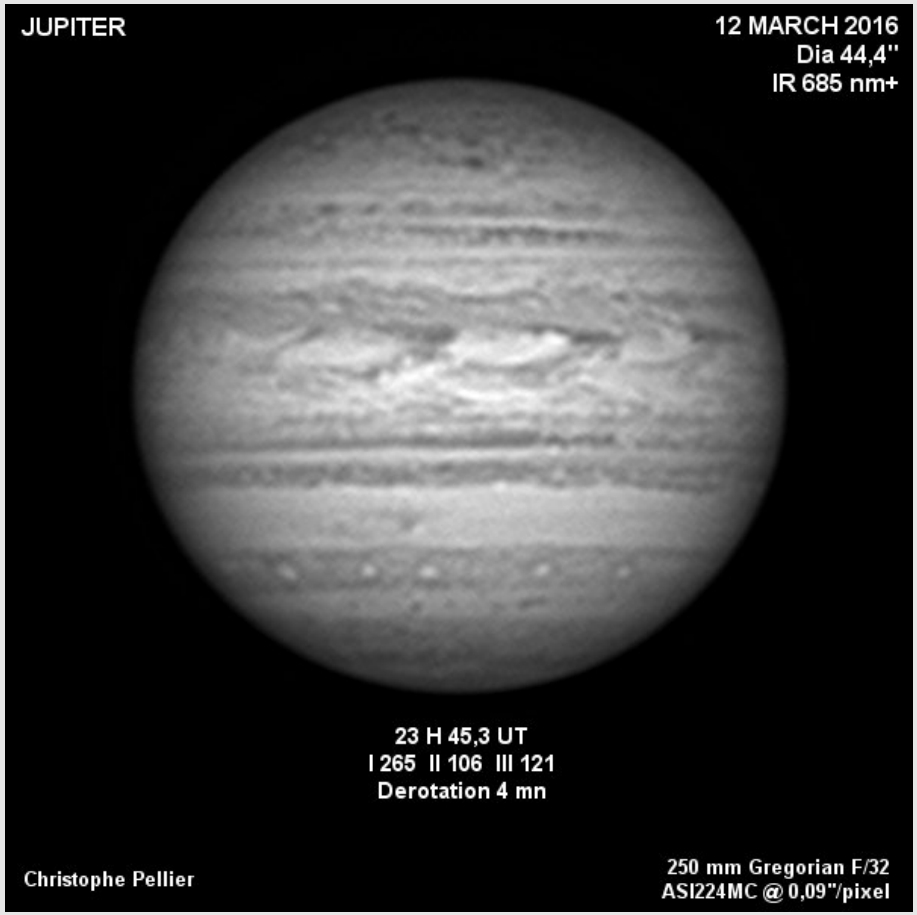


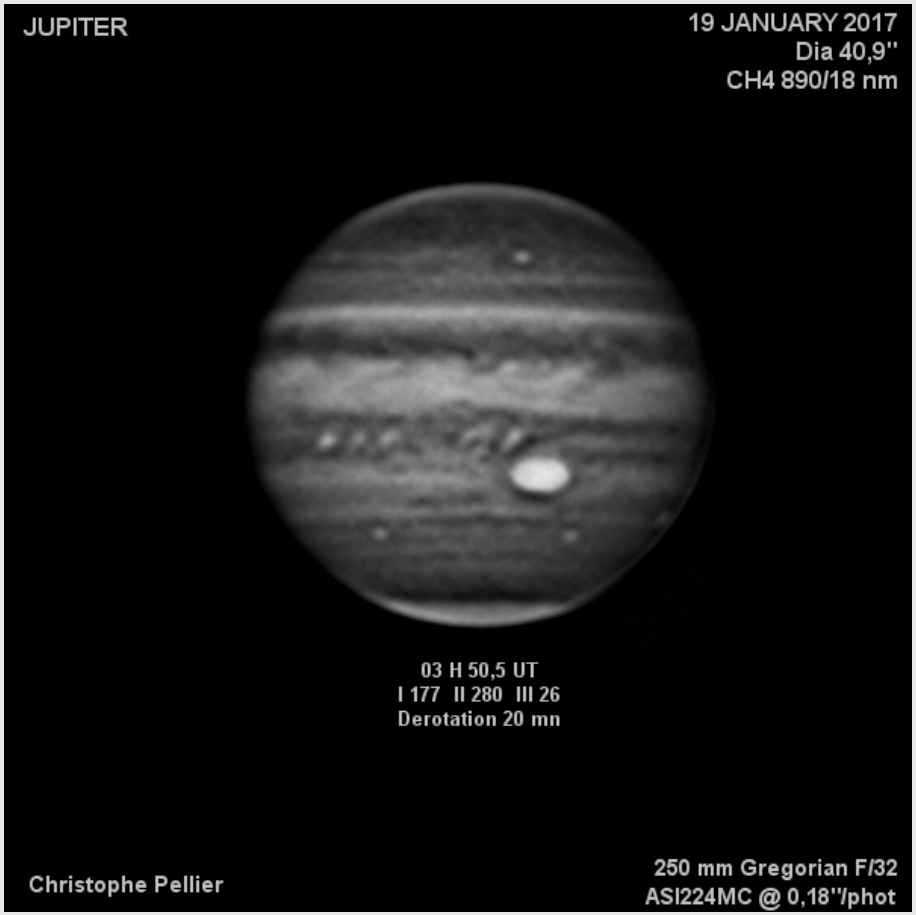


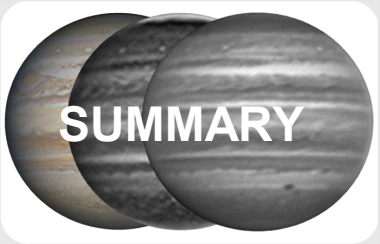
Apart of this slightly less satisfaying colour rendering, the ASI224MC is particularly well suited for Jupiter imaging, a planet that spins very fast.



