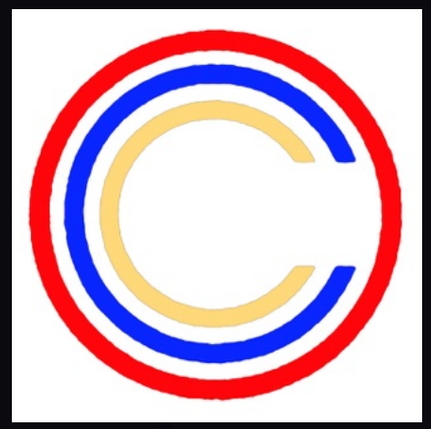


Capturing light

Low light capabilities of cameras

Jamie B-S

Capturing light

The pixel

Think of a pixel as a bucket….and light as balls.

The buckets collect the balls (well, most of them).

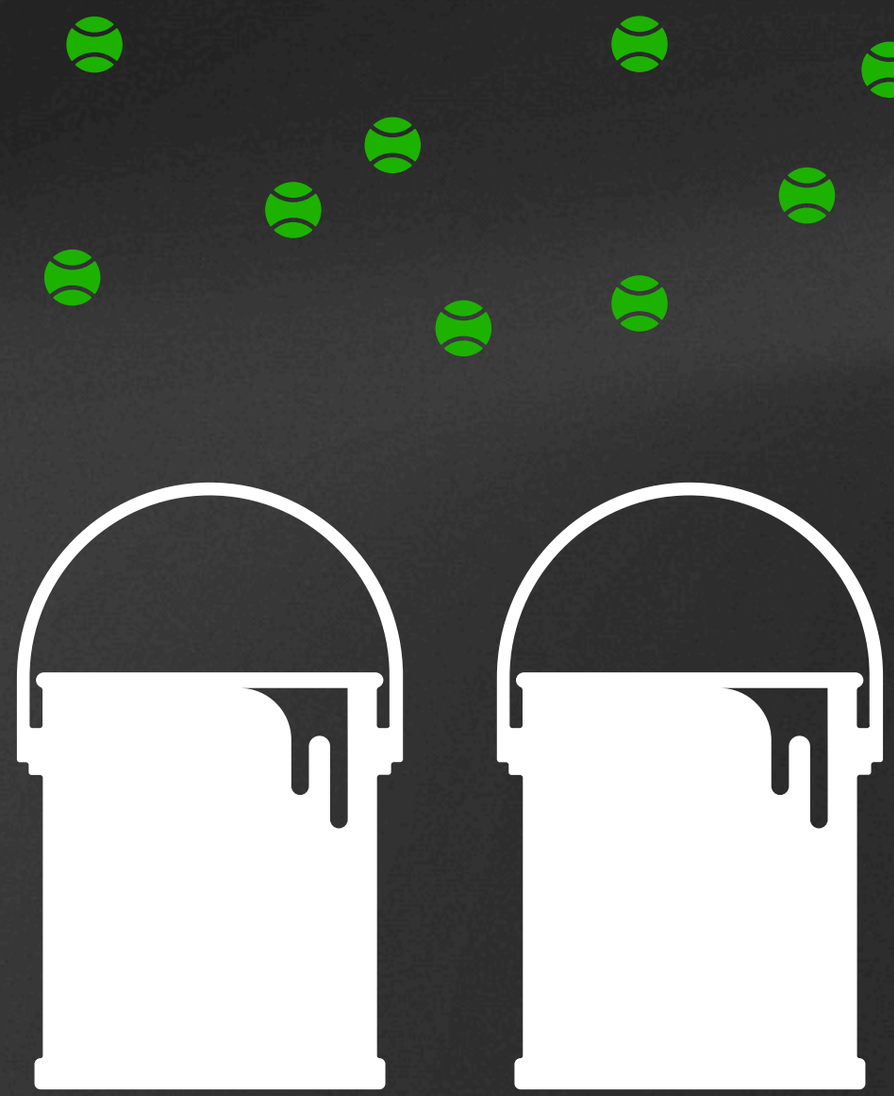
The number of balls in each bucket is added up every whenever (1/50th sec).

The number equals the brightness (in this case 2)

Capturing light

The pixel

If you have bigger buckets….and the same number of balls.



The buckets will each collect more balls (in this case 4).

