





Astrophotography: Art of catching the light!!

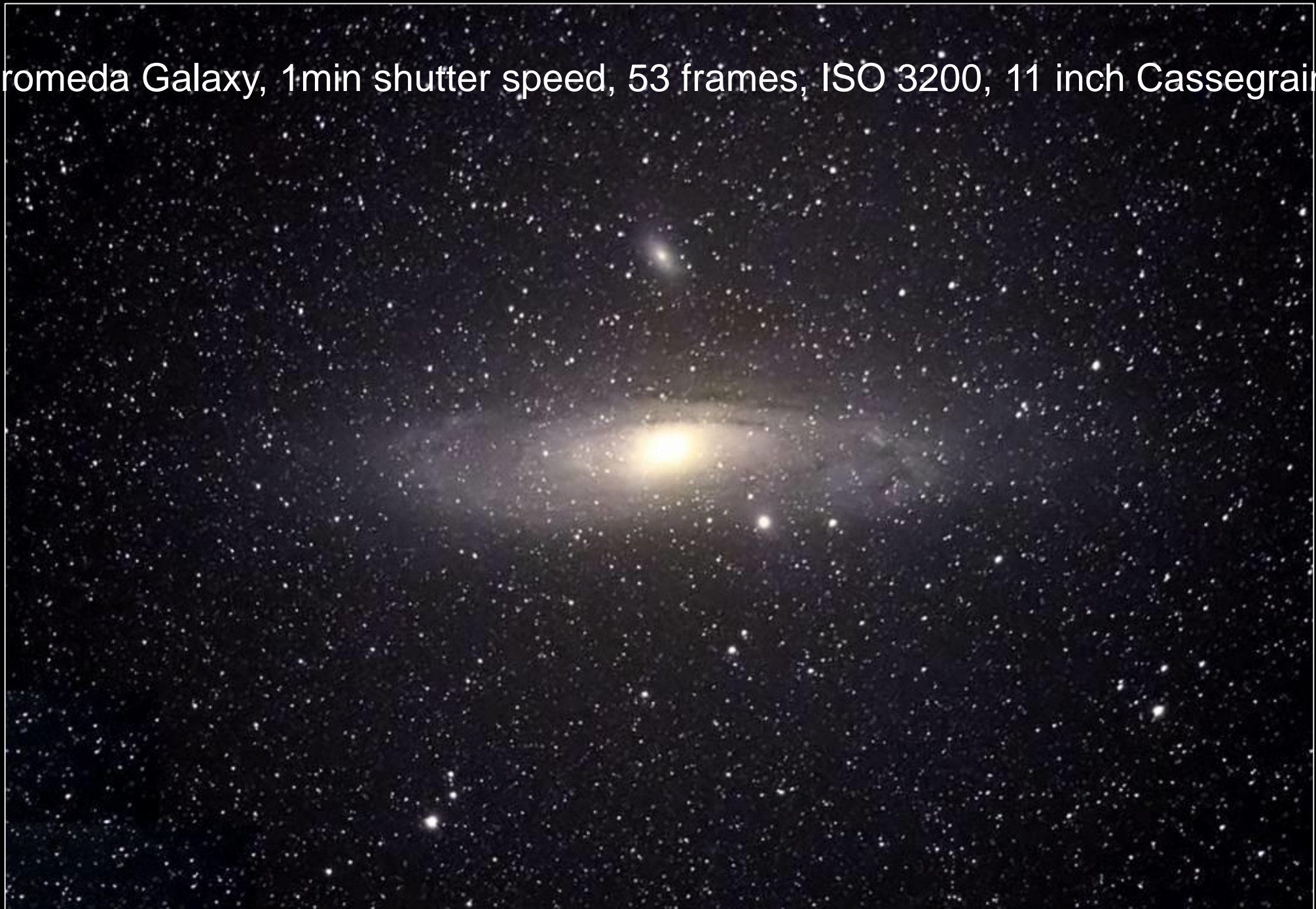
Vinita Navalkar

DAA

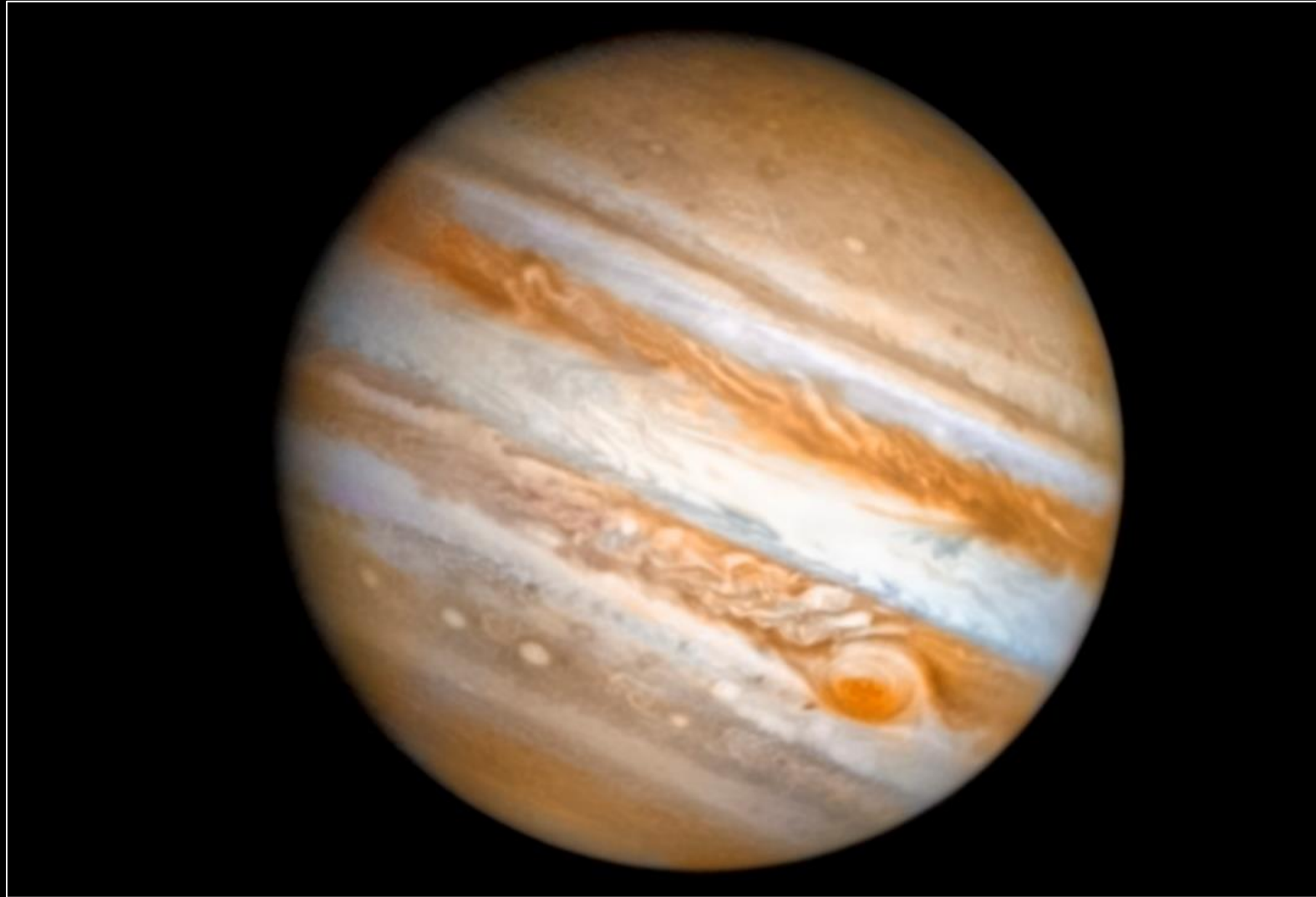
Pleiades Open Cluster, 1 min shutter speed, 43 frames, ISO 3200, 11 inch Cassegrain...



Andromeda Galaxy, 1min shutter speed, 53 frames, ISO 3200, 11 inch Cassegrain...



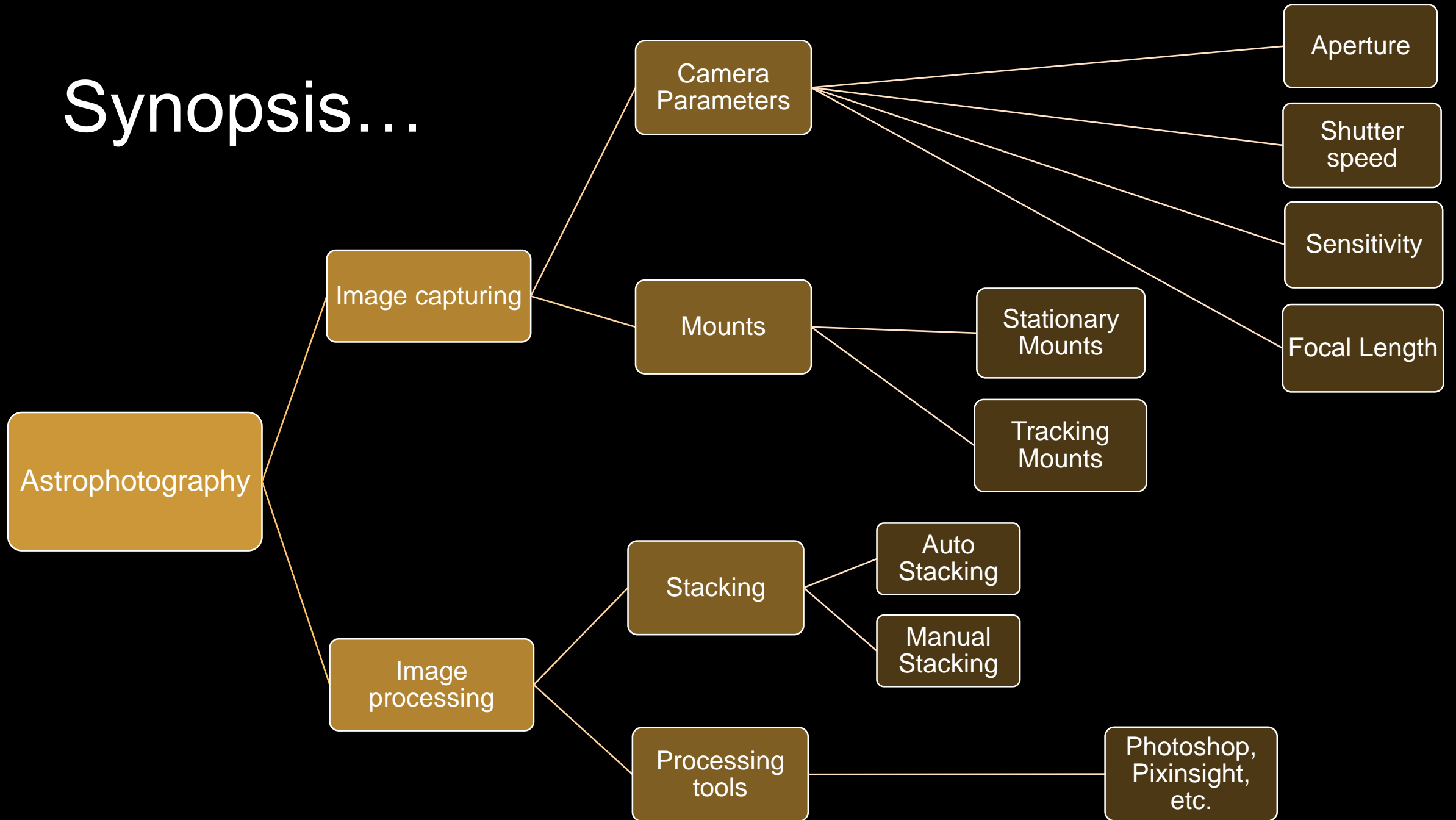
Jupiter, 130 mm reflector with 3x barlow, HD video recording of 1.5 mins, 1209 off 2900 frames stacked in Registax...



Milkyway, 30 sec shutter speed, 71 frames, ISO 3200, 18mm focal length.



Synopsis...



Basic Requirements

- Choosing the right Camera...
- Choosing the right Mounts...
- Which image processing tools to use...

Choosing the right Camera...