5 – SOME RESULTS : JUPITER

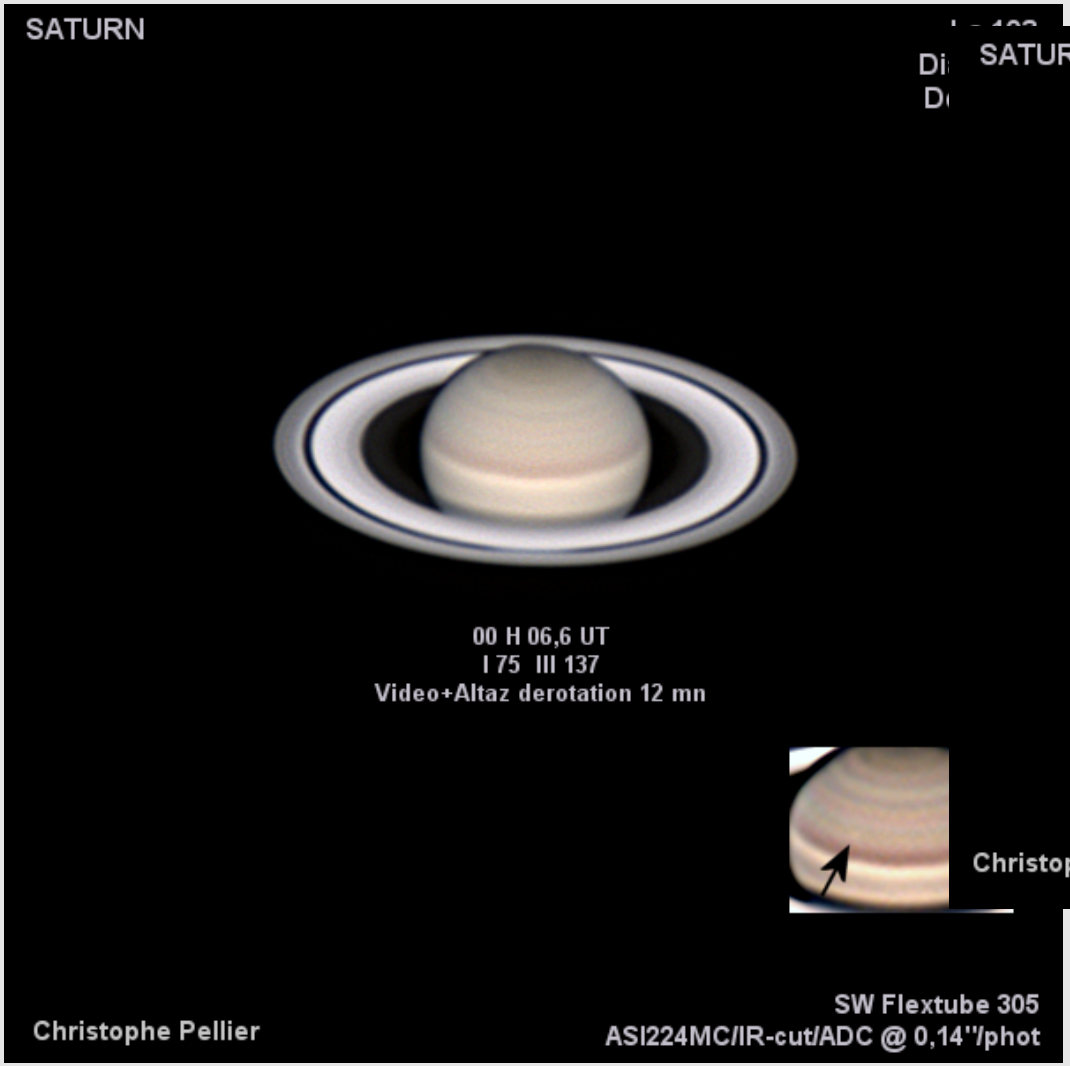


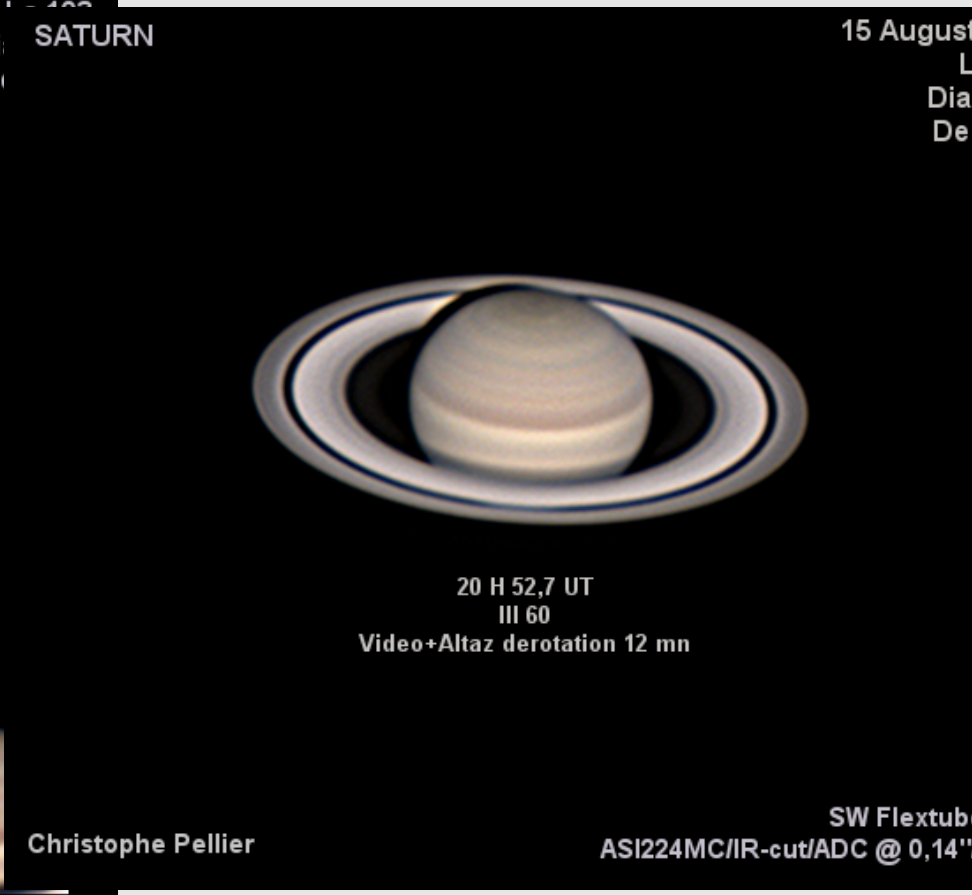


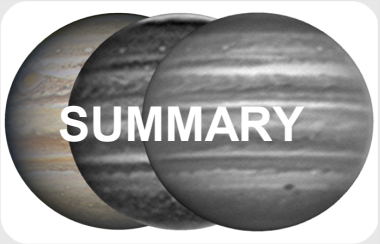


Some results in infrared. Not only the wide-band IR filters can be used, but it is also possible to get very good methane-band images of the planet.