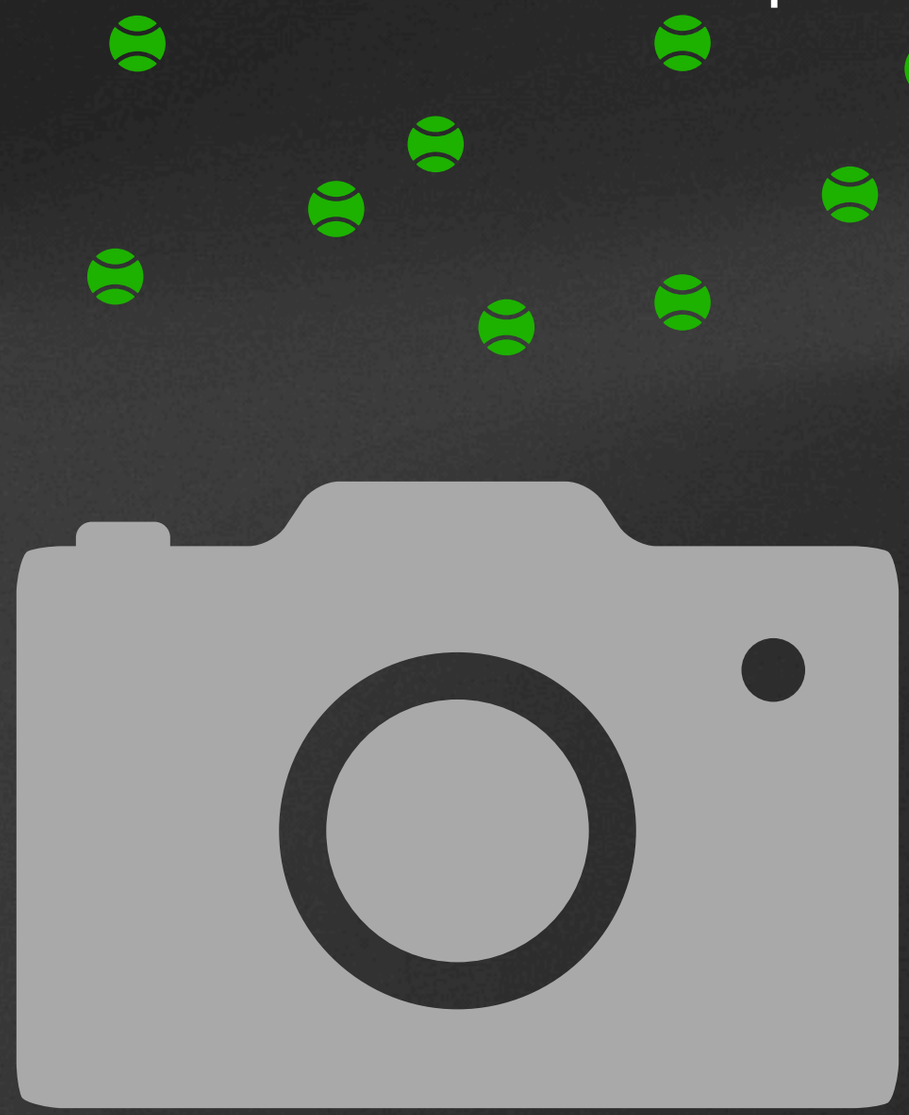
The brightness has doubled.

But the resolution will be less (we only have 2 pixels now instead of 4).

Capturing light

The sensor

So cameras with big sensors are better because they have bigger buckets - well it’s not that simple.



There are other things to consider:

- Pixel density
- ISO
- Noise reduction
- Lenses & f numbers

Capturing light

Backside Illuminated Sensors

Making buckets a bit bigger without making the sensor bigger.

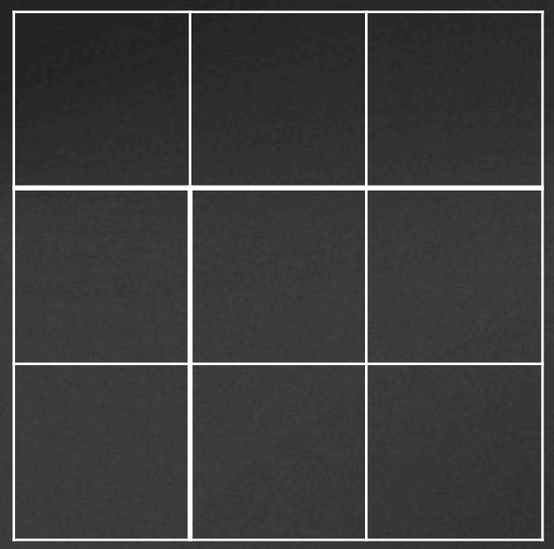
Instead of making room for the guy who measures the count in each bucket…

Some clever buckets let the light in through through the bottom of the bucket! And the guy measures the count from the other end.

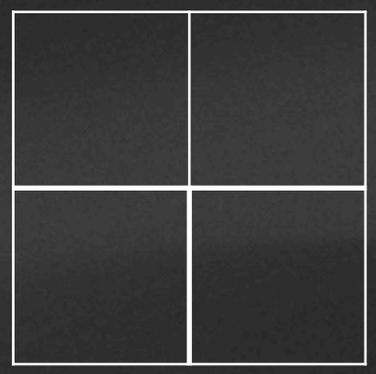
Capturing light

Full frame vs APSC

APSC sensors are (about) 2/3 of the size of Full frame.



Full frame



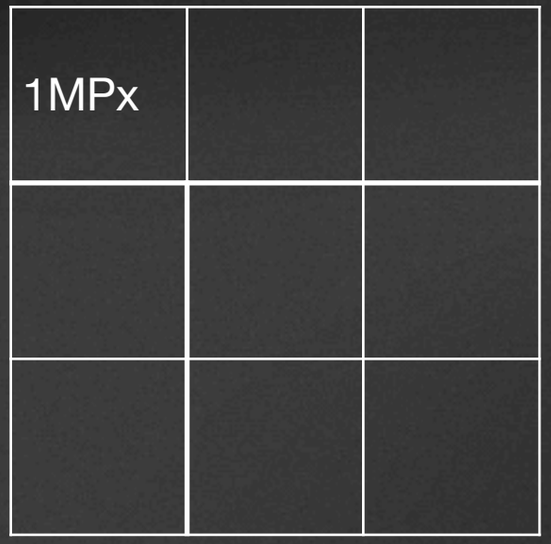
APSC

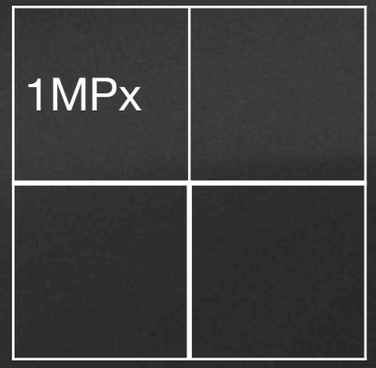
Capturing light

Full frame vs APSC

The squares all represent 1MPx.

In this case the Full frame has say 9 MPs vs the APSC’s 4 MPx.