- Point and Shoot Camera
- Digital SLR cameras
- Webcams
- Astronomical CCD cameras

Important Camera Parameters

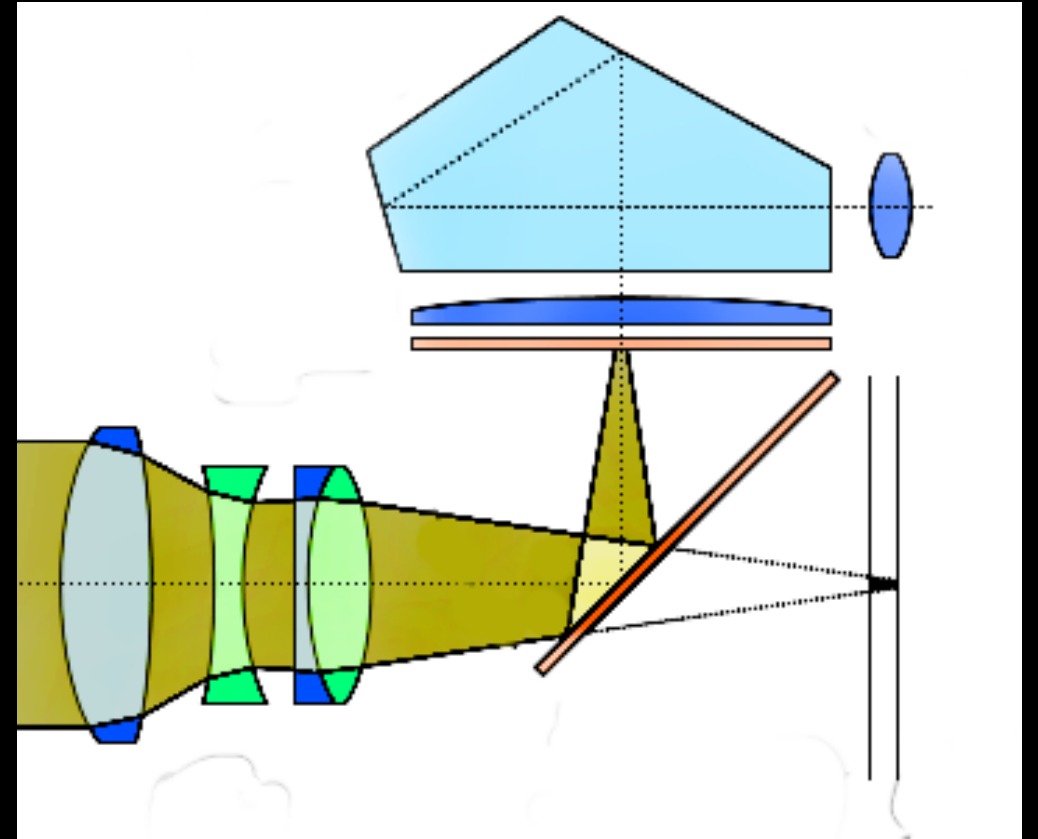
- Shutter Speed
- Aperture (not much used in case of astrophotography)
- Sensitivity - ISO settings
- Focal length

Point and Shoot Camera

- Point-and-shoot cameras, use a viewfinder in which the image that the photographer sees is not the same image that passes through the primary lens of the camera. Rather, the image in the viewfinder passes through a separate lens.
- **Advantages**
 - Inexpensive and easy to use
 - Low weight and compact
 - No computer or external power supply needed
- **Disadvantages**
 - Lens not replaceable
 - Automatic modes and no Bulb Settings
 - Mounting to telescope not easy

Digital SLR's

- A **single-lens reflex camera (SLR)** uses a mirror and prism system (hence "reflex" from the mirror's reflection) that permits the photographer to view through the lens and see exactly what will be captured.
- When the shutter button is pressed on, the mirror flips out of the light path, allowing light to pass through to the light receptor, and the image to be captured.



Digital SLR's

- **Advantages**

- Bulb settings
- Easy adjustment of ISO speed
- Changeable lens
- Photo quality is better than Point and Shoot in low light conditions
- You can play with the raw image!

- **Disadvantages**

- Limited red sensitivity through IR blocking filter
- High power consumption

Webcams

- **Advantages**

- Inexpensive
- Good focus control
- Useful for planetary imaging

- **Disadvantages**

- Tiny sensor so small field of view
- No bulb exposures possible
- Operation impossible without a computer
- Operation without a telescope not reasonable

Astronomical CCD Cameras

- **Advantages**

- Low noise due to sensor cooling
- High resolution with monochrome sensor
- True raw data
- High spectral sensitivity, shorter exposure times
- Maximum image quality

- **Disadvantages**

- Expensive
- Complex handling
- Computer is required
- Time consuming for color shots

Choosing the right parameters...

- Exposure is determined by three key settings - Aperture, Shutter Speed and Sensitivity to light (ISO).



Exposure Chosen by the Camera



Exposure Chosen by the Photographer



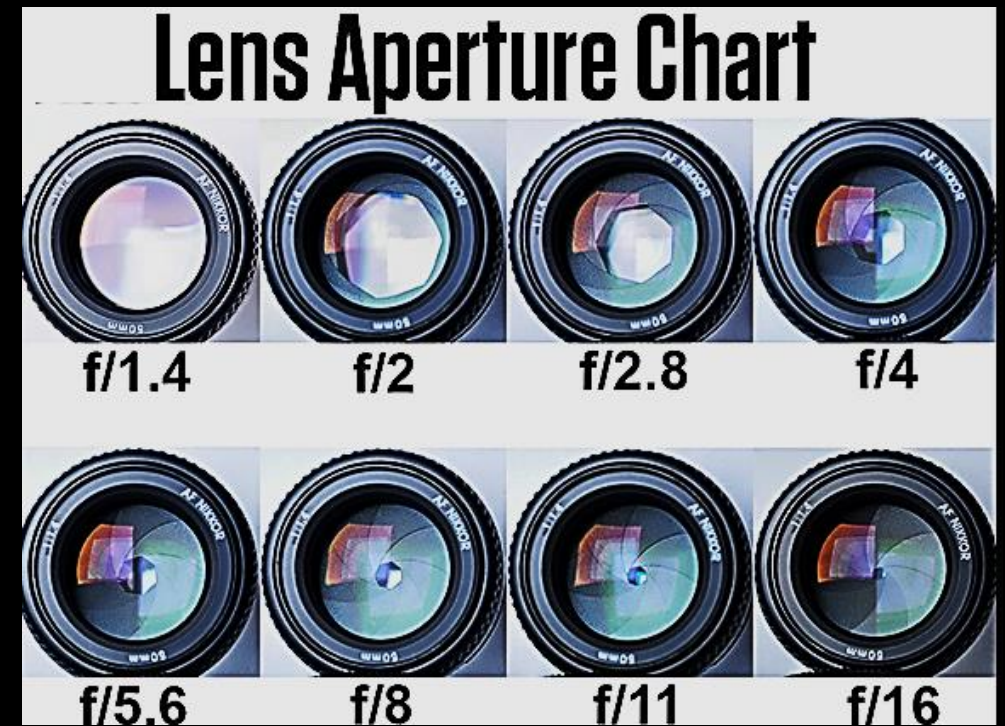
Exposure Chosen by the Camera



Exposure Chosen by the Photographer

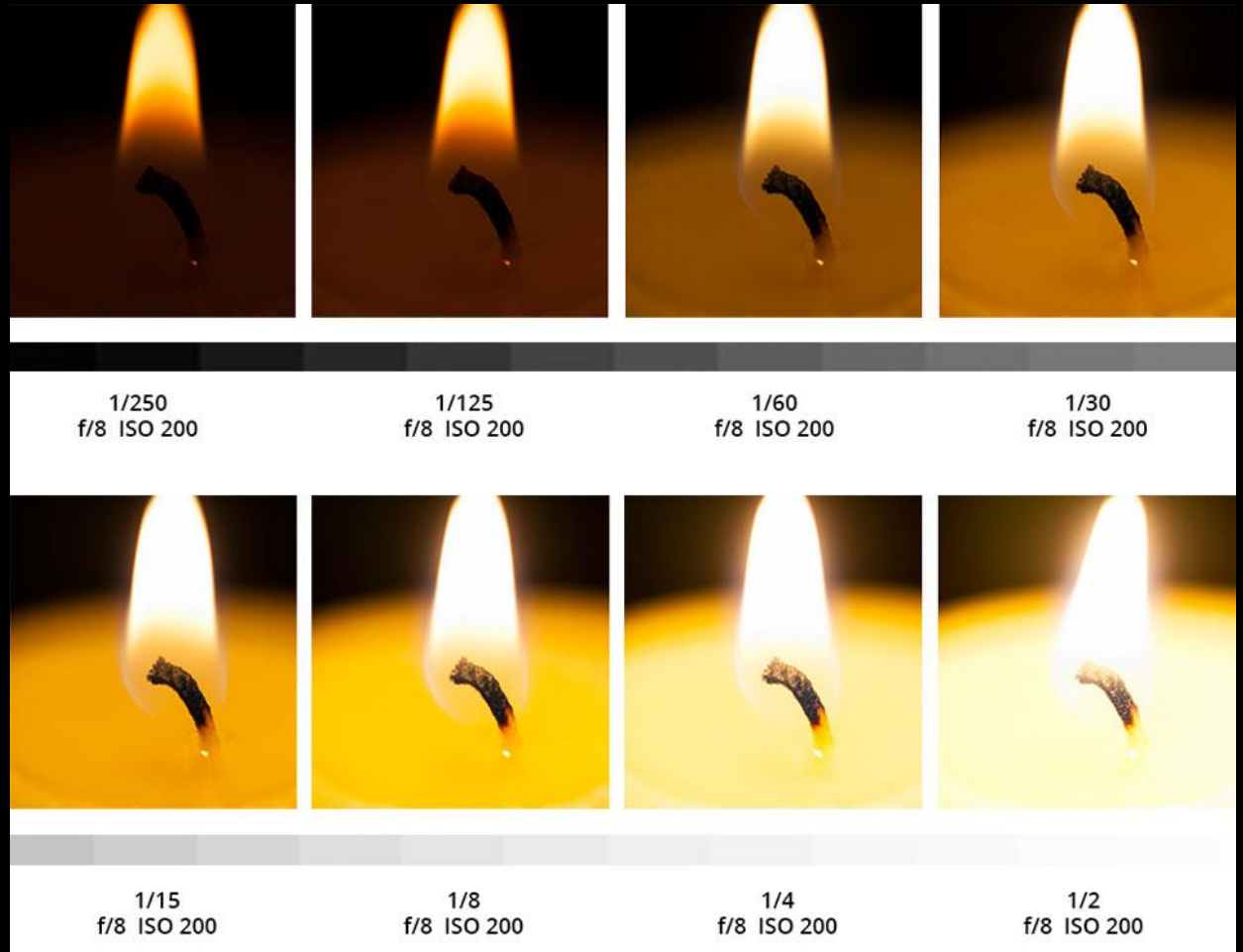
Aperture

- It is the size of the opening of the lens that controls the amount of light passing through to the sensor. The size of the aperture is called the f-stop and shows up as a number displayed on top of the camera or on the rear screen.



Shutter Speed

- Shutter speed determines how long the camera's aperture stays open to admit light to the digital sensor



Shutter Speed

- When photographing things that move...
- In bright light, choosing a very fast shutter speed, 1/1000 or higher, to freeze action.
- Slow shutter speeds (1/30 or longer) allows enough time for the moving object to blur, conveying motion.
- Long shutter speed times can also produce artistically interesting results in low-light situations.



Shutter Speed for Astrophotographs



ISO 6400, 15 Sec*25 frames= 6.25 mins



ISO 6400, 30 Sec*25 frames= 12.5 mins

Bulb Settings

- Bulb mode simply allows the photographer to take a picture for as long as the shutter is depressed.
- The main advantage is that it allows the photographer to achieve shutter speeds longer than the 30 seconds on most DSLRs.
- This is generally done through a remote control or software settings.



Sensitivity - ISO

- It is the measure of sensitivity of camera sensor's to light.
- The higher the ISO, the more sensitive the sensor is, allowing it to absorb light faster.
- Very handy for dim situations where you can't lower your shutter speed or open up your aperture any more.

