

# Doing astrophotography with a DSLR on a tripod

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# Doing astrophotography the easiest way:

- DSLR on a tripod:
  - Minimum equipment.
  - No tracking device or telescope needed.
- Easy procedure of taking pictures:
  - Just get outside wherever you are and start taking pictures.
  - Includes doing astrophotography in a light-polluted environment.
- Minimum image processing:
  - Limit yourself to what is absolutely necessary.

# Doing astrophotography the easiest way:

- Starting point for people who want to try some astronomy in general or astrophotography specifically.
- Possibility to get people interested in astronomy no matter where they are.
- It does not replace tracking, it does not replace going to a dark sky, it does not replace more sophisticated equipment and more and better image processing.
- But it is amazing what you can achieve.

# My pictures:

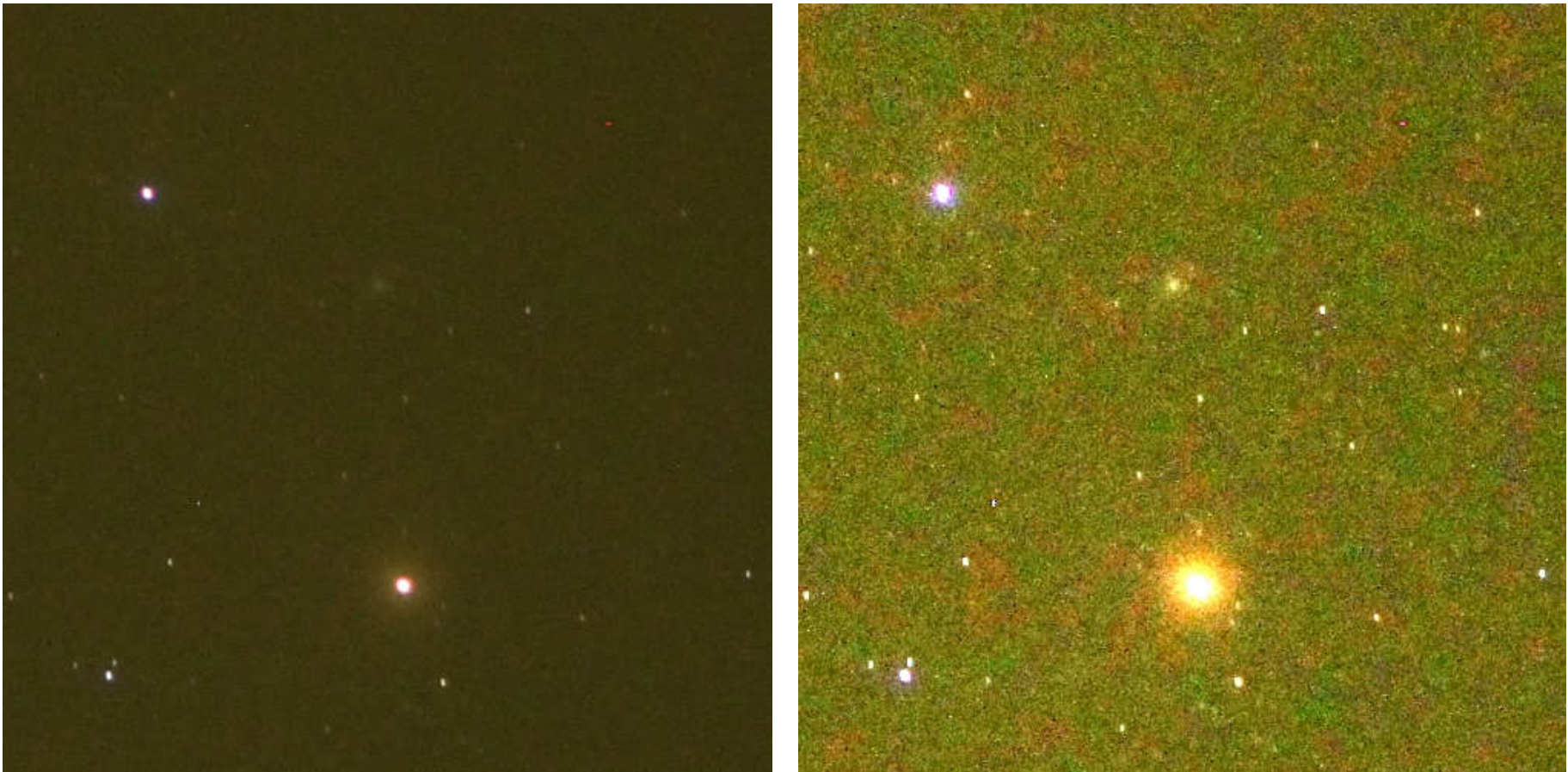
- Taken with a DSLR on a tripod.
- Pictures mainly taken in:
  - Erasmuskloof in Pretoria: Light-polluted sky
  - Lilienthal in Germany:
    - Latitude  $53^{\circ}$  North
    - Sky darker than in Pretoria, but still light pollution present.
- Series of short exposures of the objects in the night sky.
- Minimum image processing (two steps only):
  - Stacking of the short exposures
  - Creating a background image (light pollution contribution) and subtracting it.