5 – SOME RESULTS : SATURN

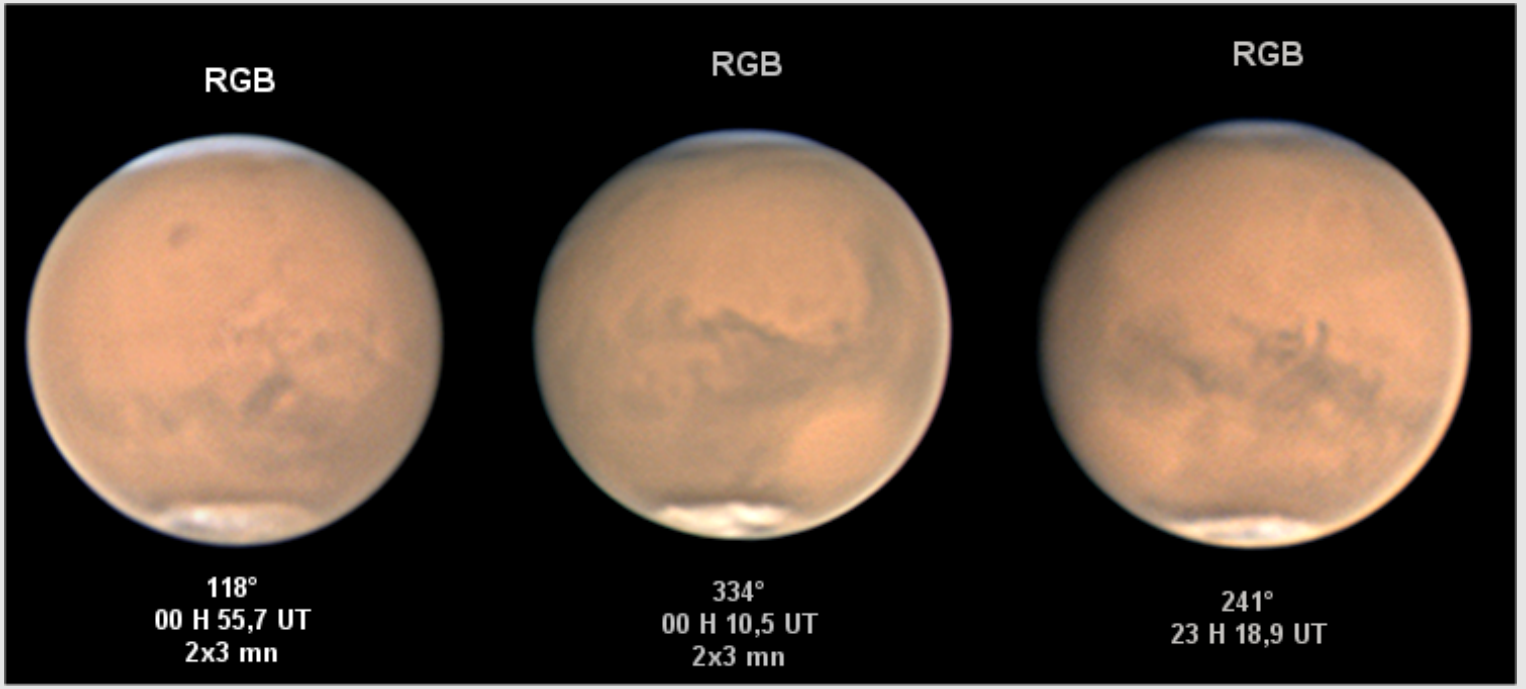




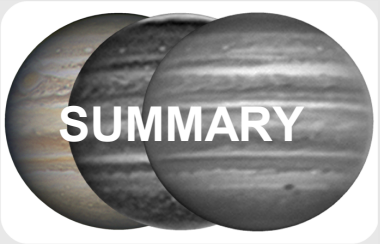


Same thing for Saturn. Combined with the video derotation from WinJupos, the camera is performing very well. Note that these images have been made at an elevation of around 20° only.