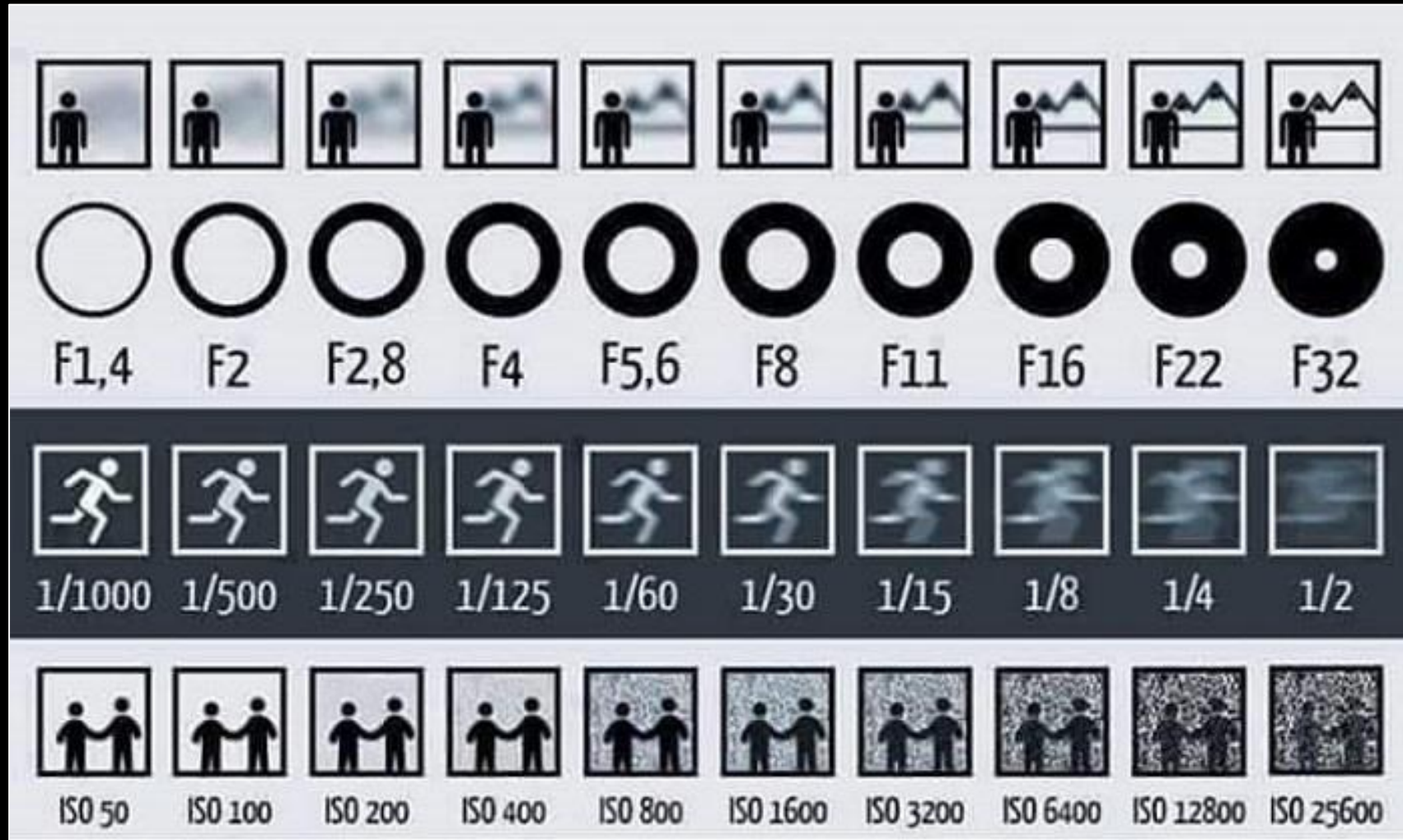


ISO

- At ISO 200, the sensor is twice as responsive to light as it is at ISO 100; ISO 400 is twice as light-sensitive as ISO 200, and so on.
- The tradeoff is image noise: The higher the ISO setting, the more grainy, multicolored speckles pollute your pictures.



Summing up...



Metering

- The picture is underexposed if the arrow is pointing towards -3.
- The picture is overexposed if the arrow is pointing towards +3.
- The right exposure is when the arrow is pointing towards 0.



Focal length

- The focal length of the lens is the distance between the lens and the sensor when the subject is in focus, usually stated in millimeters.
- The shorter the focal length (e.g. 18 mm), the wider the angle of view and the greater the area captured.
- The longer the focal length (e.g. 55 mm), the smaller the angle and the larger the subject appears to be.

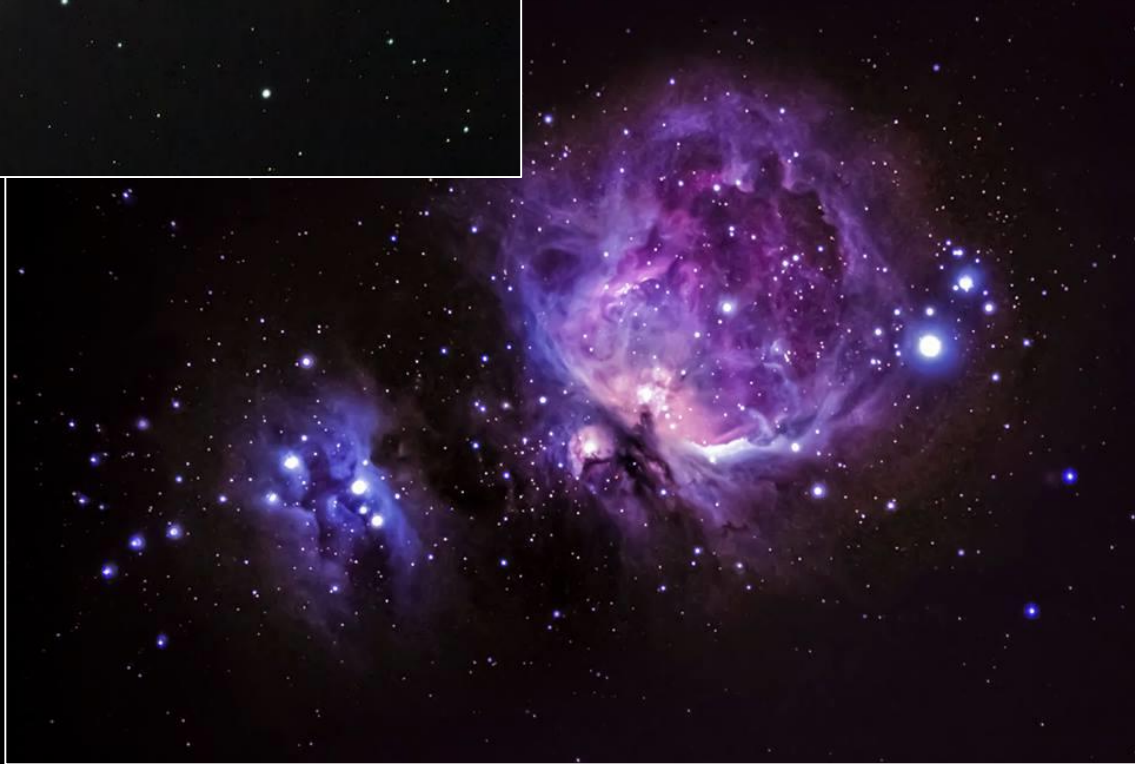


For example to get a good detailed photograph of Orion Nebula a focal length above 250 mm is always better.

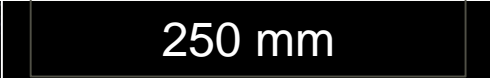
18 mm



400 mm



250 mm



Effects of rotation



Choosing the right mounts...

- Simple 2 or 3 axis camera tripod
 - Camera tripods are enough to shoot a Milkyway since they are taken at wide angle i.e. large field of view or shorter focal length.
 - Hence we can go upto 30 sec shutter speed without introducing trails.
 - For images taken at more than 30 sec shutter speed requires a tracking mount.



Choosing the right mounts...

- Attaching the camera to telescope at prime focus.
 - For objects that require magnification, camera can be attached to the prime focus of the telescope.
 - Another way to achieve magnification is to use a lens of higher focal length.



Choosing a right mounts...

- Attaching the camera as piggy back mount on the telescope.
 - This arrangement works with camera lens and does not provide extra benefit of magnification from the telescope.
 - But when the camera and telescope tube is aligned, this arrangement helps in finding objects easily through a telescope.

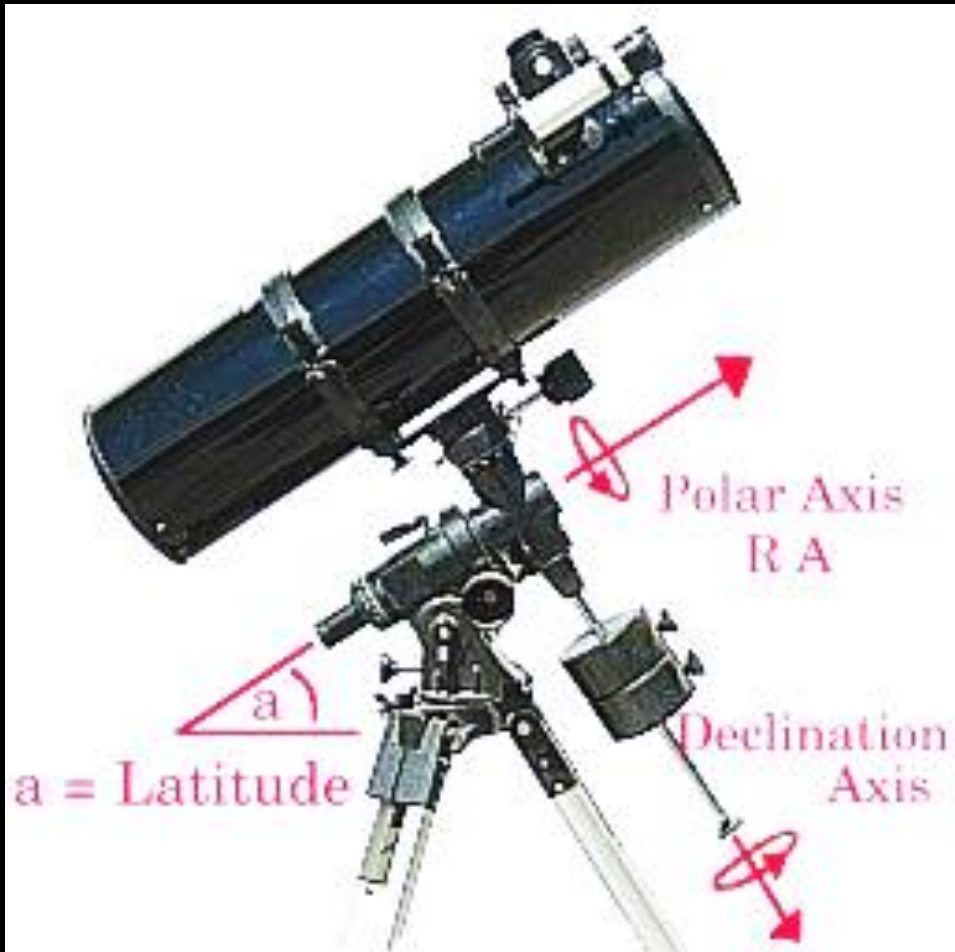


Tracking mounts

- At high magnification, to photograph objects without trailing, tracking mounts are must!
- More the magnification, less is the field of view and effects of earths rotation are felt more!
- For example, shutter speed of 30 sec does not give trails at 18mm focal length, but at 250 mm it will give trails.



Equatorial vs Altazimuth



How to take images...

- There are two ways in which image can be captured.
 - By taking multiple images (frames) of shorter duration and stacking them together to get good exposure. This helps in any irregularities in tracking mount. But stacking can increase the noise in the image.
 - Taking single image of long duration. In this case the tracking has to be as accurate as possible. These images are less noisy.
 - Dark and Flat Frames are must in both the cases!!!