Two major problems with my pictures:

- DSLR on a tripod: Sky rotation
- Not a dark site: Light pollution

# Sky rotation:

- Short exposure times needed, otherwise star trails.
- Short exposure  $\rightarrow$  low signal  $\rightarrow$  noisy images.

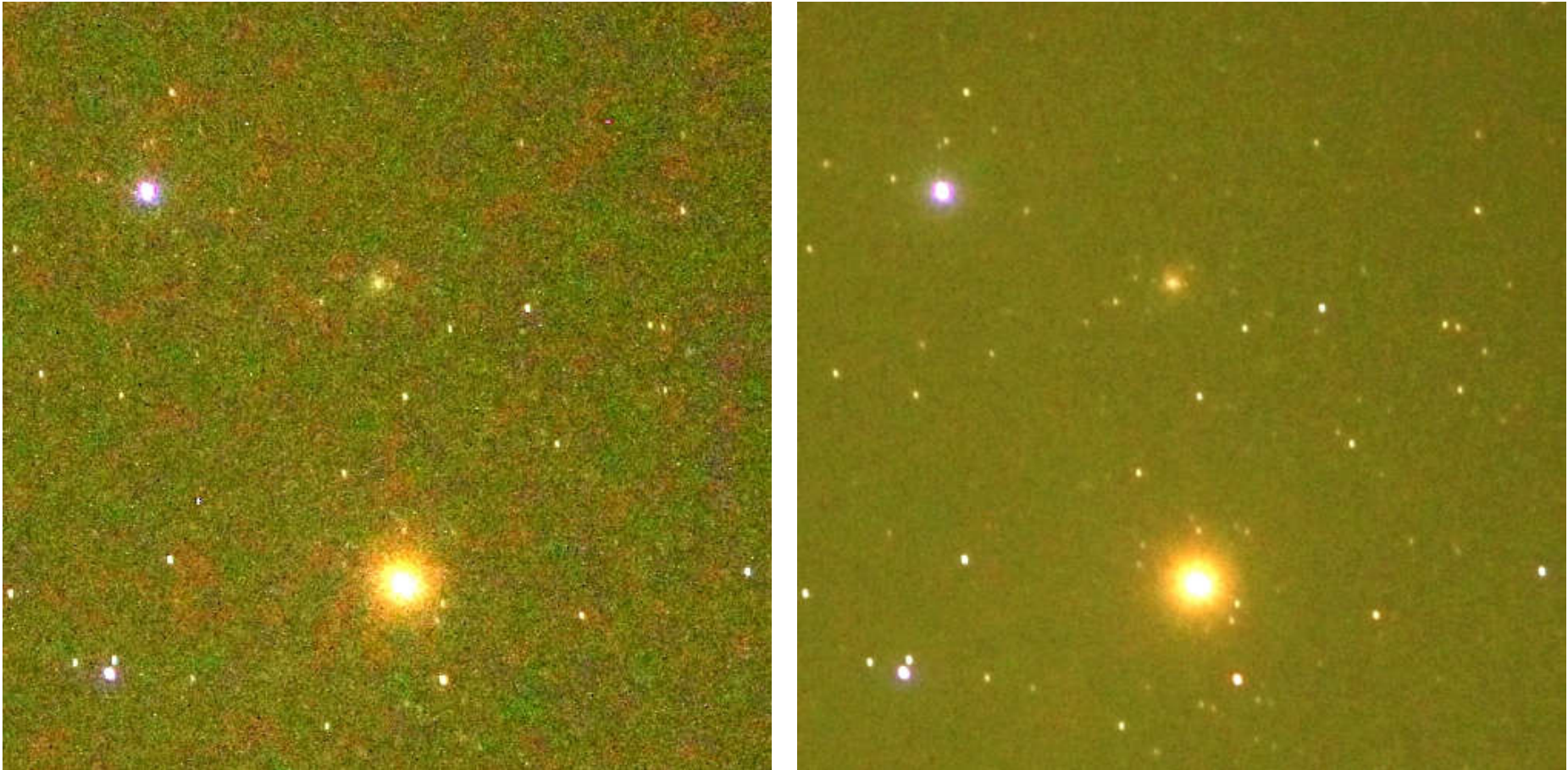


Single 6s exposure of Antares and M4. Left: original, right: enhanced contrast.



## Taking series of short exposures and stacking them:

- Stacking reduces noise



Antares and M4: Left: 6s exposure, right: ten 6s exposures stacked.  
→ Less noise.

## Using the median when stacking the images:

- My pictures: No dark images. Therefore we have hot pixels present.
- Mean image: Hot pixels still visible (left image).
- Median image: Hot pixels disappear (right image).
- Median works because the sky rotation gives us built-in dithering feature.