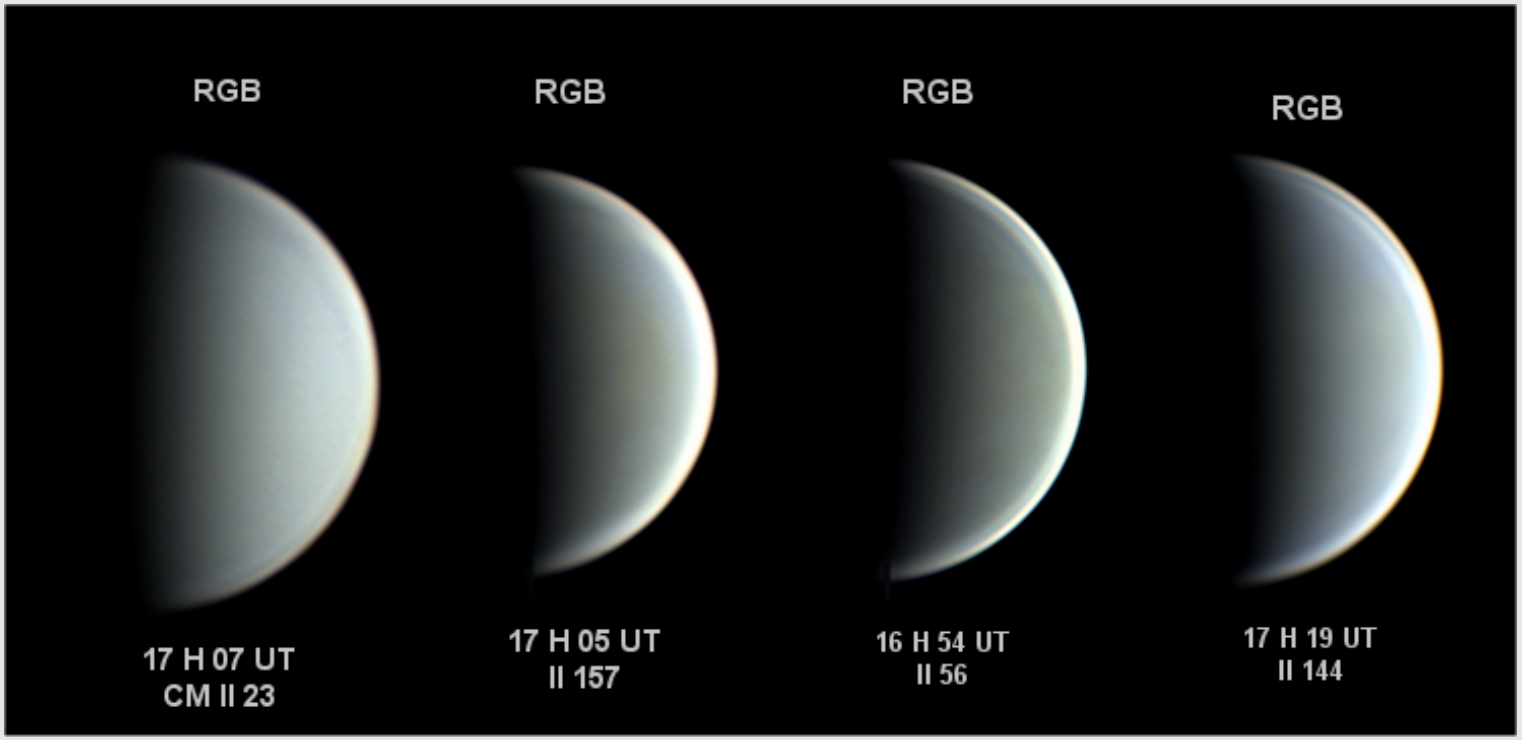
5 – SOME RESULTS : MARS



Mars imaging during the great 2018 summer dust storm. The elevation was even lower than for Saturn at only 15° reached in August. Despite a very low blue input, the camera is still doing very well, with a frame rate of around 200 images per second. These are final images derotated under WinJupos.