Photo credits: David Lane

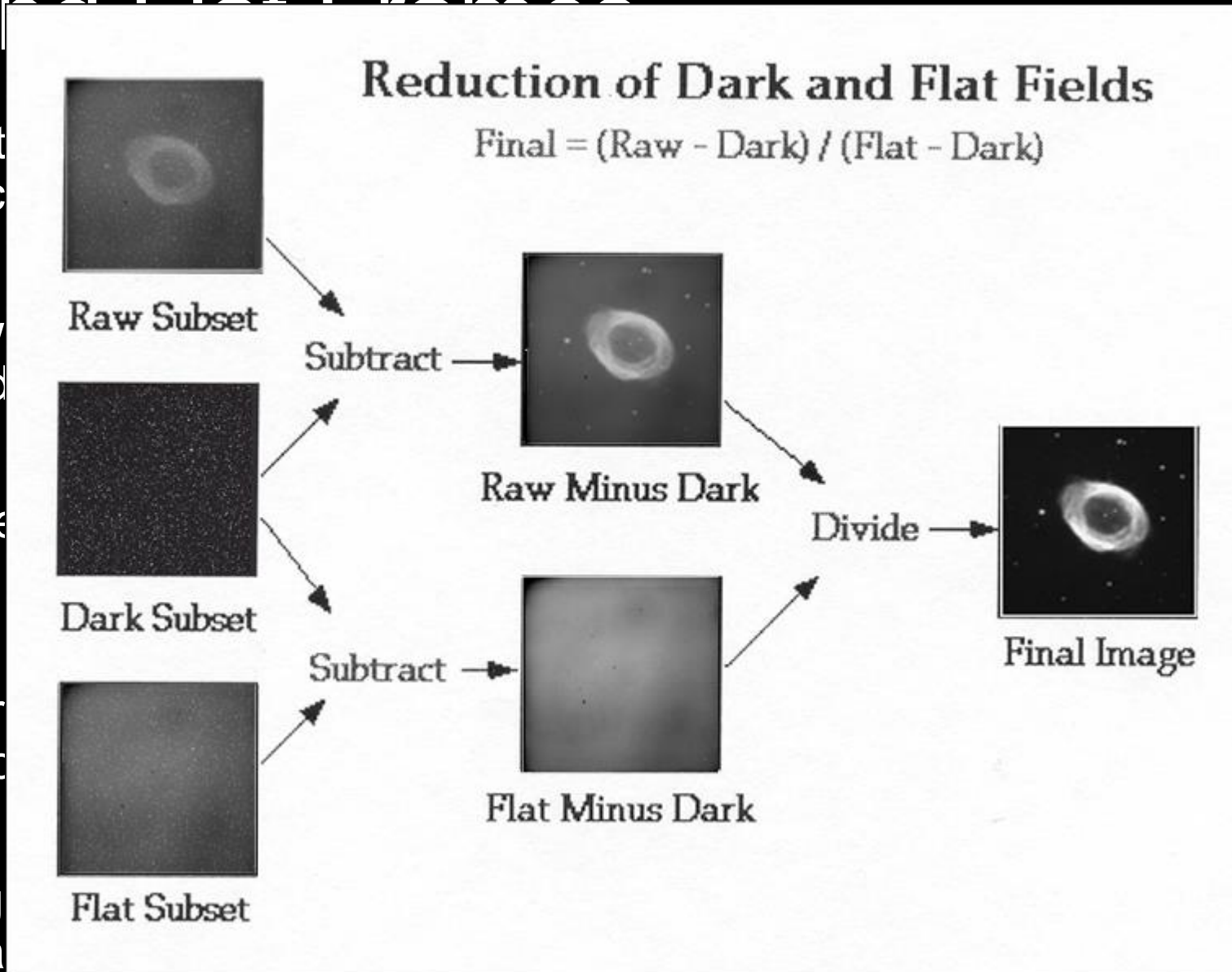
Single shot: 8 mins at 400mm

12 frame at 40 sec = 8 mins at 400mm



Dark and Flat Frames

- To remove the dark frame that causes
- The best wavelength settings and
- Since the temperature during your
- The Flat Frame created by
- To create good view and save

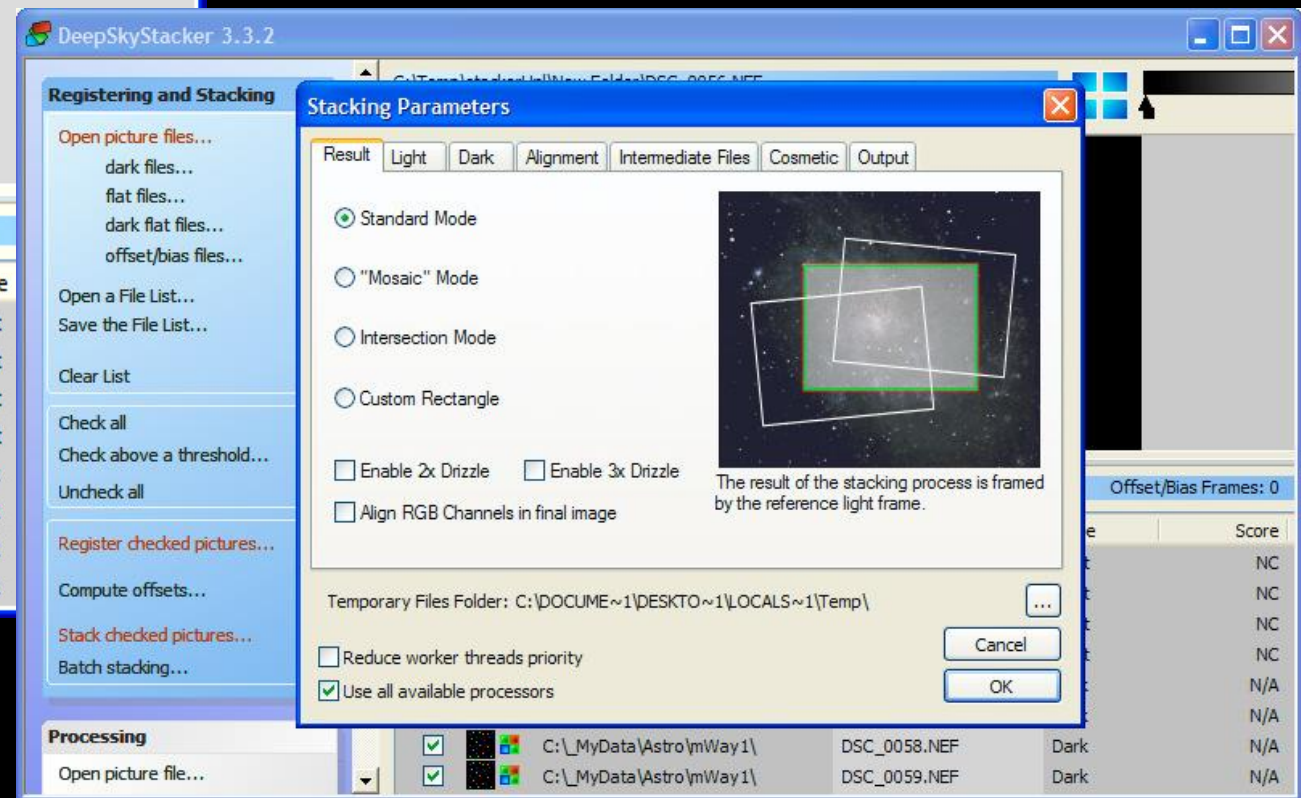
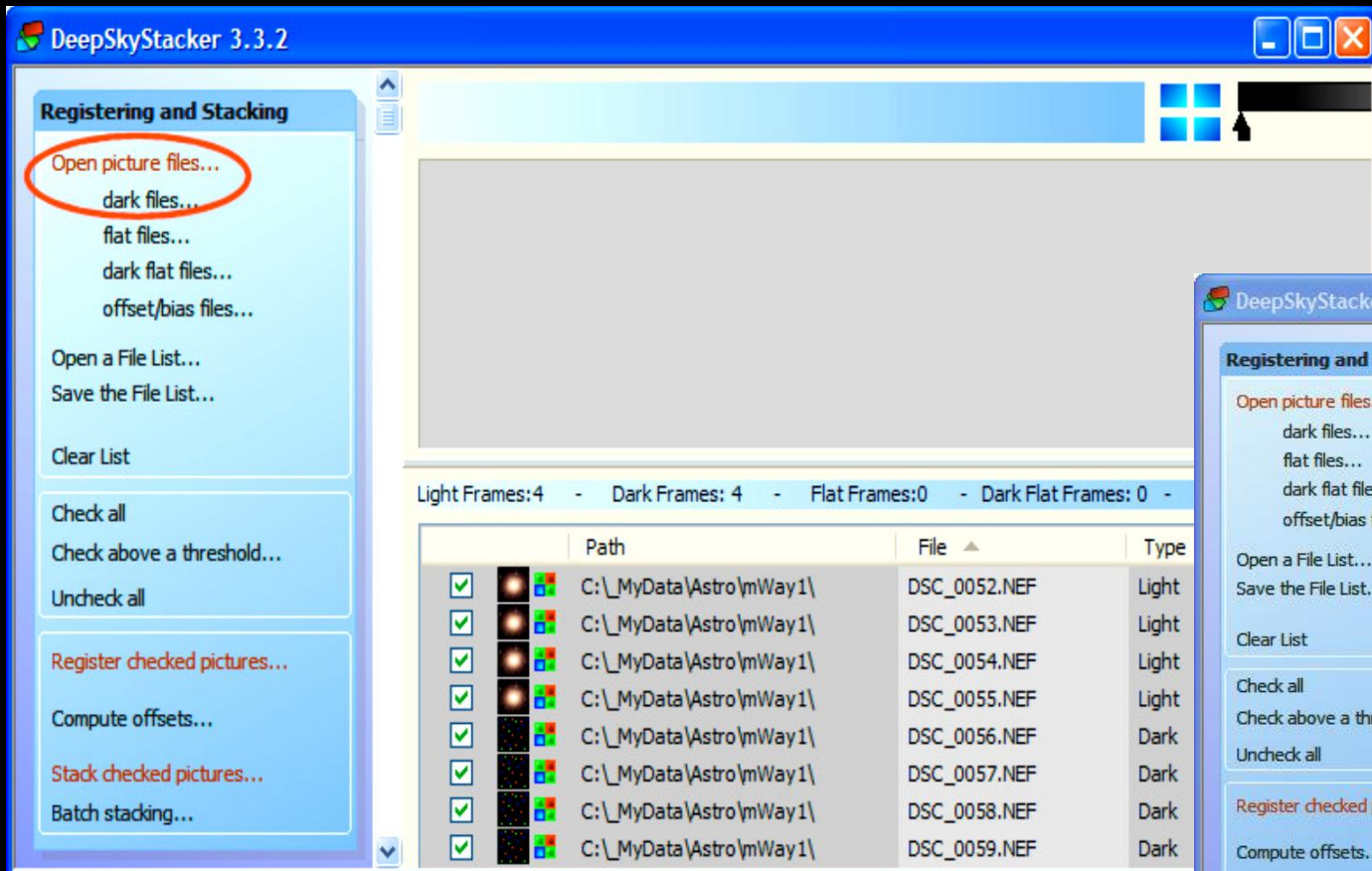


- You use a dark
- same exposure
- at the end or
- illumination
- length (field of

Which processing tools to use...

- If multiple shots are taken over time, then there is a shift in position of stars in every image, due to rotation of earth.
- We need to stack them aligning all the stars.
 - Manually in Photoshop as layers.
 - Using stacking softwares like Deep Sky Stacker or Registax.

Deep Sky Stacker



Deep Sky Stacker

The screenshot displays the DeepSkyStacker 3.3.2 application window. A notification at the top indicates that version 3.3.4 is available for download. The main interface is divided into several sections:

- Registering and Stacking:** Contains buttons for opening picture files (dark, flat, dark flat, offset/bias), opening and saving file lists, clearing the list, and checking/unchecking files. It also includes options to register, compute offsets, stack, and batch stack checked pictures.
- Processing:** Includes buttons for opening a picture file, copying to clipboard, creating a star mask, and saving to file.
- Options:** Contains settings for Raw/FITS DDP, loading, saving, and recommended settings.

The central area shows a list of image files with columns for Path, Light/Dark frames, Flat frames, and a table of star detection parameters. A "Register Settings" dialog box is open, showing the "Advanced" tab with a "Star detection threshold" slider set to 4%. A "Compute the number of detected stars" button is highlighted, showing a result of 207 star(s). A checked checkbox indicates "Reduce the noise by using a Median Filter".

Path	Light	Dark	Flat	dX	dY	Angle	Date/Time	Size	Depth
E:\All milkyways\All milkyways\milky... IMG_6211.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:49:10 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6212.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:49:32 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6213.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:49:50 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6214.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:50:08 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6215.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:50:26 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6216.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:50:45 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6217.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:51:03 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6218.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:51:21 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6219.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:51:39 AM	1336 x 3516	Gray ...
E:\All milkyways\All milkyways\milky... IMG_6219.CR2	Light	NC	NC	NC	NC	NC	8/6/2014 1:51:57 AM	1336 x 3516	Gray ...

