Introduction to Astro Imaging

By
Conrad Cardano
Dye Hill Observatory, Hope Valley, Rhode Island

"Intro to Astrophotography" will be presented in 3 Zoom meetings.

Zoom #1 The camera

Zoom #2 Mounts, Computers, and Techniques

Zoom #3 Software: Capture & Processing

Goals for these 3 Zoom Meetings

1) Give you an introduction to astrophotography
2) Present the <u>new</u> aspects of astrophotography
   - It's all digital now: Hardware and Software

Wall of my office.

Very satisfying to look at.

You could do this!

Resources


AOL Mail
youtube - Bing
Beginning Astro Photography -
https://www.youtube.com/results?search_query=Beginning+Astro+Photography
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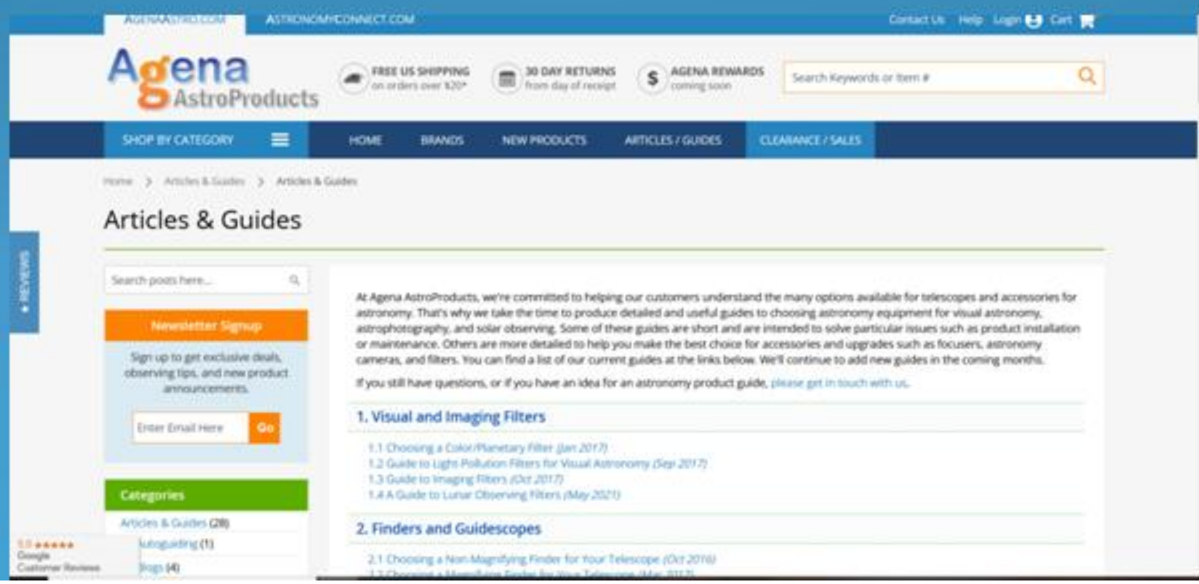
7 Astrophotography Tips for Complete Beginners
197K views • 1 year ago
AstroBackyard
Astrophotography Tips for beginners (no telescope, no tracker) In this video, I cover the basics of astrophotography with a DSLR ...
4K
14:44
ASTROPHOTOGRAPHY FOR BEGINNERS - How to get started, basic gear and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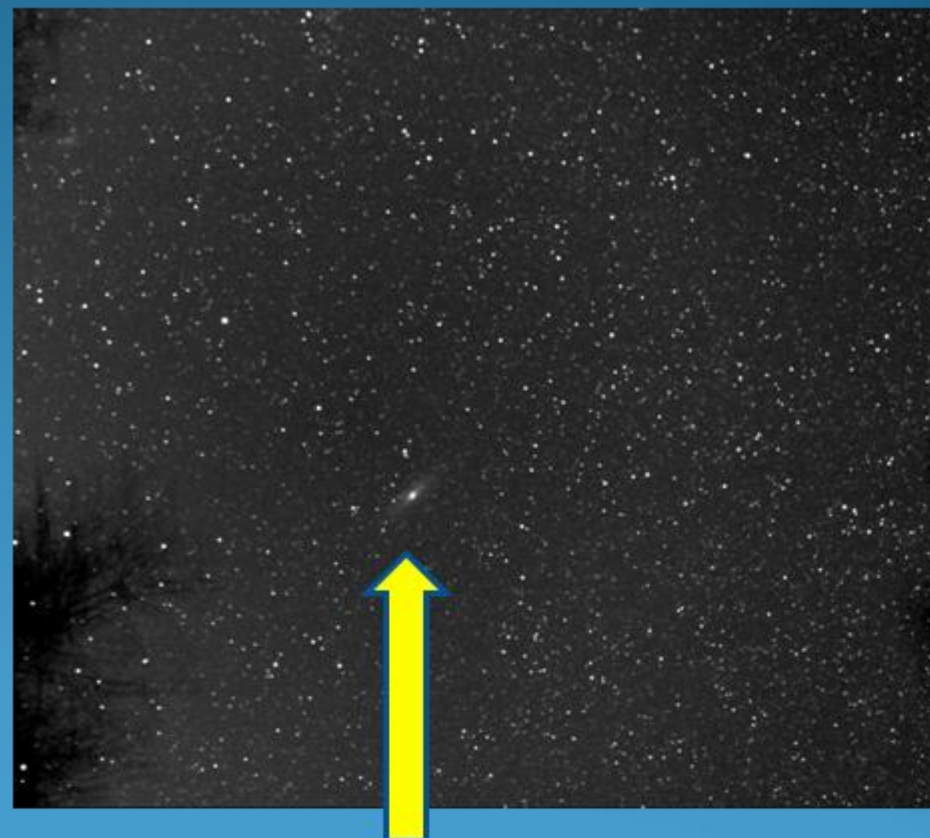
Categories
1. Visual and Imaging Filters
2. Finders and Guidescopes