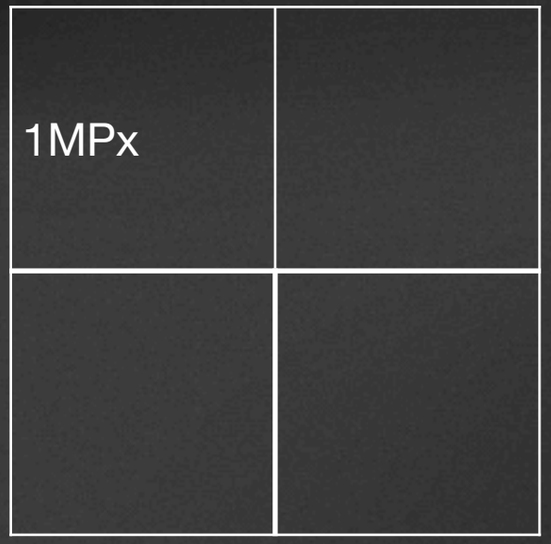


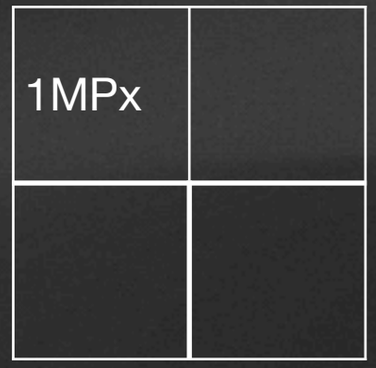
Capturing light

Full frame vs APSC

What if both have the same 4MPx?

The Full frame’s pixels are now 225% (9/4^{ths}) in size.

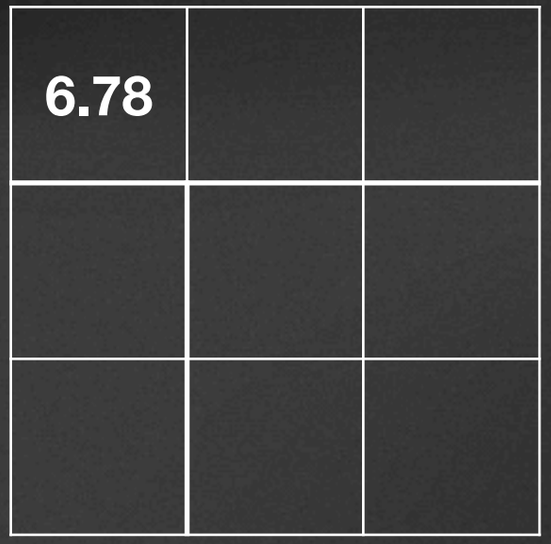




Capturing light

Full frame vs APSC

- Sony A7R IV 61MPx / 9 = 6.78 MPx per square
- Sony A6700 26MPx / 4 = 6.50 MPx per square

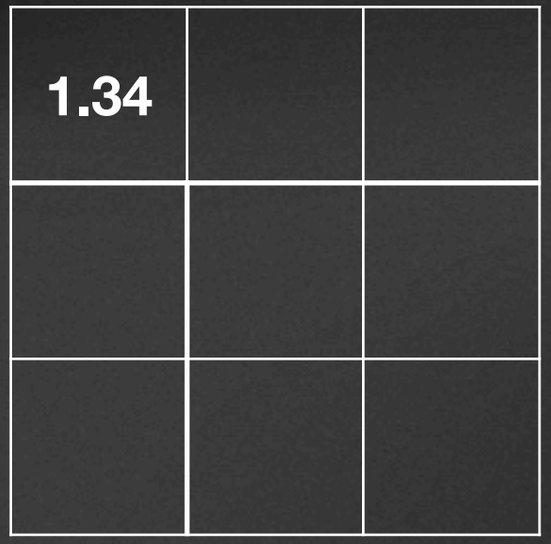


- So the two cameras share almost exactly the same sized pixels!

Capturing light

Full frame vs APSC

- Sony A7S III 12.1MP / 9 = 1.34 MP per square
- Sony A6700 26MP / 4 = 6.50 MP per square



So the Full frame has pixels 485% in size - which can therefore capture a lot of light and totally see in the dark.

Capturing light
ISO

- ISO stands for “International Standards Organisation”.
- Ever since the two film standards called ASA and DIN were combined into ISO standards in 1974, film sensitivity was simply referred to as “ISO”.
- Digital camera manufacturers engineered ISO settings so that they would appear to produce similar brightness levels as film.