Light Frames: 28 - Dark Frames: 0 - Flat Frames: 0

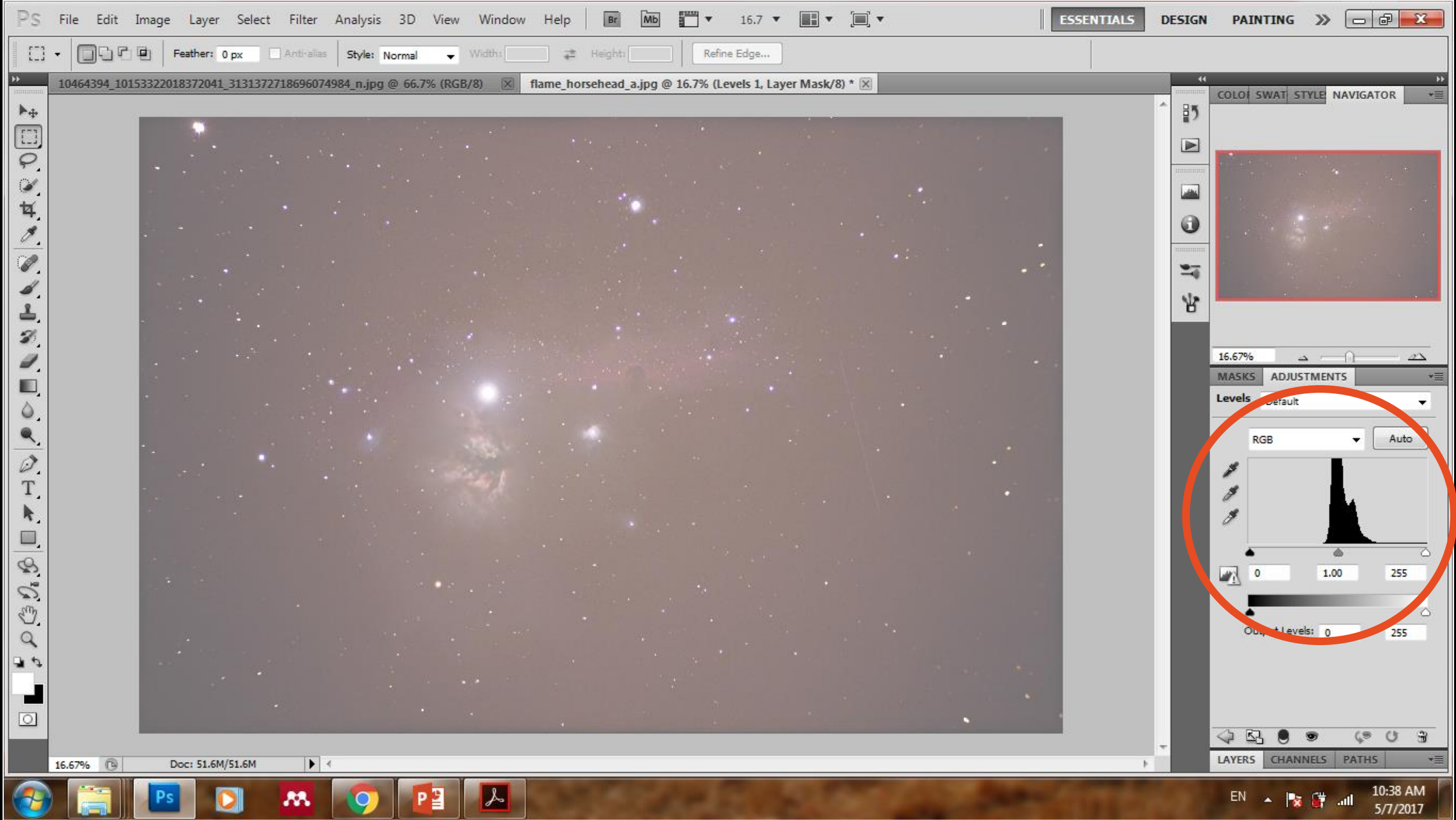
EN 2:34 PM 6/2/2017

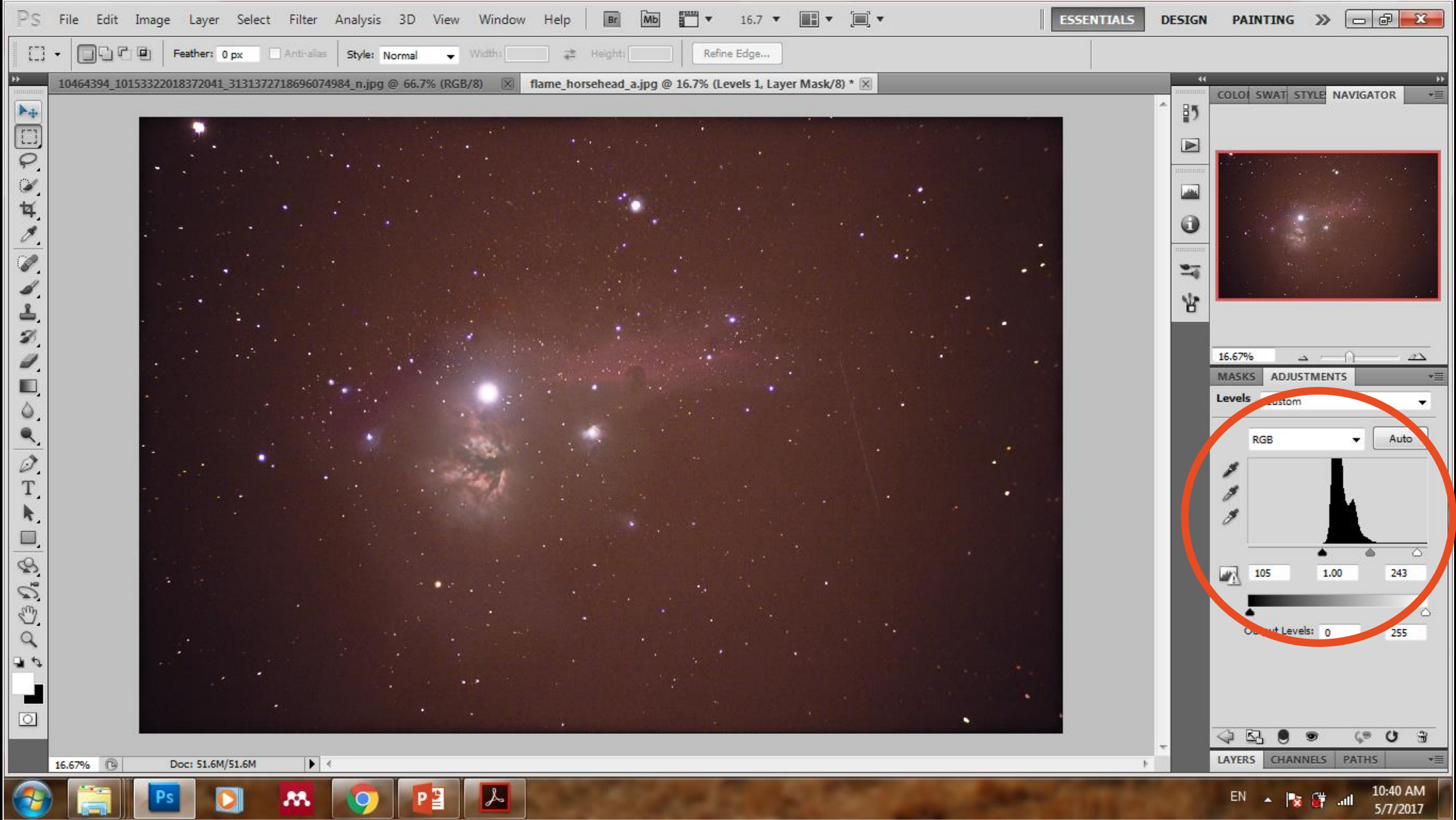
Final s

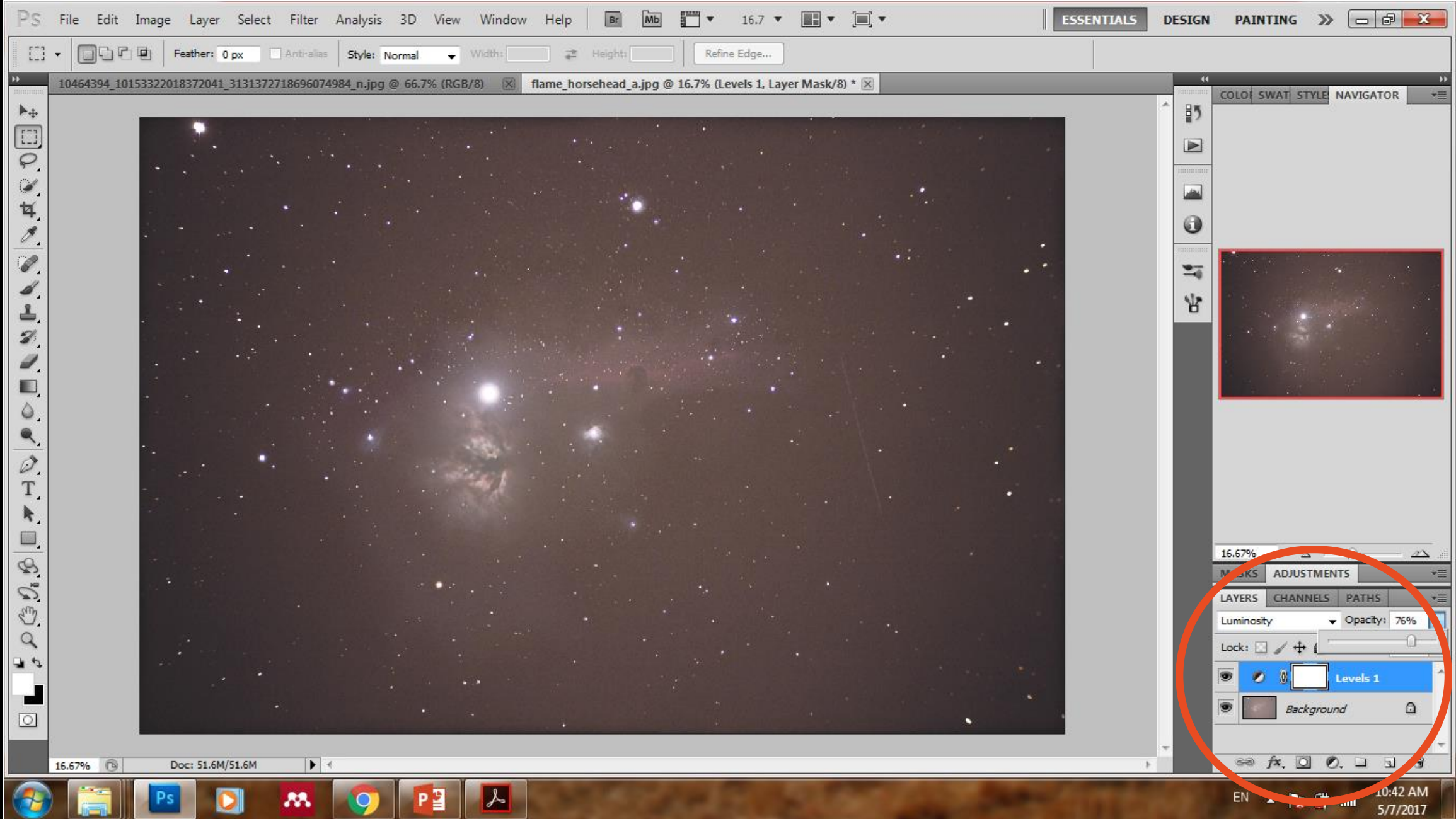


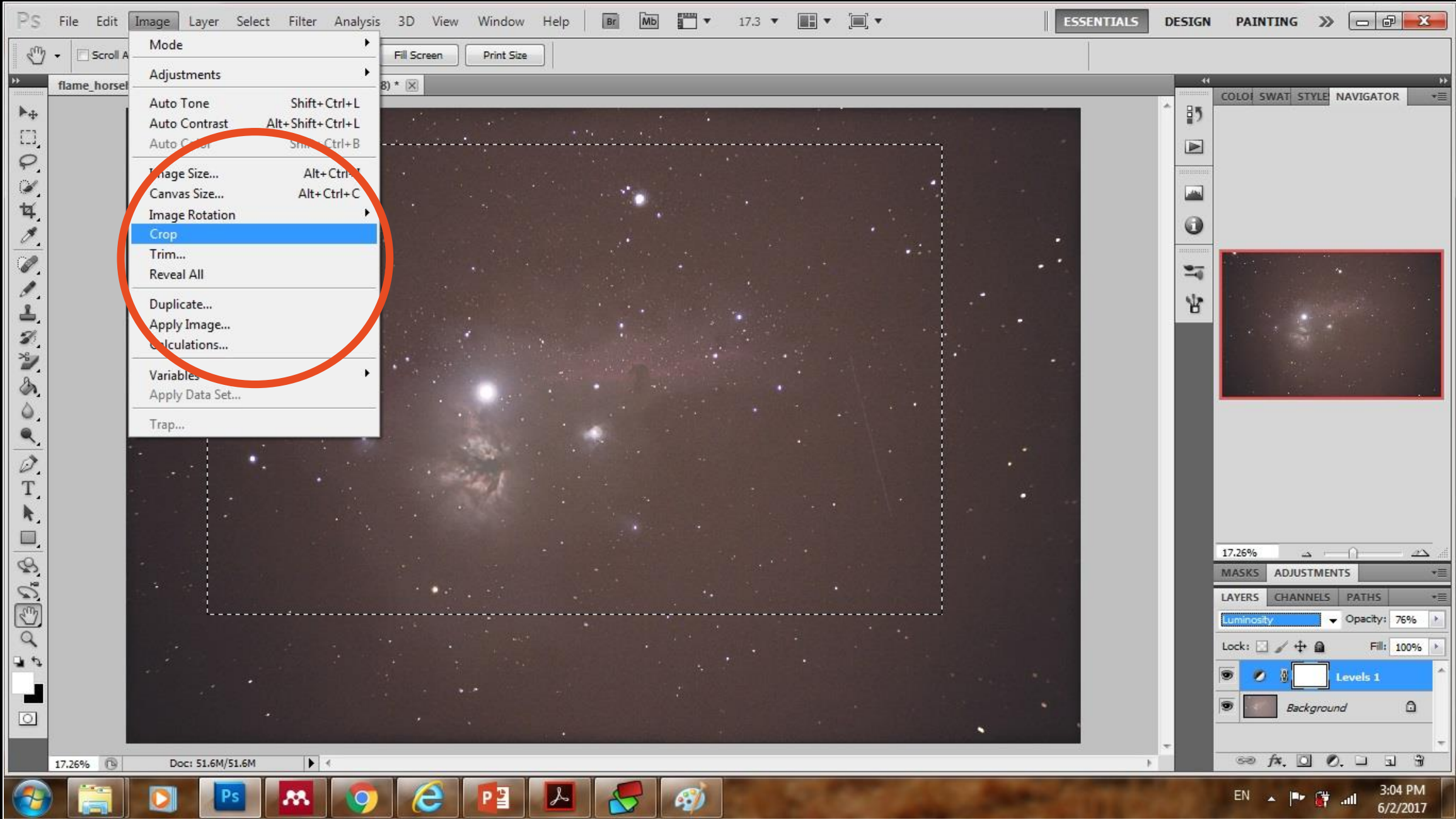
Processing the stacked image...

- Processing method for each object is different.
- For more star clusters, we have to make sure they do not bloat.
- For nebulosity, stars can blur a bit.
- Hence separate masking is sometimes necessary.
- For planets, the procedure is completely different.









- Mode
- Adjustments
 - Auto Tone Shift+Ctrl+L
 - Auto Contrast Alt+Shift+Ctrl+L
 - Auto Color Shift+Ctrl+B
- Image Size... Alt+Ctrl+I
- Canvas Size... Alt+Ctrl+C
- Image Rotation
- Crop
- Trim...
- Reveal All
- Duplicate...
- Apply Image...
- Calculations...
- Variables
- Apply Data Set...
- Trap...