The First Question

What kinds of astrophotography are there?

Night Scapes

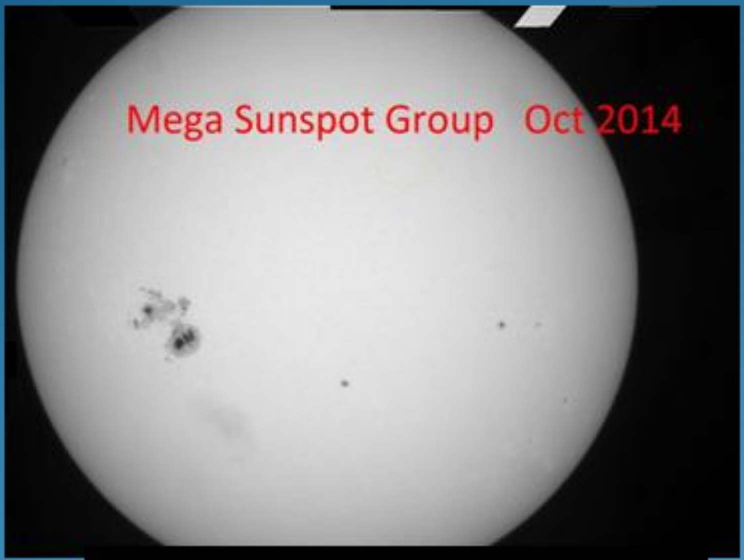


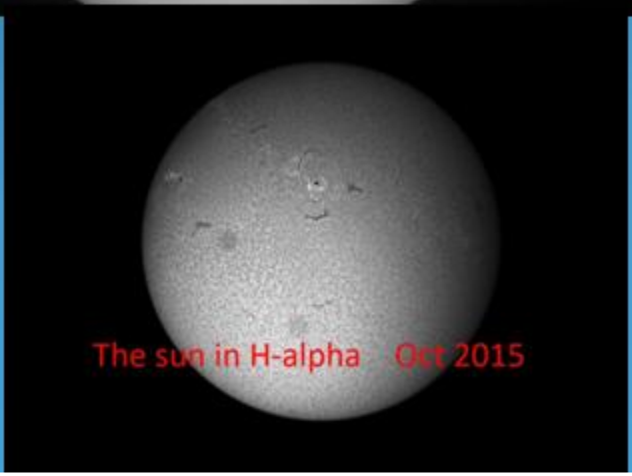
Andromeda Galaxy

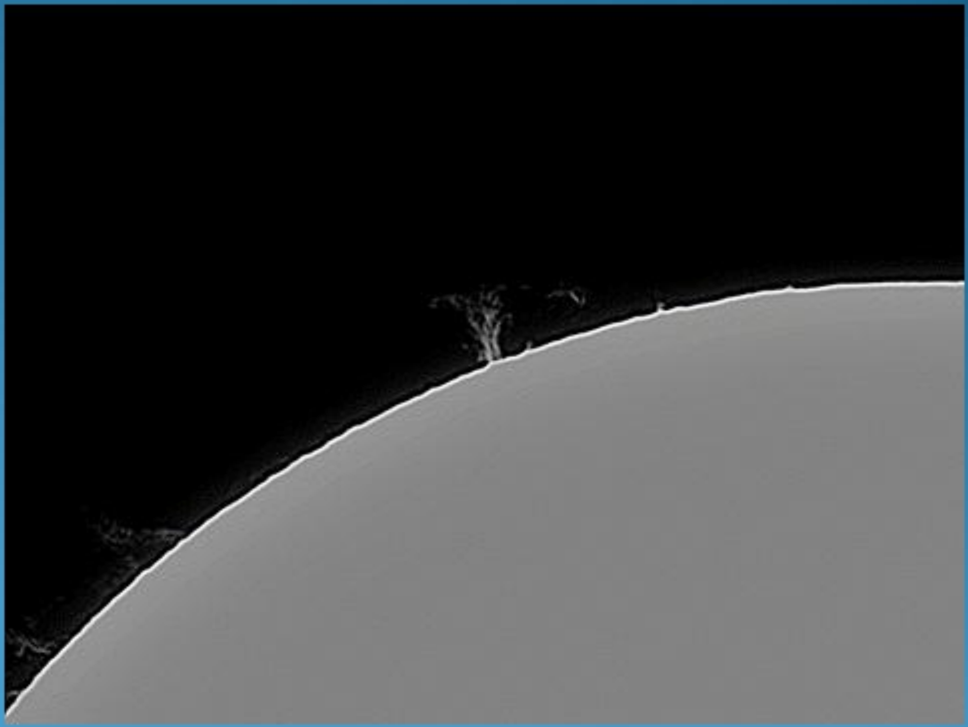
Lunar and Planetary

Deep Sky

Solar Astronomy

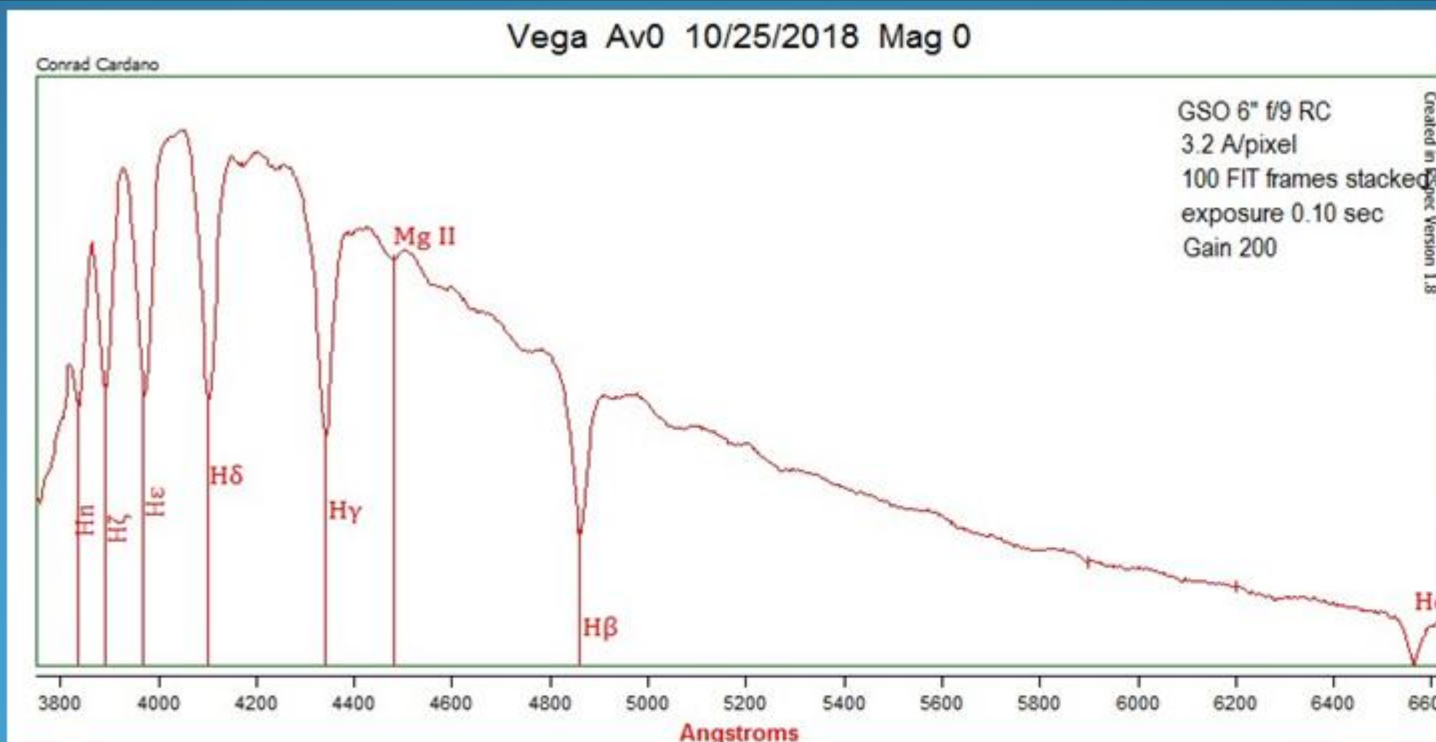






Specialized Astrophotography

(Stellar spectra)