# Software for stacking:

- Software needed that:
  - Automatically shifts the individual images of a field relative to each other so that the stars are in the same position in each image.
    - Includes automatic identification of the same stars in different images.
    - Important because of large number of images per field.
  - Uses the median when averaging the shifted images.
- Software used:
  - Regim, written by Andreas Rörig, a German amateur astronomer.
  - Regim is freely available and can be downloaded from the author's website.

## Light pollution:

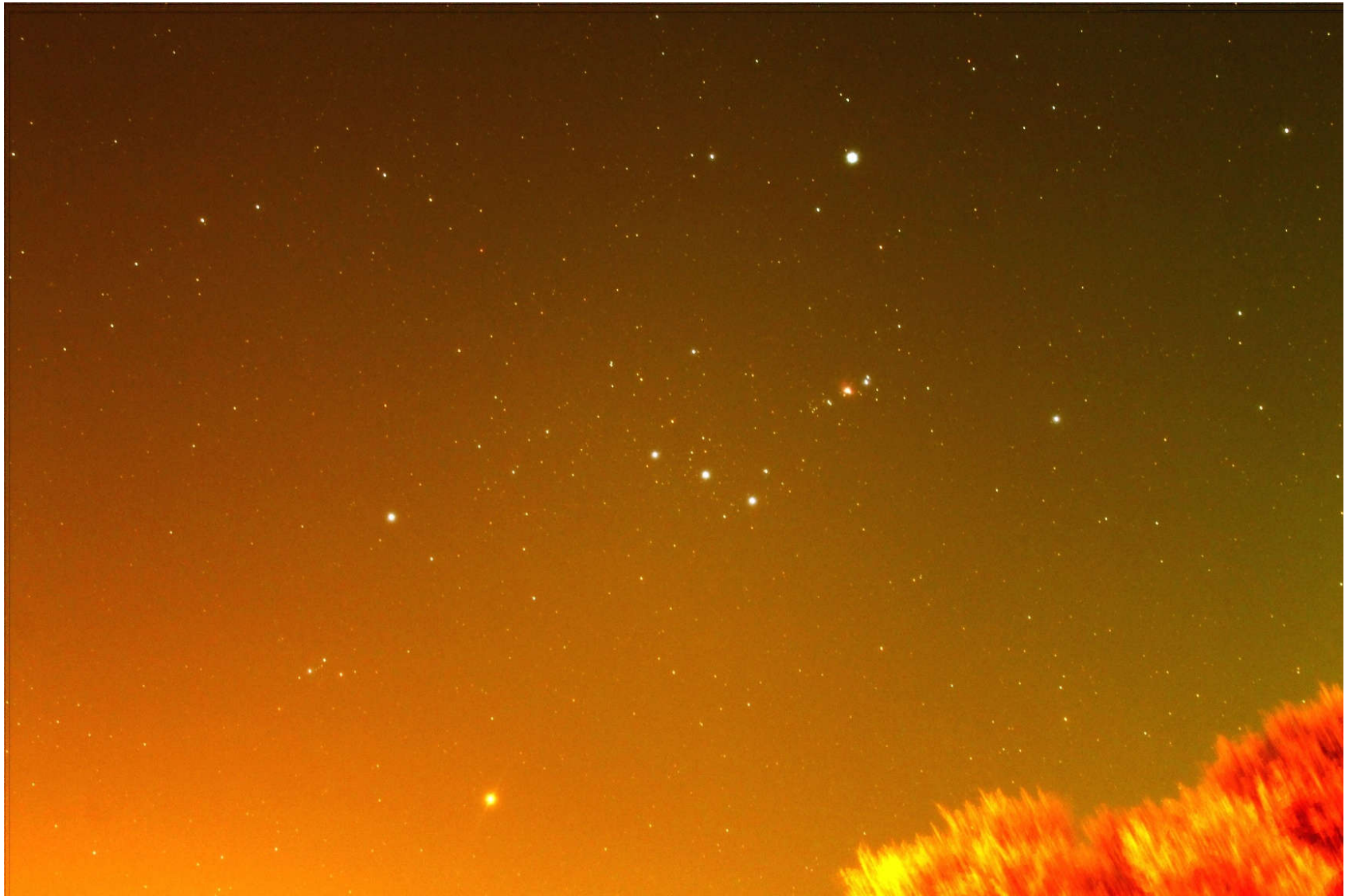
- Light pollution creates a large sky background signal:
  - Different in different sky areas.
  - Often dominates the images.
- Light pollution increases the noise.