17.26%

MASKS ADJUSTMENTS

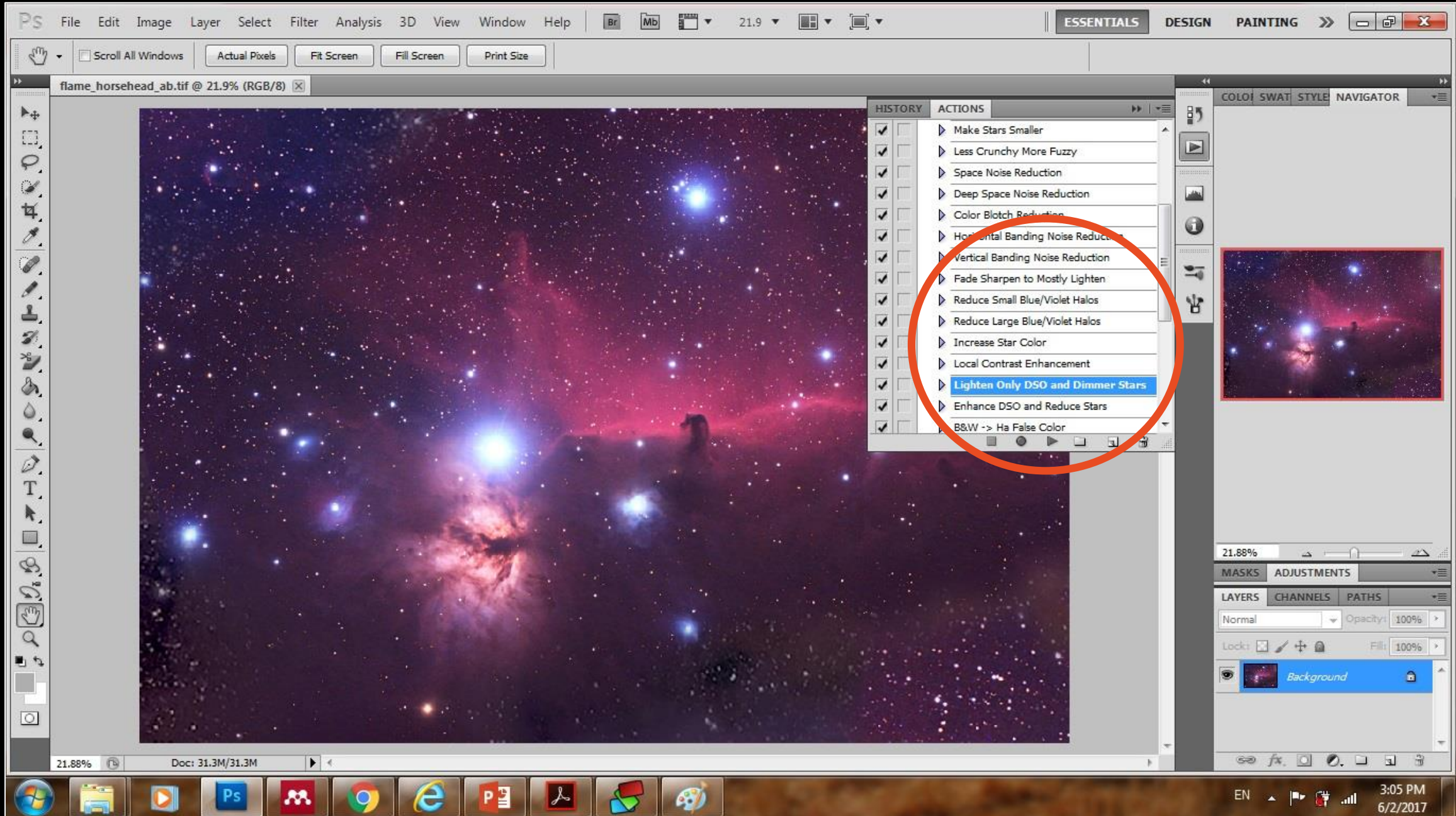
LAYERS CHANNELS PATHS

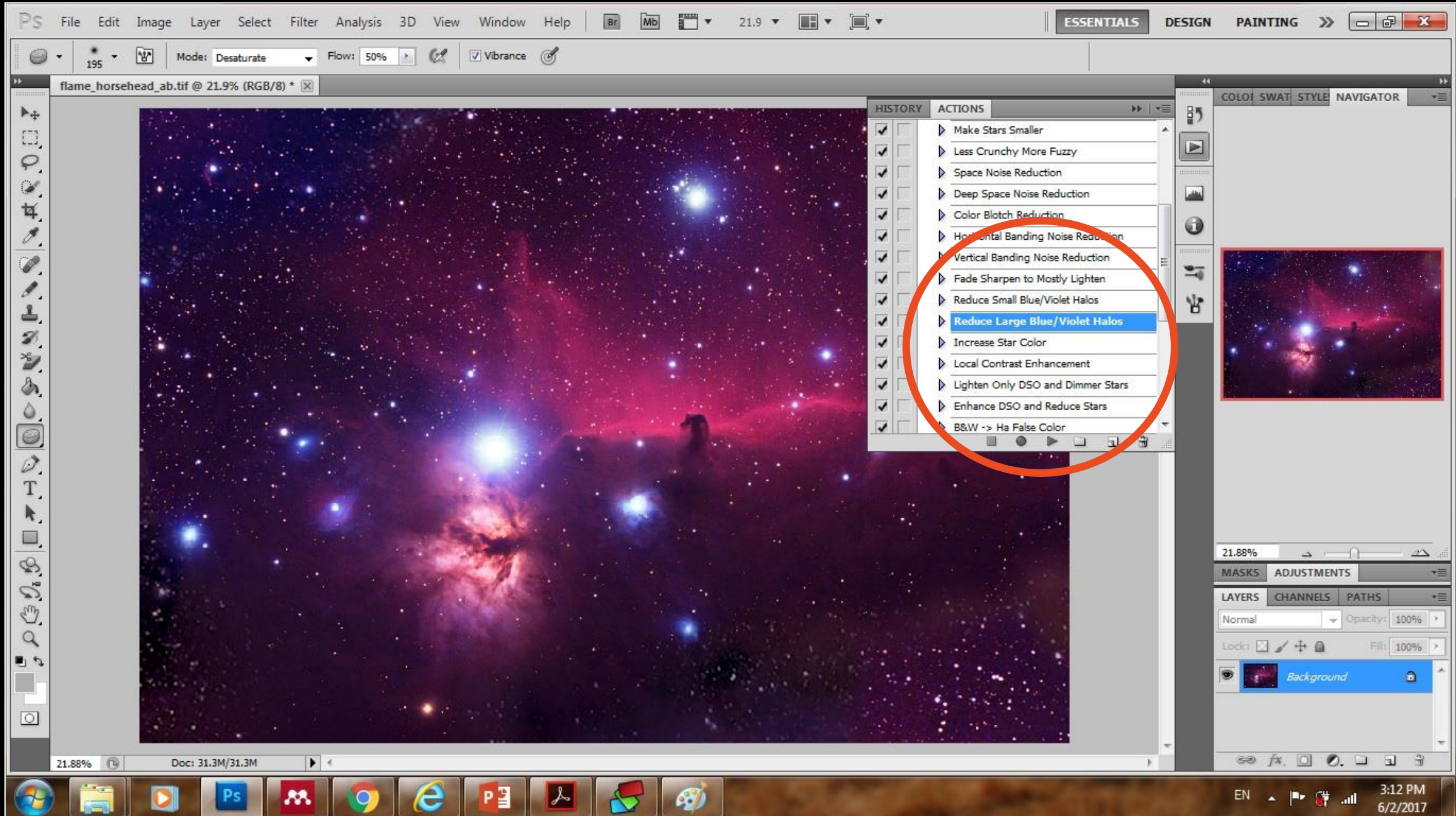
Luminosity Opacity: 76%

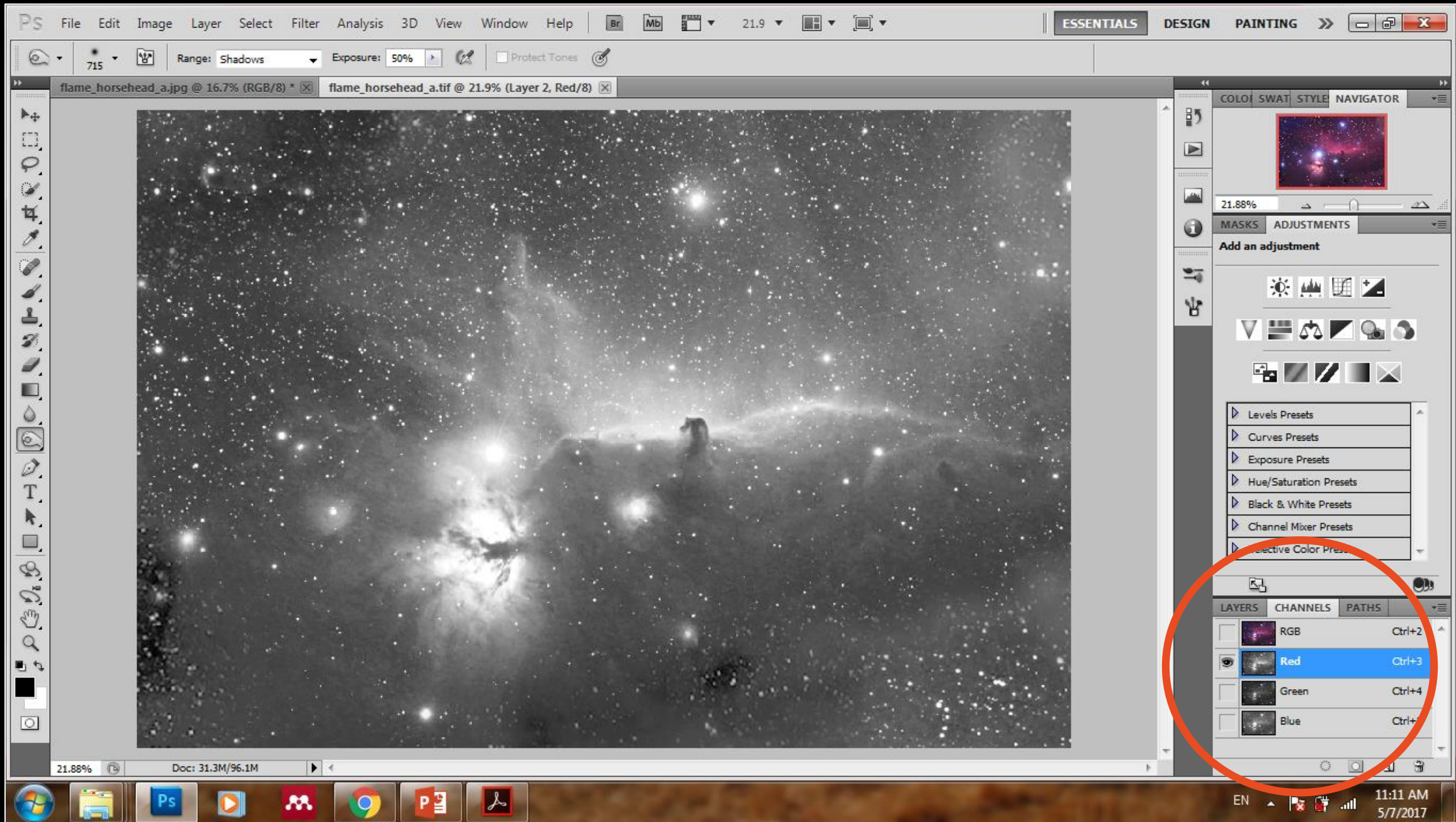
Lock: Fill: 100%