Capturing light
ISO

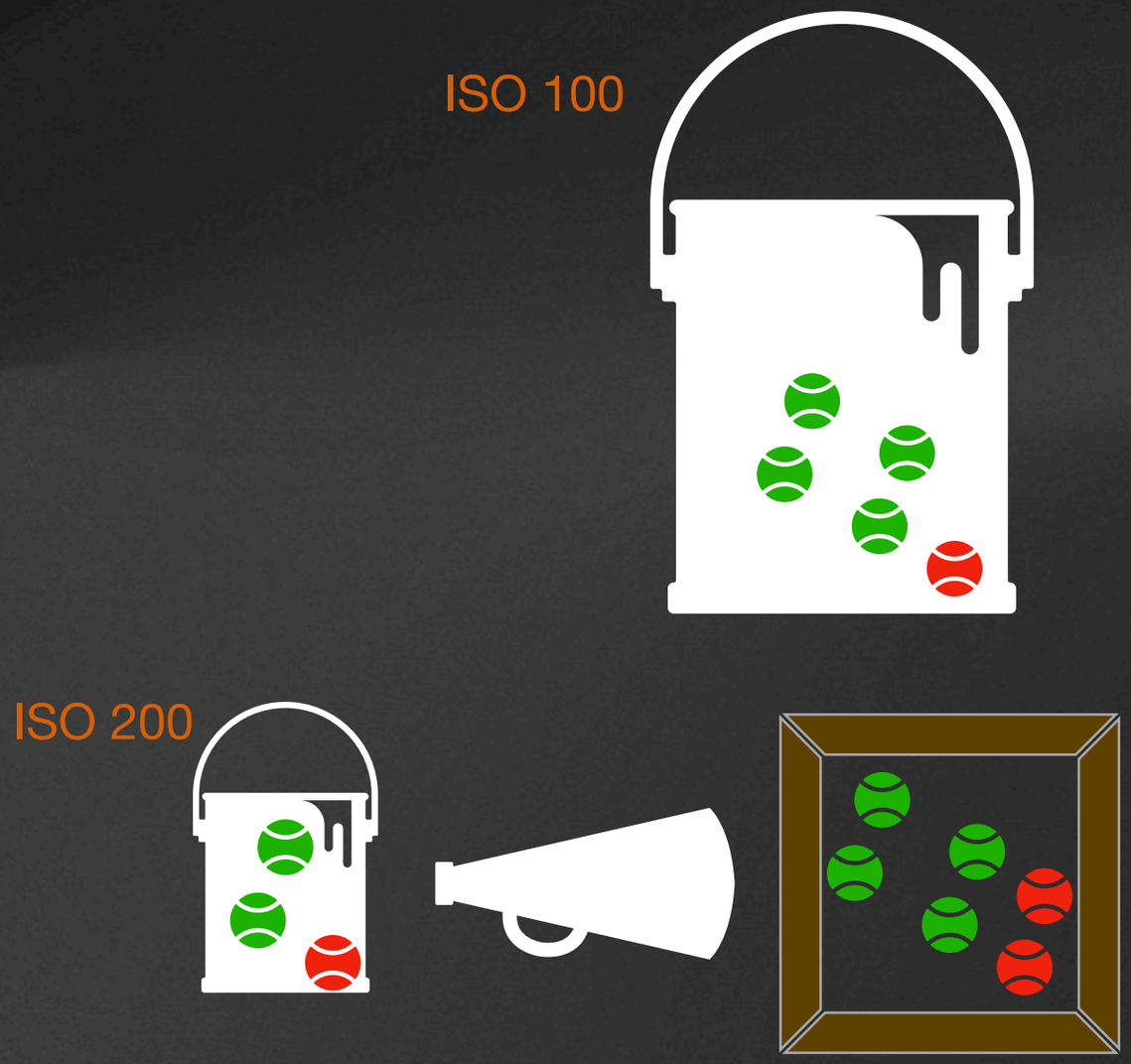
- Digital camera ISO settings are NOT the same as film in the sense that there is only one sensor in a digital camera. (You can’t swap your ISO 100 sensor for an ISO 800 sensor when you need it!)

- So digital cameras have a base ISO setting (often 50, 100 or 200) that does not change. (Its ability to capture light.)

- And they then amplify the signal from the sensor if required; so if you amplified 2x then you would have set your camera to ISO 200. (Its ability to see the light you have captured.)

Capturing light
ISO

But buckets are not as clean as you would like to think they are!



They can suffer from noise (red ball).

For the large bucket we see 4 green and 1 red ball (5).

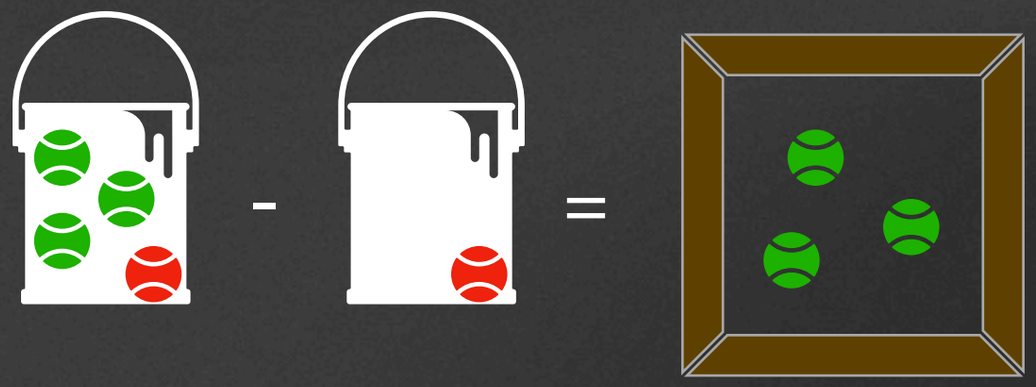
For the small bucket to see the same level of brightness we must double the ISO.

So we will see 4 green and 2 red balls (6).

Capturing light

Long Exposure Noise Reduction

Cameras often include tricks for effectively cleaning the bucket!



Your image contains noise.

The camera takes a second identical image with the shutter closed.

It then subtracts this from your original image.

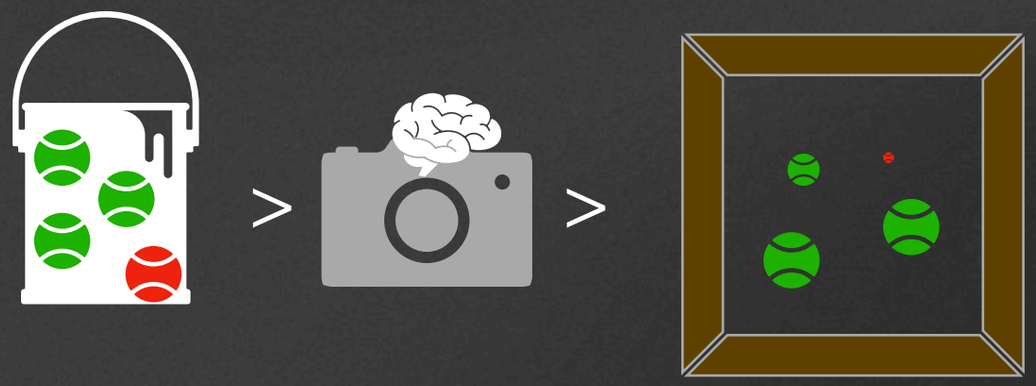
3g + 1r - 1r = 3g

Capturing light

High ISO Noise Reduction

Cameras often include image cleaning options as well! These will only apply when outputting as JPG from the camera.