Example of image with light pollution:



Orion with 10 x 10s, Pretoria: image dominated by sky background.

## Image of Orion with enhanced contrast:



- Red sky in the left half: Orange security lights and street lights
- Green sky in the right half: With compliments from the Castle Walk Shopping Centre

## How to deal with the problem of light pollution:

- Create a sky image and subtract it.
- Take a large number of exposures to reduce the noise.

## Creating the sky image:

- Start with stacked image containing stars and sky.
- Software used: Photoshop
- Main steps in Photoshop:
  - Use Median function with largest radius.
    - Median function takes median of a certain region of the image and, because most pixels are background, removes the stars.
    - Result: Image of the background.
  - Use Gaussian Blur to create a smooth sky background image.

Procedure works very well for regions with no large extended objects.

Procedure is a problem for regions with large extended objects, e.g., Milky Way regions:

After applying the median function, the resulting sky image still contains the extended object or parts of it.



How to create a sky image for an image with a large extended object:

- Use Gaussian Blur with largest radius .
- If necessary, apply Gaussian Blur more than once until the extended object is flattened enough that it disappears in the blur.
- Result: Extended object is flattened so much that it is invisible.

What does this mean?

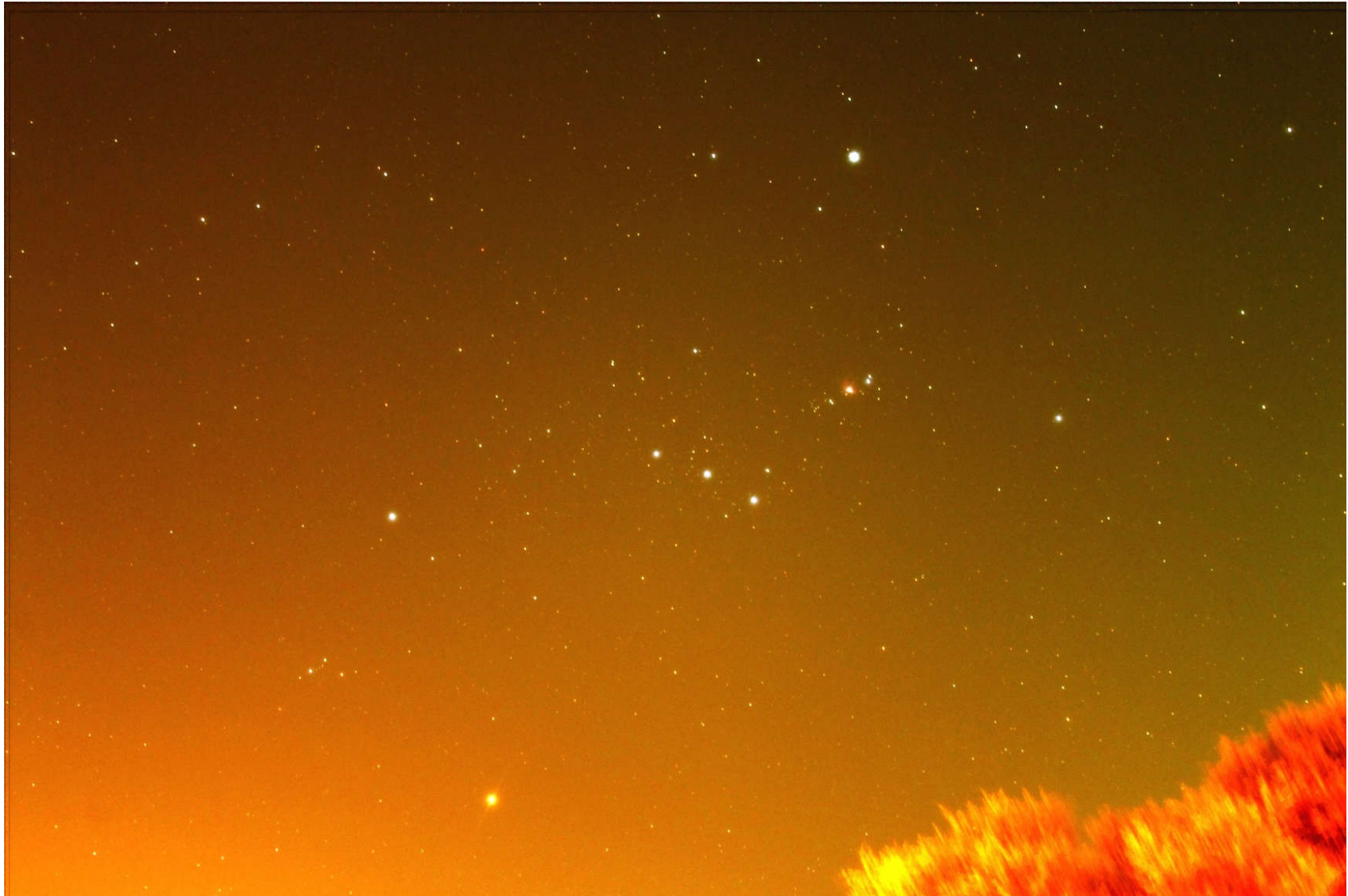
- The more you blur the image, the flatter it becomes.
- In order to create a sky image where the extended object is not visible anymore, you have to blur the image considerably.
- But if you blur considerably, the resulting sky image will also be flatter than the real sky (light pollution), and the sky subtraction will not remove all sky features, and some light pollution will be left.
- So the sky image is a compromise!

## WARNING:

The procedure I described for creating a sky image is  
very crude!!!

But it works!

Image of Orion with enhanced contrast (again):



- Red sky in the left half: Orange security lights and street lights
- Green sky in the right half: With compliments from the Castle Walk Shopping Centre

Image of Orion after sky subtraction:



Example of background image: Antares and M4:

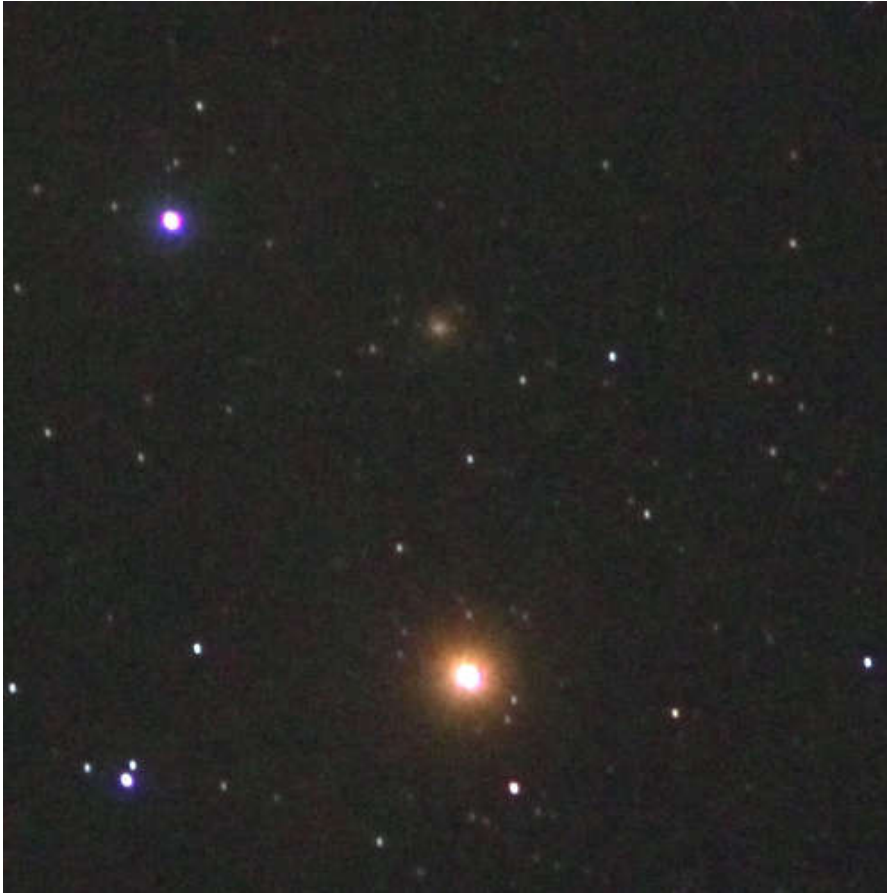


Left: Stacked image before sky subtraction (contrast not enhanced)

Right: Sky background image



Image of Antares and M4 after sky subtraction:



Left: Image after sky subtraction (enhanced contrast)

Right: Image before sky subtraction (enhanced contrast)



Some examples of what you can photograph with a DSLR on a tripod:

- Constellations
- All 88 constellations: Two observing sites needed, one in the northern hemisphere, one in the southern hemisphere.
- Star clusters, nebulae and galaxies
- Milky Way regions and Magellanic clouds (LMC and SMC)

# Examples of my results

Technical parameters of my pictures:

- Focal length: 18-55 mm, 100 mm
- Exposure times of individual images: 3.2s ... 10s
- Number of images in a series: 10 ... 480
- Total exposure times: up to 1 hour
- Use a diffuser filter for creating “bigger” stars.
- DSLR has been modified to show emission nebulae.

Images of constellations taken in Pretoria (latitude =  $26^{\circ}$  South):



Orion, 10 x 10s





Southern Cross, 10 x 10s



Images taken in Lilienthal, Germany, latitude =  $53^{\circ}$  North:



Big Dipper, part of Ursa Major, 10 x 10s



Everything is upside down in the northern hemisphere ... ?!