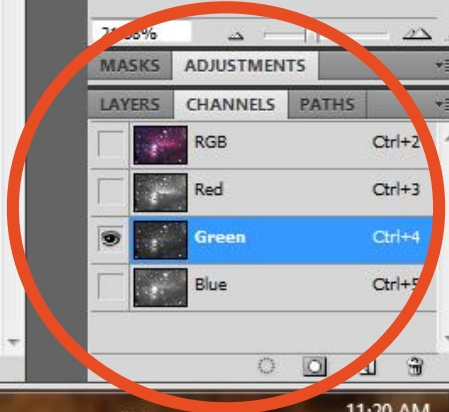
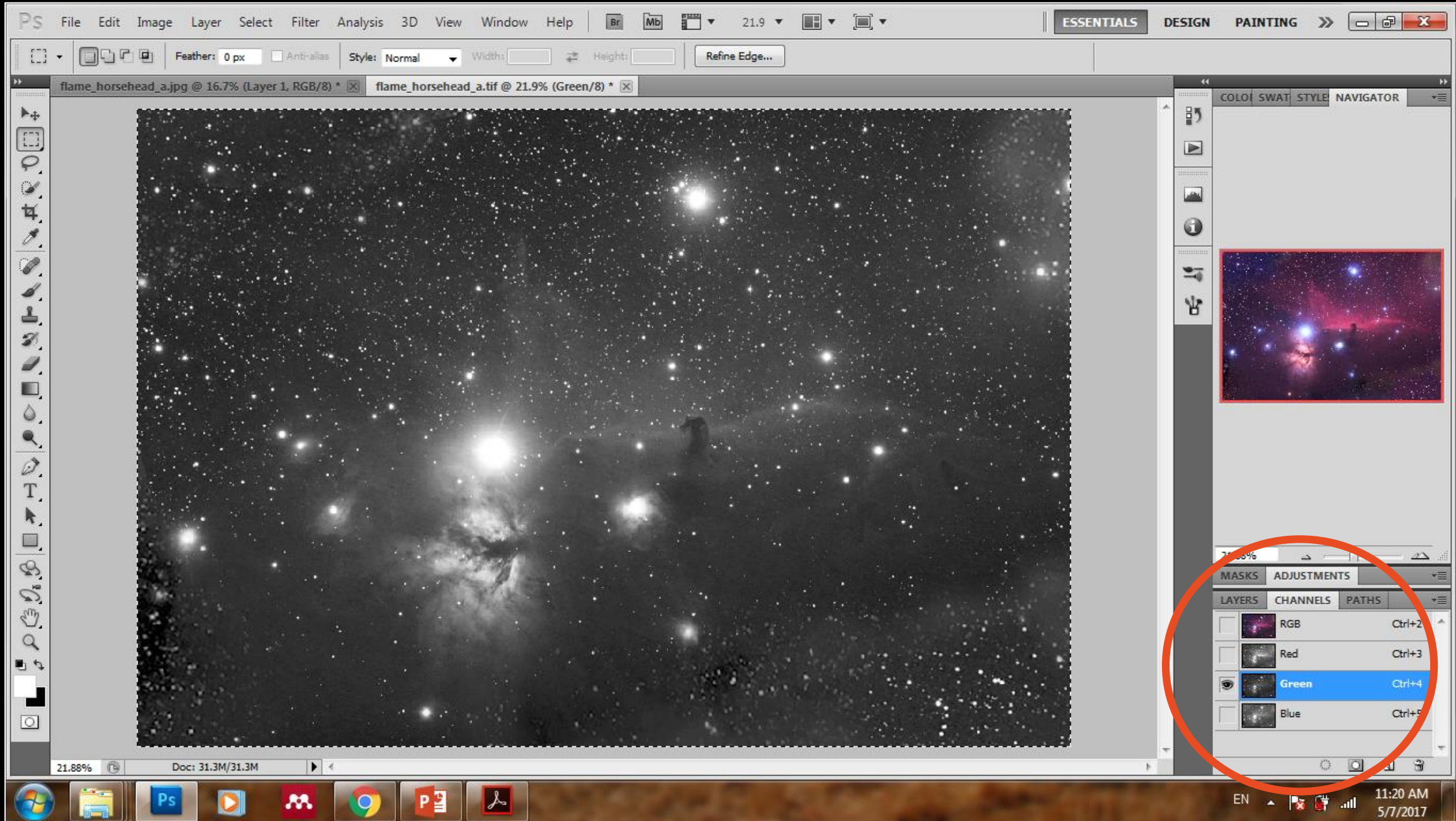
Levels 1

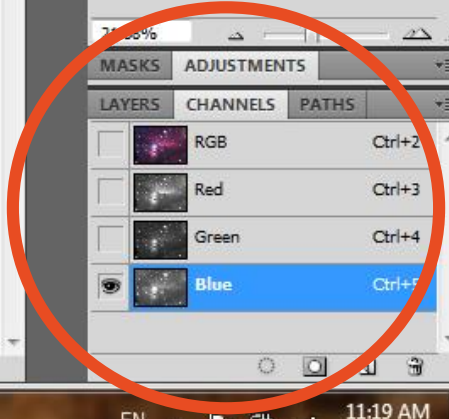
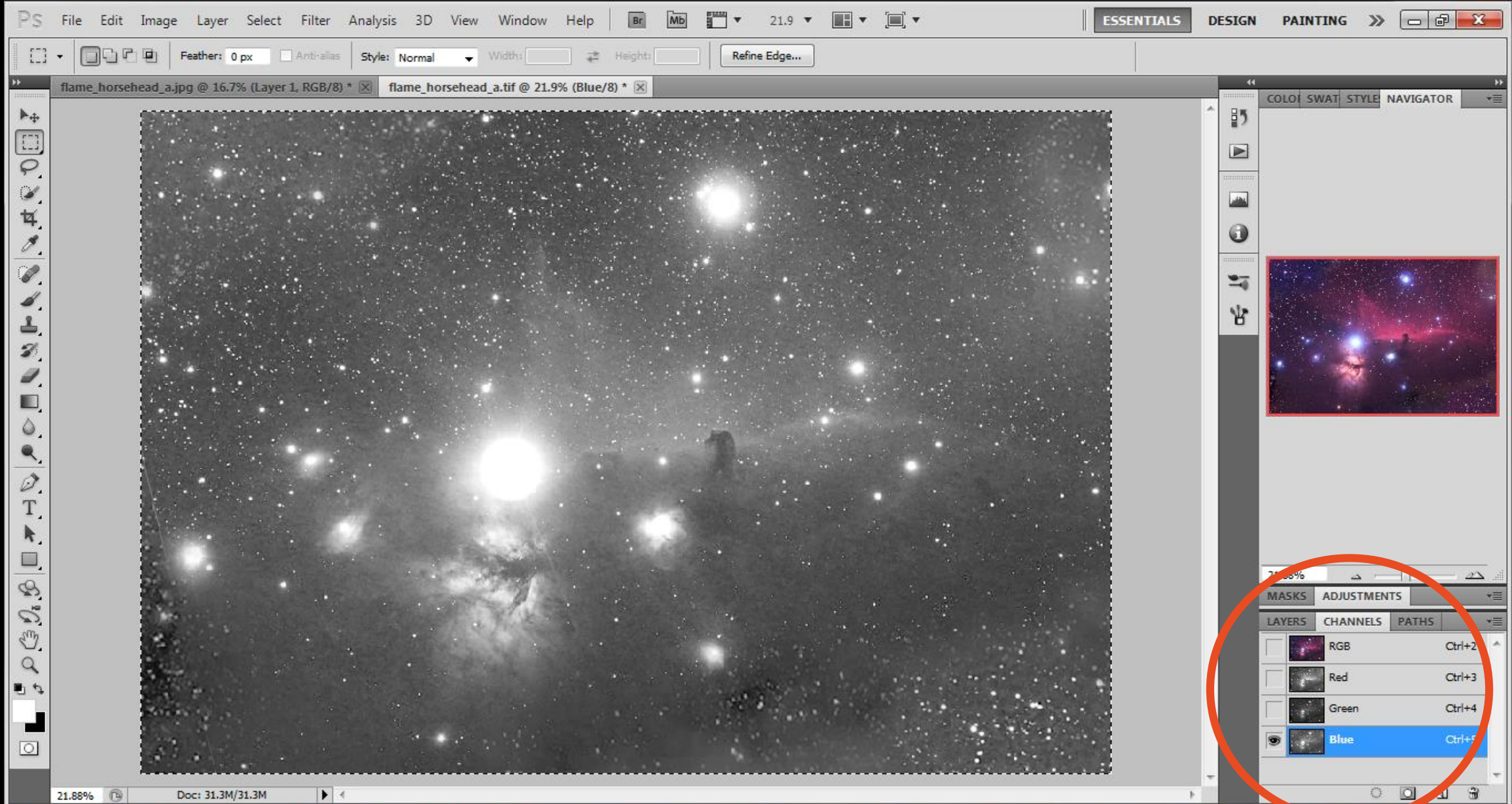
Background







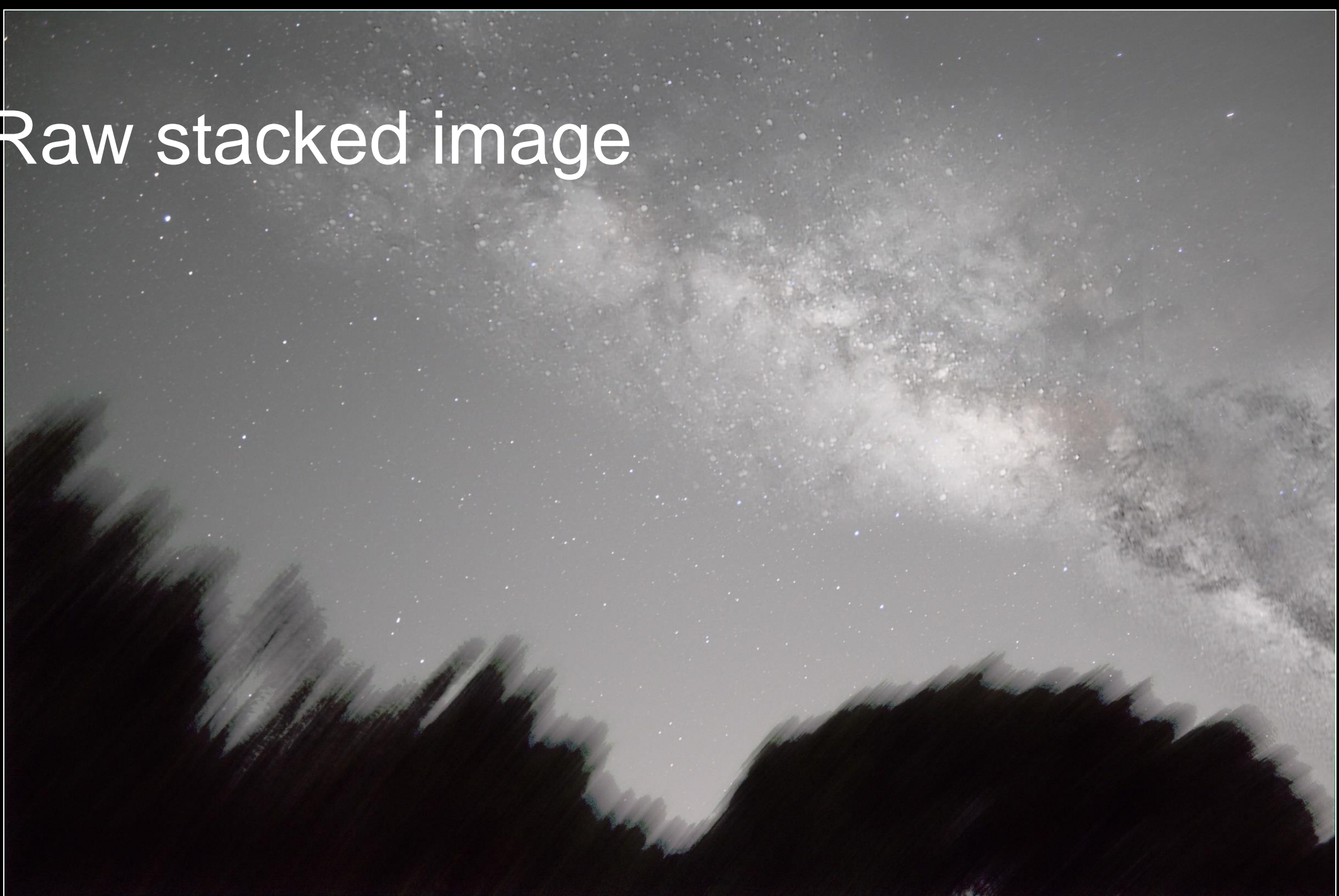




Final Image...