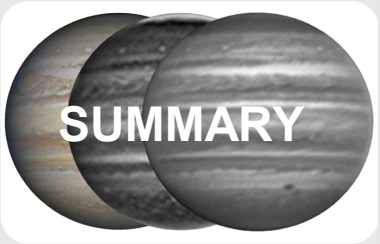


5 – SOME RESULTS : VENUS

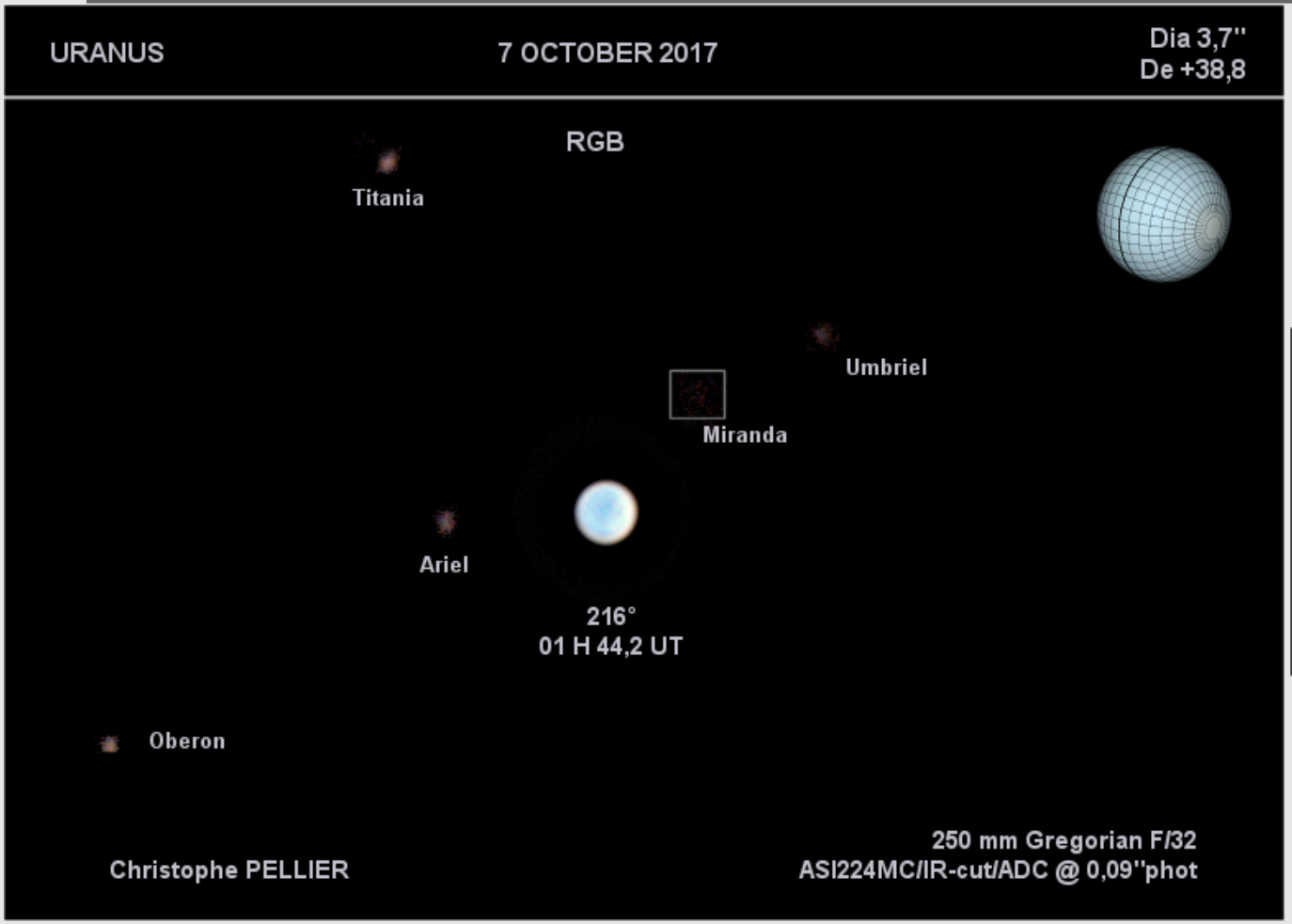


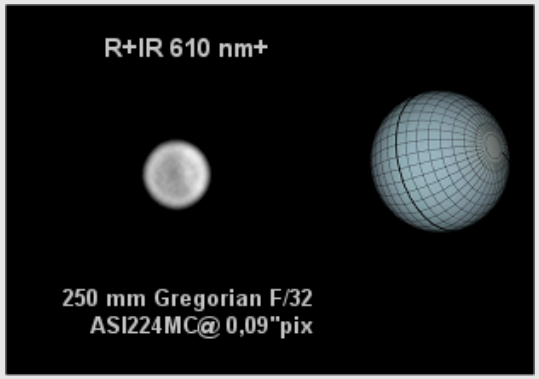
The case of Venus is a convincing example of the ASI224MC excellent capacities. The camera is able to record details in colour on this planet. The colour nuances that can be glimpsed correspond to the observed ultraviolet pattern : white regions are the polar vortices, and some subtle yellow patches can be seen on the equatorial regions, corresponding to the dark UV markings.

Images taken in 2017 January.



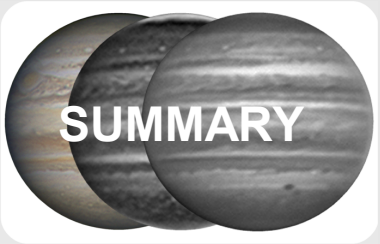
5 – SOME RESULTS : URANUS





Colour Uranus imaging is also a fine example of how good is the camera. Like on Venus, some details can be recorded in colour. Here is the north polar region of the planet, seen as a whiter region than the rest of the disk, much bluer. This polar region is quite contrasted on infrared images.

At right is an image taken with again the ASI224MC but with Baader R+R RG610 filter, following the methods exposed above.



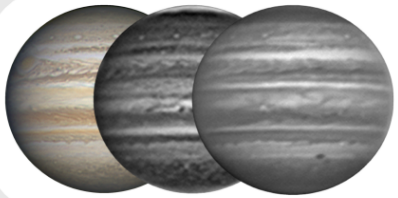
CONCLUSION

Modern colour CMOS sensors now offer excellent performances. If b&w sensors can still pretend to reach a better rendering especially for colours, they do not have anymore their usual advantage as more sensitive cameras.

Those new colour cameras open the field of infrared planetary imaging, including methane band imaging.

One field remains largely inaccessible though, which is ultraviolet imaging. This band is very interesting especially for Venus. It's still possible to use an UV-pass filter with the same methods as for IR imaging, but the results will remain inferior to those obtained with b&w cameras.

For this reason at least, the complete planetary imager will get a b&w camera as well !



PLANETARY ASTRONOMY

A website by Christophe Pellier