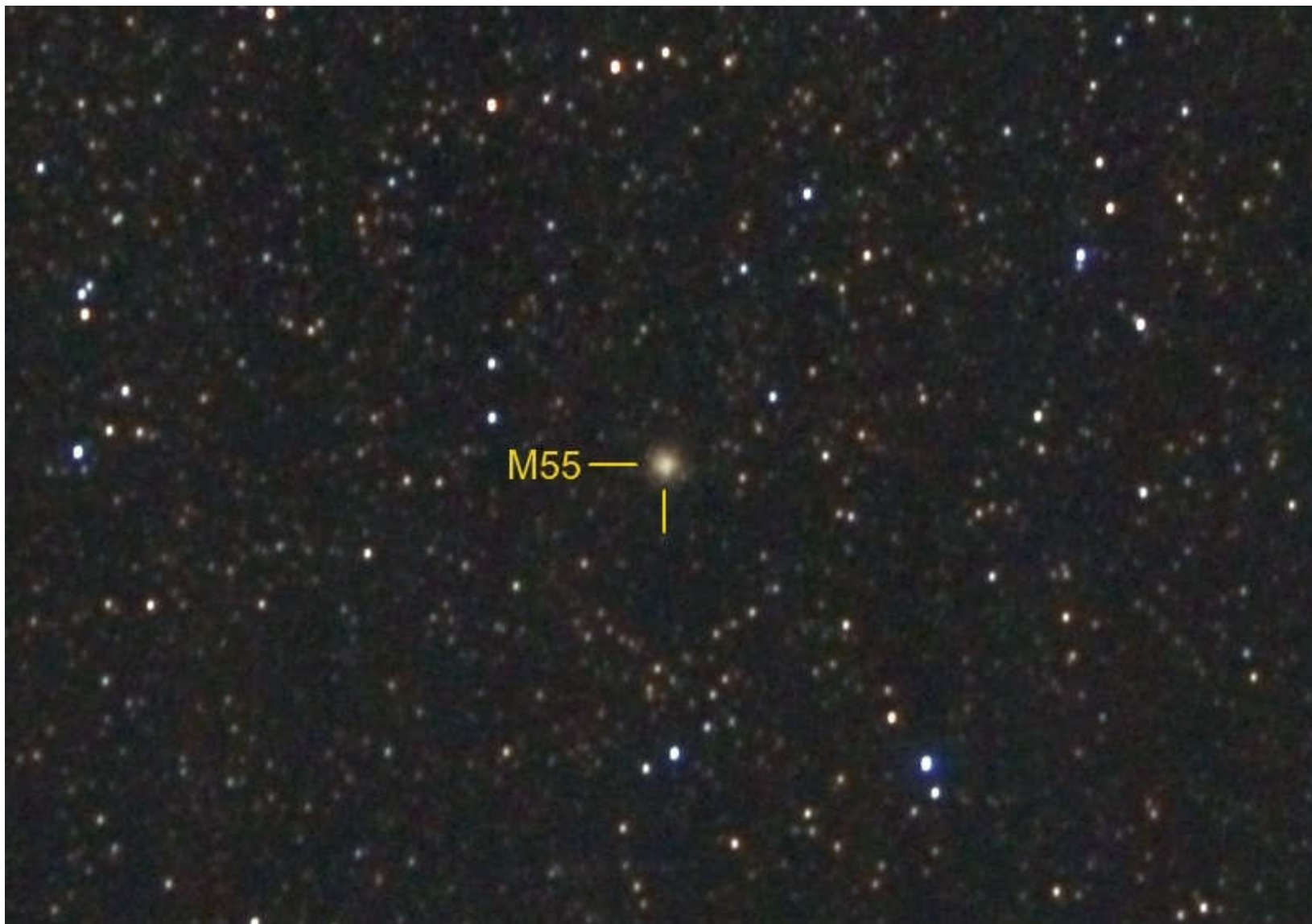
Orion, 10 x 10s



Examples of star clusters, nebulae and galaxies, all images taken in Erasmuskloof, Pretoria:



Open clusters M6 (mag = 4) and M7 (mag = 3) in Scorpius  
Focal length = 100 mm,  $180 \times 3.2\text{s} = 9 \text{ min } 36\text{s}$  for each object



Globular cluster M55 (mag = 6.3) in Sgr  
Focal length = 55 mm, 120 x 6s = 12 min