Your image contains noise.



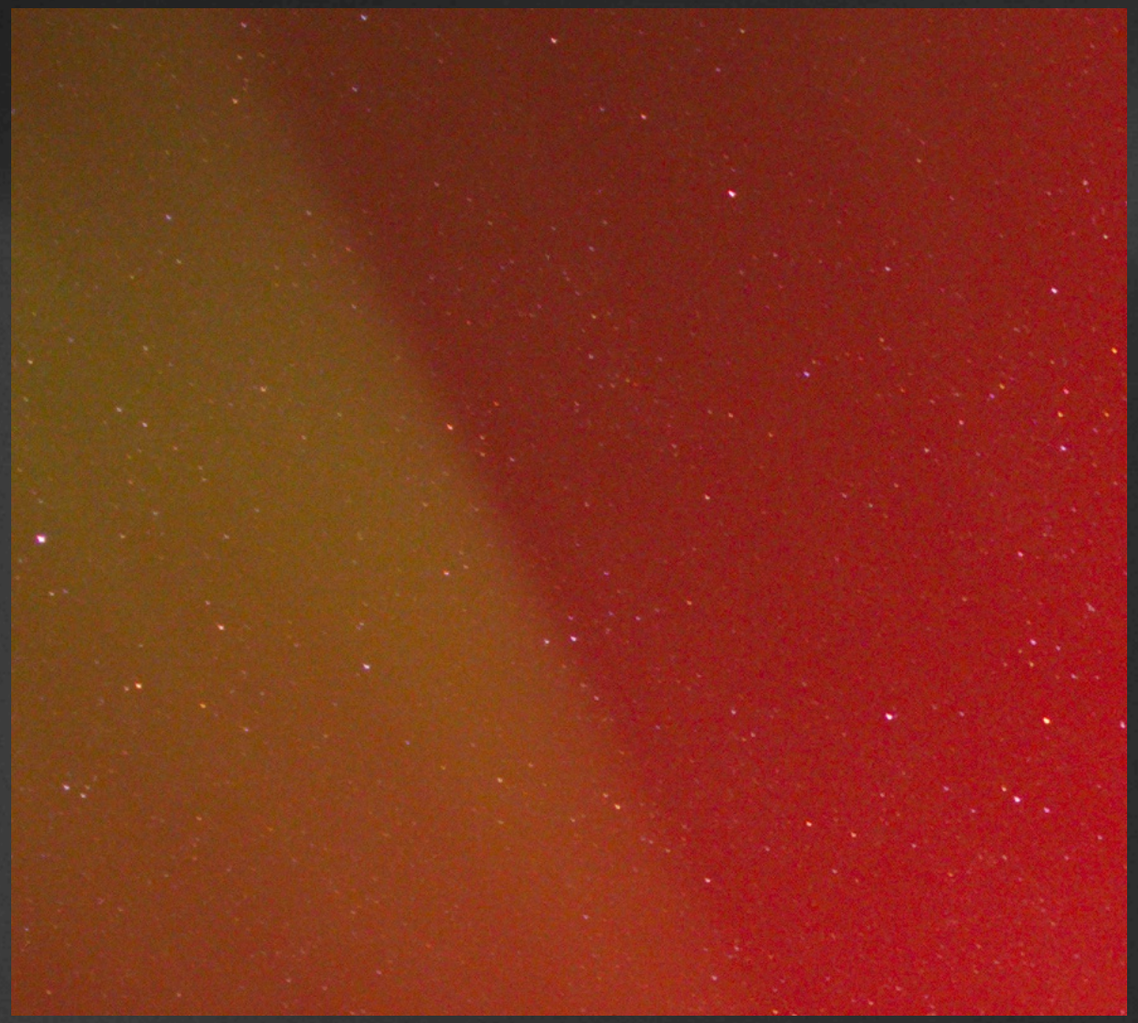
The camera has built in noise reduction algorithms that will have a go at eliminating the noise.

But they are limited and have no controls - so may damage the image more than you had hoped.

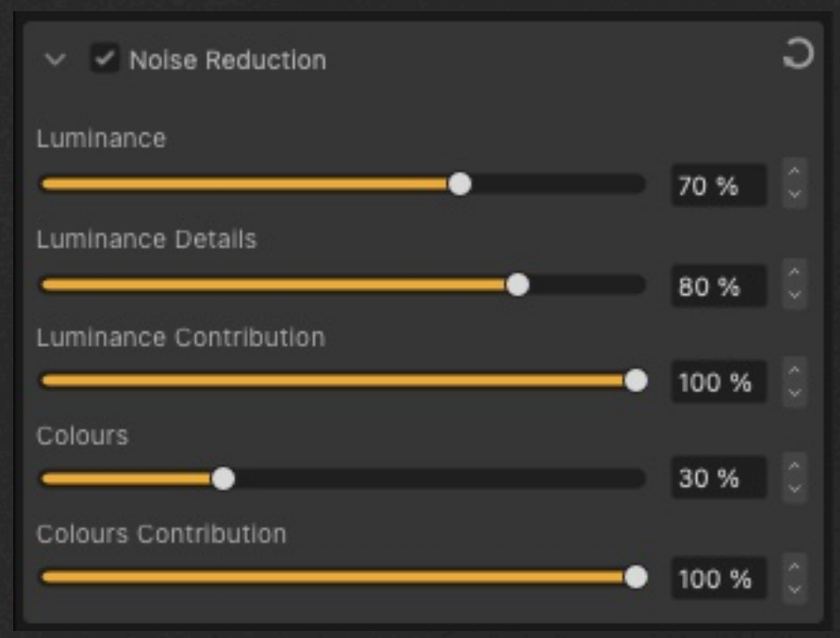
Capturing light

High ISO Noise Reduction

RAW converters will include image cleaning options as well! These are usually much better and offer more controls.