Raw stacked image

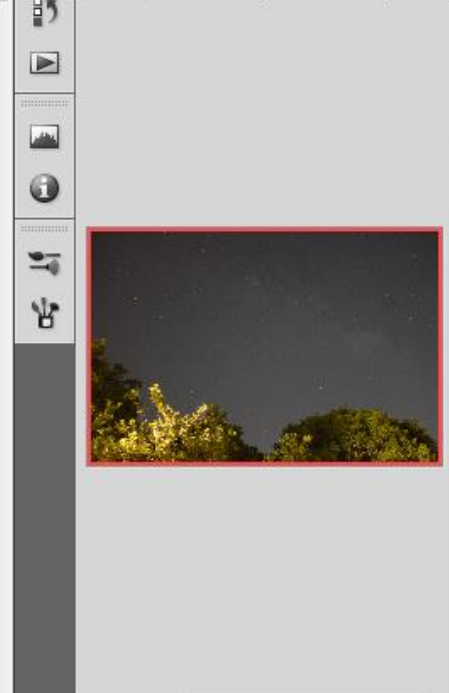


[Tools] [Sample All Layers] [Auto-Enhance] [Refine Edge...]

milkyway.tif @ 16.7% (RGB/16) * [x] milkywaynsp2015.png @ 66.7% (Layer 0, RGB/8) [x] SkySurveyBanner.jpg @ 66.7% (RGB/8#) [x] IMG_8892.CR2 @ 16.7% (RGB/8*) [x]



COLO SWAT STYLE NAVIGATOR



16.67%

MASKS ADJUSTMENTS

LAYERS CHANNELS PATHS

Normal Opacity: 100%

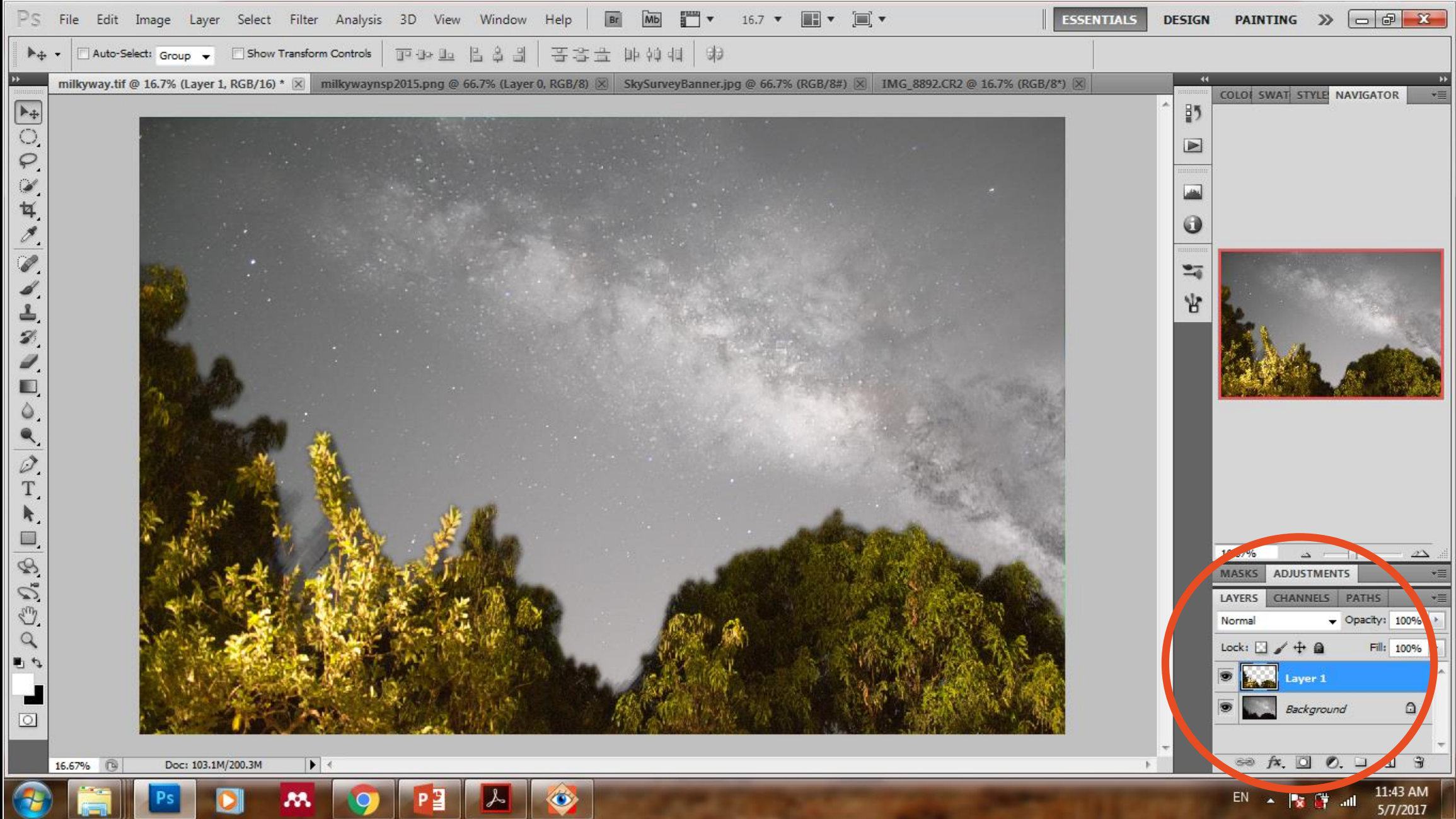
Lock: [Icons] Fill: 100%

[Eye] Background [Lock]

[Effects] [Layers] [Properties] [Zoom]

16.67% Doc: 51.3M/51.3M





Sagittarius Arm of Milkyway, 18mm, 20 sec, 49 frames, ISO 3200



Persius Arm of Milkyway, 30 sec shutter speed, iso 3200, 50 frames, 18mm focal length...



Pleiades Open Cluster, 1 min shutter speed, 43 frames, ISO 3200, 11 inch Cassegrain...



Andromeda Galaxy, 1min shutter speed, 53 frames, ISO 3200, 11 inch
Cassegrain...

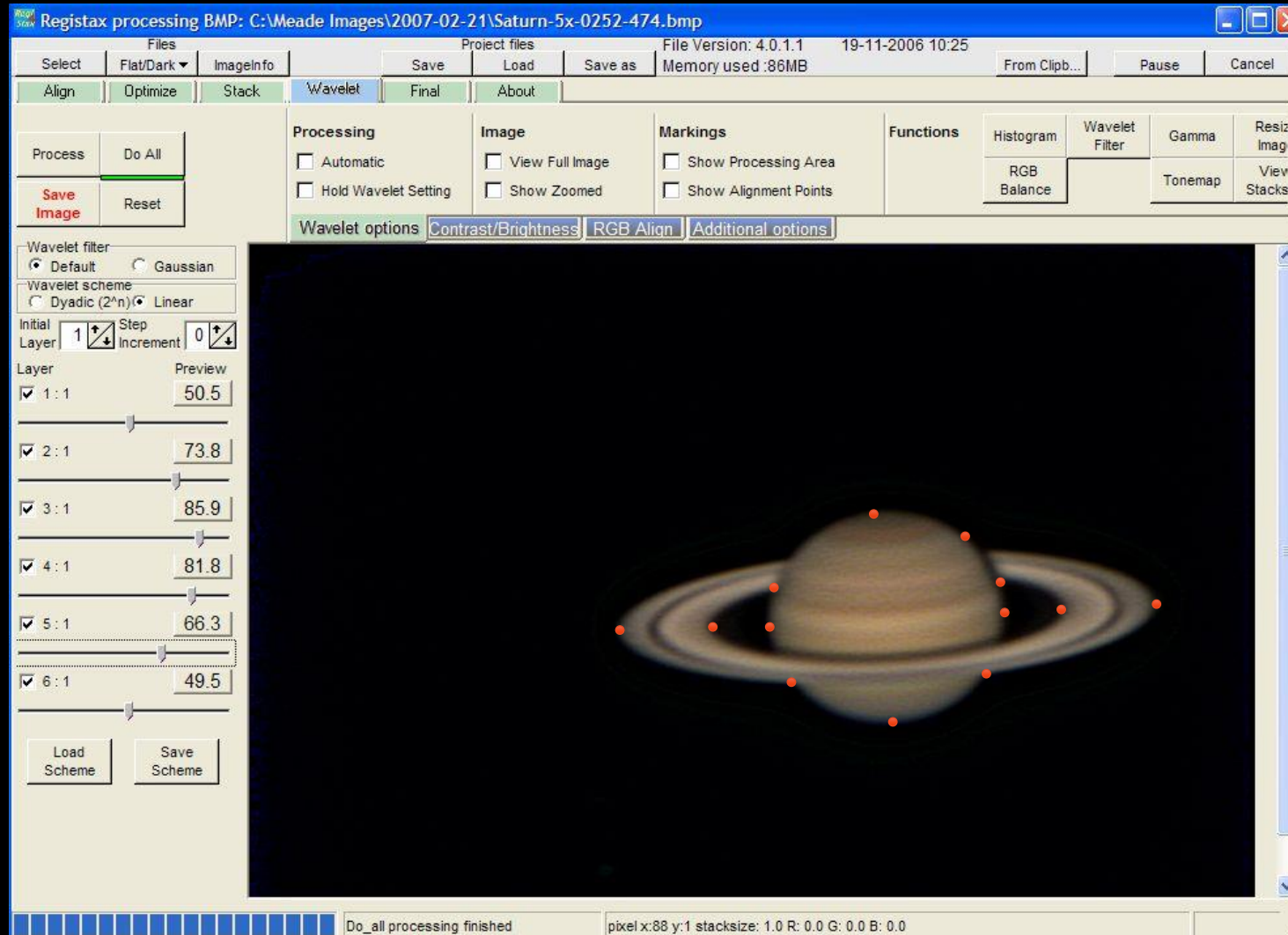


Planetary Photography

- HD Video of 1 min was taken using 8 inch telescope and 3x barlow lens to magnify.
- Around 3000 frames were obtained (it depends on the camera speed, how many frames/sec it can shoot!).
- Best 1000 frames were selected and stacked in Registax.
- Final processing done in Photoshop CC.



Registax stacking tool for planets



Jupiter, 130 mm reflector with 3x barlow, HD video recording of 1.5 mins, 1209 off 2900 frames stacked in Registax...



Handheld Shot of Moon, 1/200 shutter speed, 6 frames, ISO 100, 250mm focal length...stacked in Registax.



Solar Eclipses



22nd July, 2009, Varanasi



15th January, 2010, Kanyakumari

Comet Lovejoy 2013, 10 sec shutter speed, 15 frames, f3.5, 300mm



Time lapsed image of Comet Panstarrs and crescent Moon



Time Lapse Milkyway