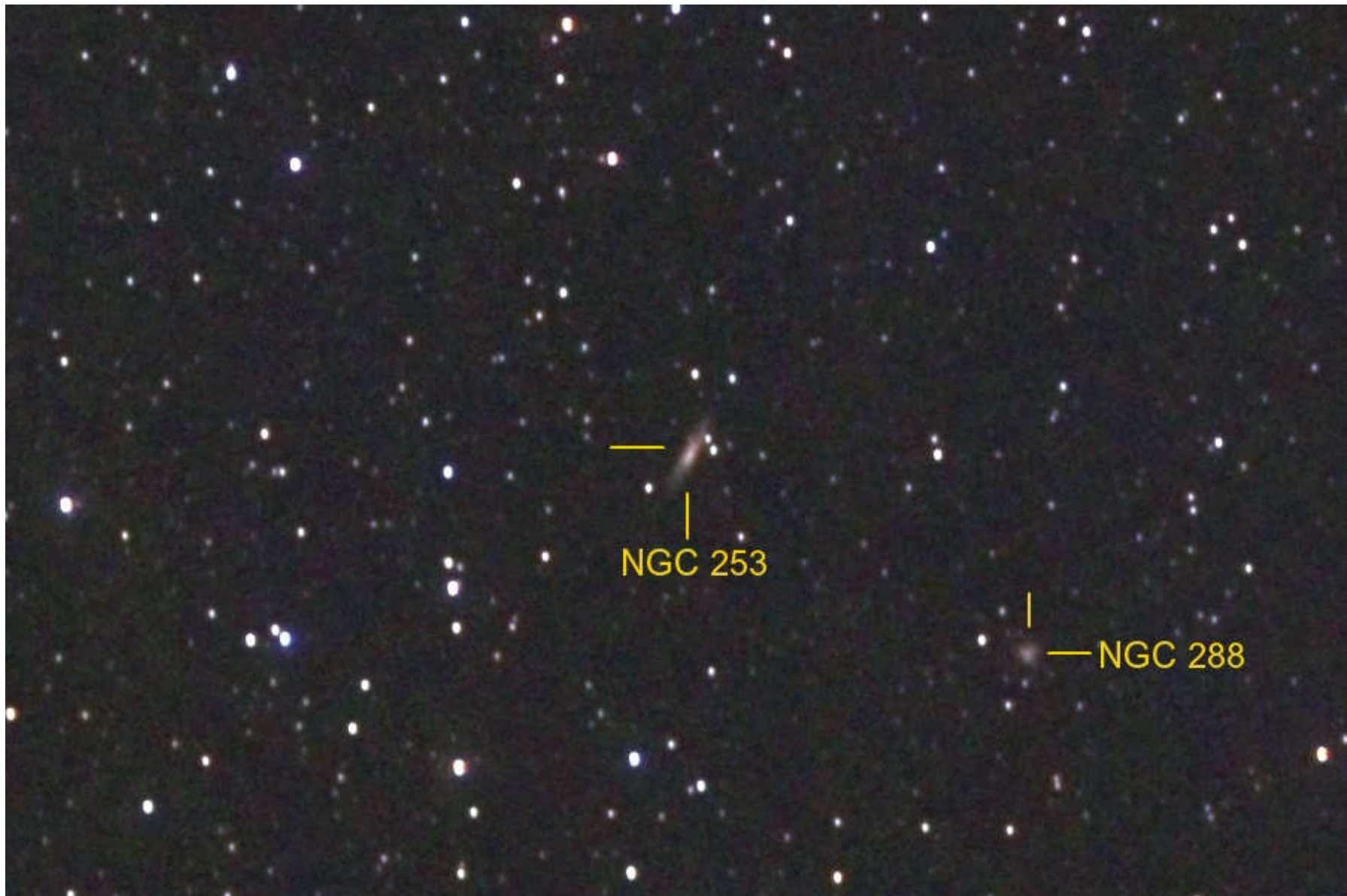
Bright nebula: NGC 3372 =  $\eta$  Car nebula  
Focal length = 109 mm, 180 x 4s = 12 min





Dark nebula: Coalsack. Focal length = 55 mm, 150 x 8s = 20 min





Galaxy NGC 253 (mag = 8) + globular cluster NGC 288 (mag = 9)  
Focal length = 55 mm, 360 x 6s = 36 min



Magellanic Clouds LMC (left) and SMC (right), images taken in PTA  
Focal length: 55 mm,  $360 \times 10\text{s} = 1$  hour for each object.





Totally eclipsed Moon and Milky Way, June 15, 2011, 10 x 10s, Pretoria



## My Messier atlas



Images taken in Pretoria and in Lilienthal

## Summary of what my images show:

- Faintest objects: about 10 mag
- Bright and large clusters, nebulae and galaxies: structures visible
- Faint and small objects: small fuzzy patches with no structure

## Examples of what have I achieved so far:

- Constellations: Images of all 88 constellations
- Messier objects: Images of all Messier objects
- NGC and IC objects: Images of many of the brightest objects

## Conclusions:

- What I have shown does not replace tracking and does not replace going to a dark site.
- However, there is a lot that can be done with a DSLR on a tripod, even in a light-polluted environment.
- So light pollution and only having a camera on a tripod is no excuse for not taking images of the stars!!!