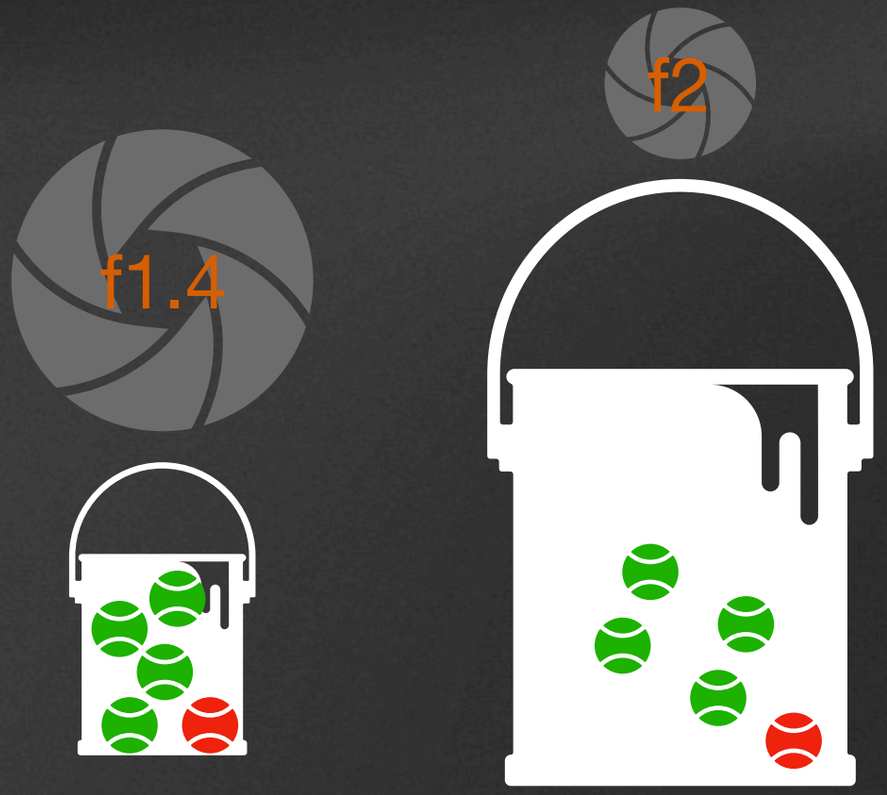
Typically you can control luminance and colour separately.



Capturing light

Lenses

Instead of fighting with noise, you can double the amount of light. An especially good idea if you only have a small bucket. Now your image will contain more green without more red.



f number is a measure of the brightness of the lens. It is in fact: focal length / diameter.

So 50mm lens with a 25mm hole for the light to pass would be classed as f2.

Capturing light

Lenses

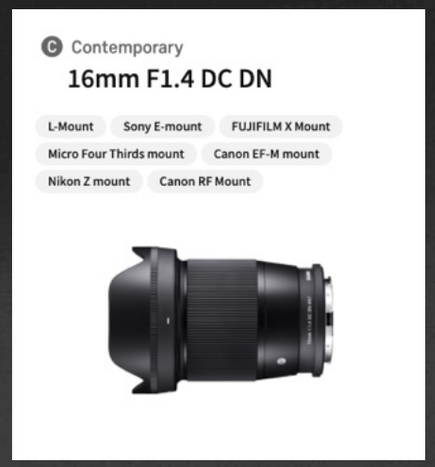
But before you rush out an buy a new lens - don’t forget that full frame sensors can see more. So an APSC camera needs a wider lens or you will only be seeing 4/9 of your image.

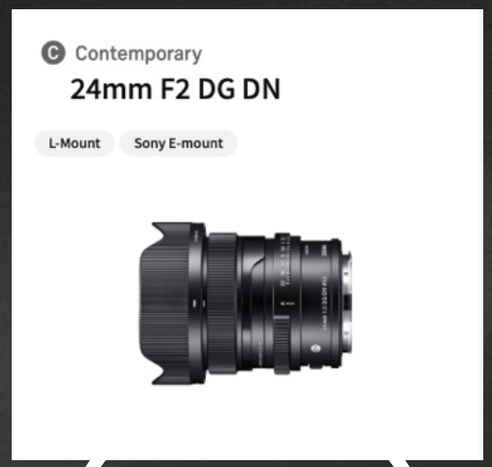
For certain images this might not work out so well :-(

Capturing light

Lenses

An APSC camera (left) and a a Full frame camera (right); both with 24MP sensors; equipped with these 2 lenses would…..





- See the same image
- Capture the same amount of light per px (number of balls in the bucket)
- Use the same ISO setting
- Have the same resolution (number of px)

Capturing light

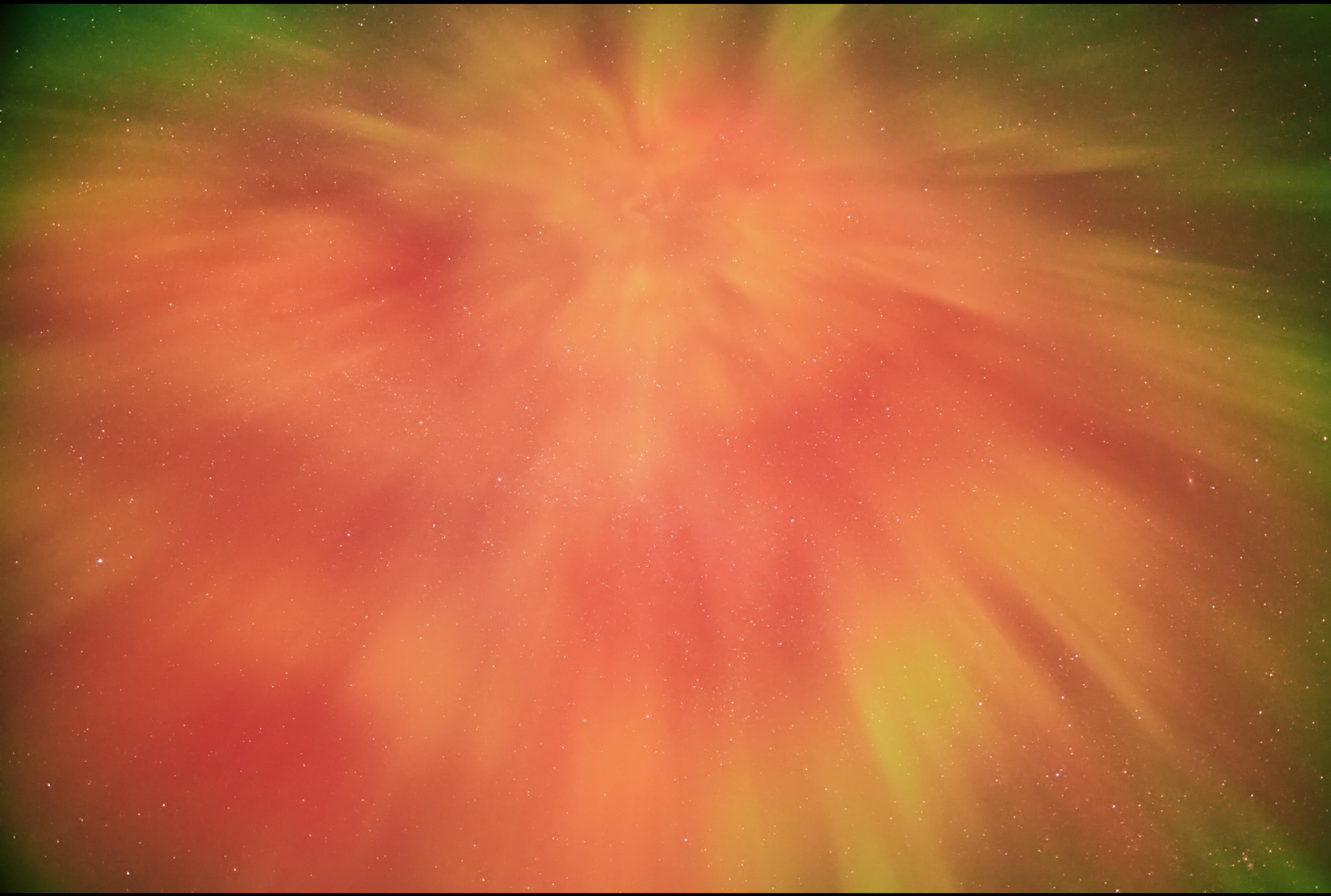
In summary

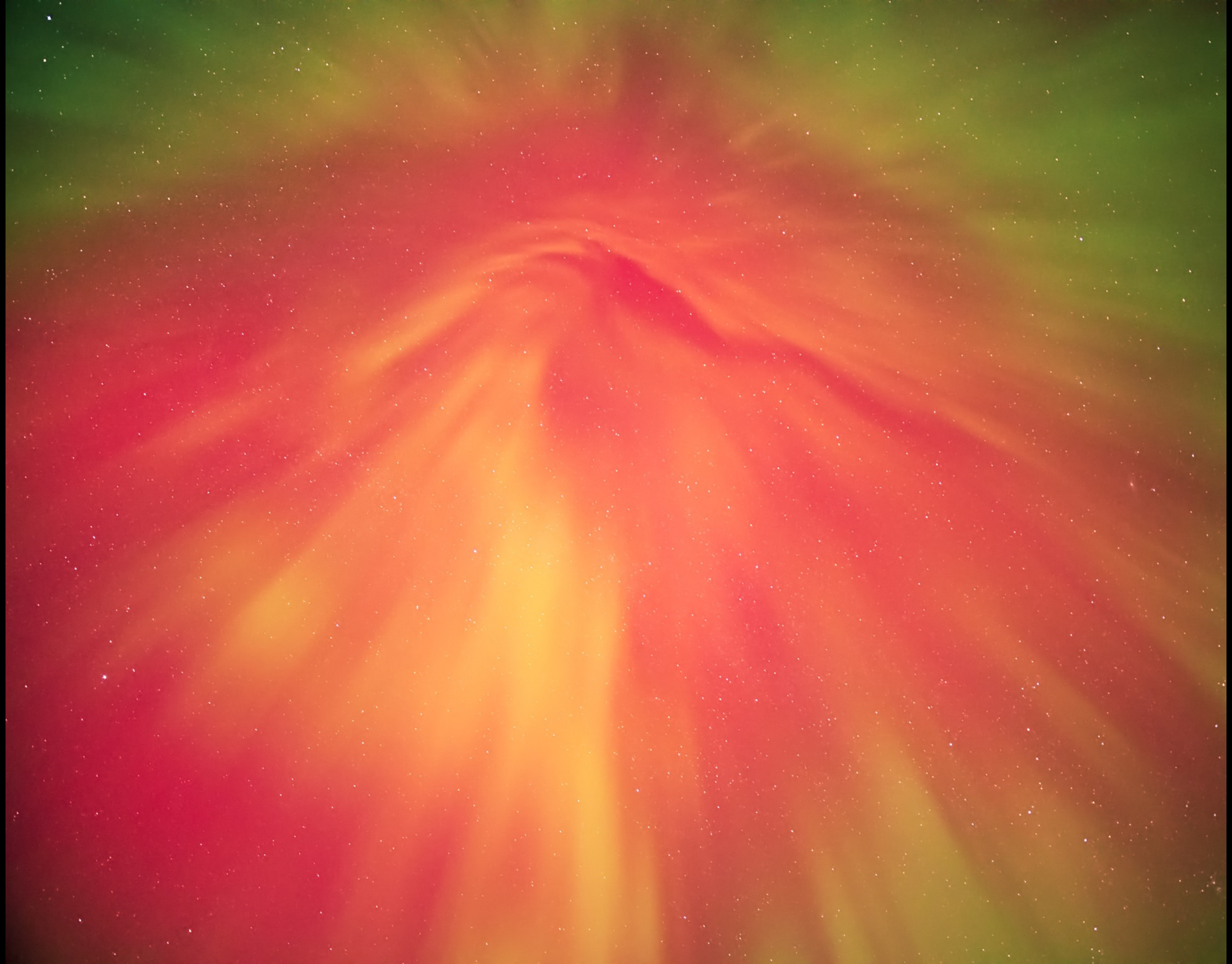
- Use whatever camera you have - but if you are doing low light seriously buy one with big pixels.
- Capture as much light as you can - use an f2 lens or better
- Keep your ISO low - if you can
- Use long exposure noise reduction
- Use RAW with external noise reduction software

Capturing light

Examples

- APSC sensor
- 15mm lens at f1.4
- ISO 1250
- Exposure 4 sec - with long exposure noise reduction
- RAW with external noise reduction in Affinity Photo

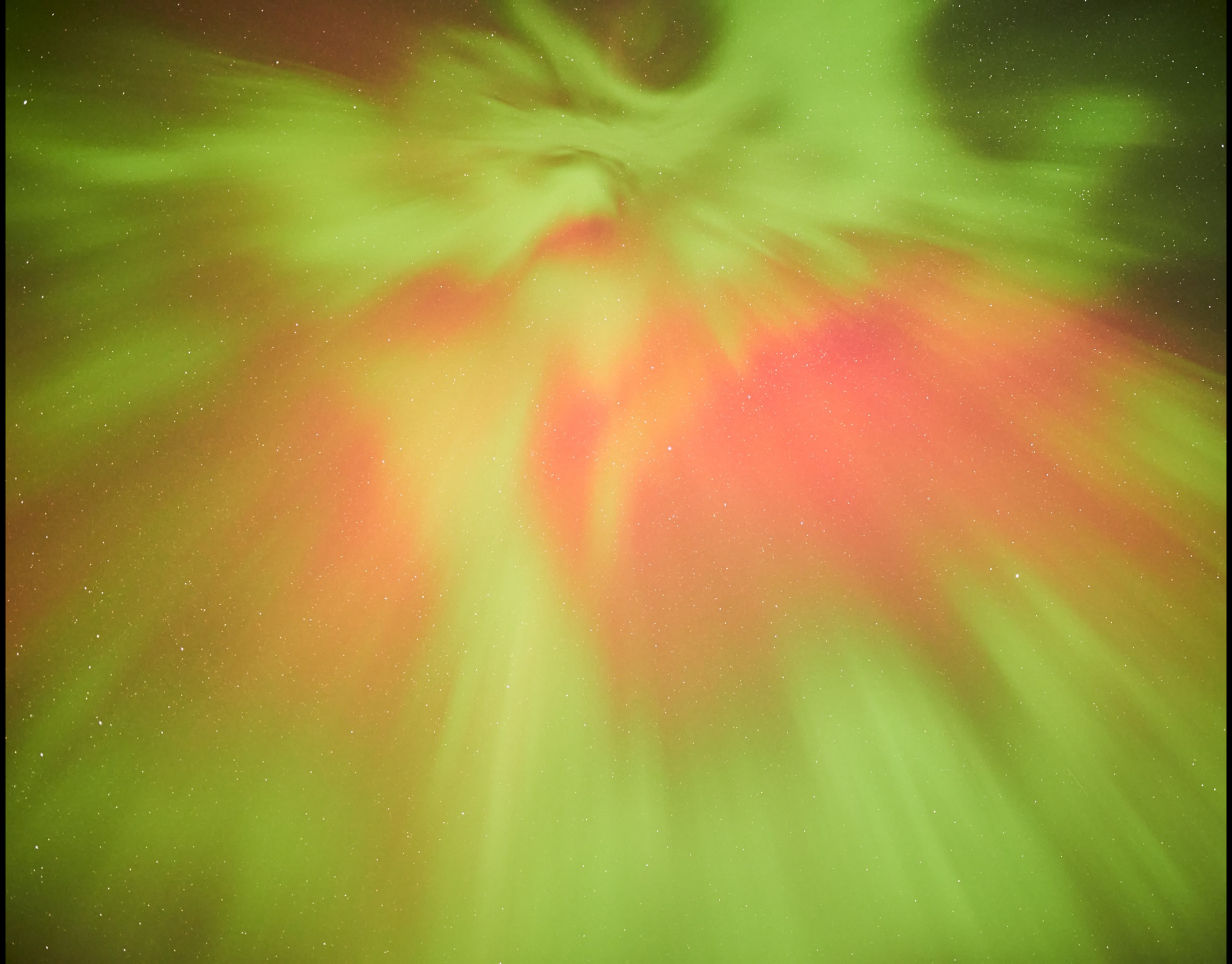




Capturing light

Examples

- APSC sensor
- 15mm lens at f1.4
- ISO 800
- Exposure 8 sec - with long exposure noise reduction
- RAW with external noise reduction in Capture One



Capturing light

Examples

- APSC sensor
- 15mm lens at f1.4
- ISO 1000
- Exposure 4 sec - with long exposure noise reduction
- RAW with external noise reduction in Capture One

Capturing light

The end