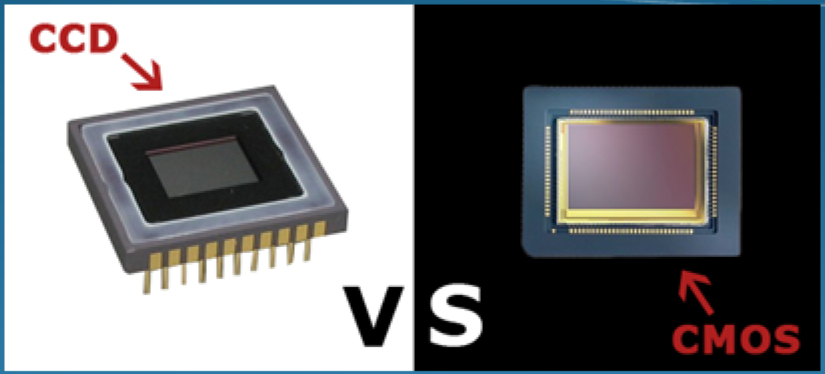


Tonight's Zoom Meeting Cameras

- The Sensor – the heart of the camera
- Types of Cameras
  - DSLR (Digital Single Lens Reflex)
  - Smartphones
  - Dedicated Astro Cameras
- Field of View (FOV)

Part One: Sensor Attributes

- CMOS and CCD
- Sensor size
- Pixel size
- Pixel well depth
- 8 bit,10, 12, 14, 16
- Binning
- Color vs Monochrome



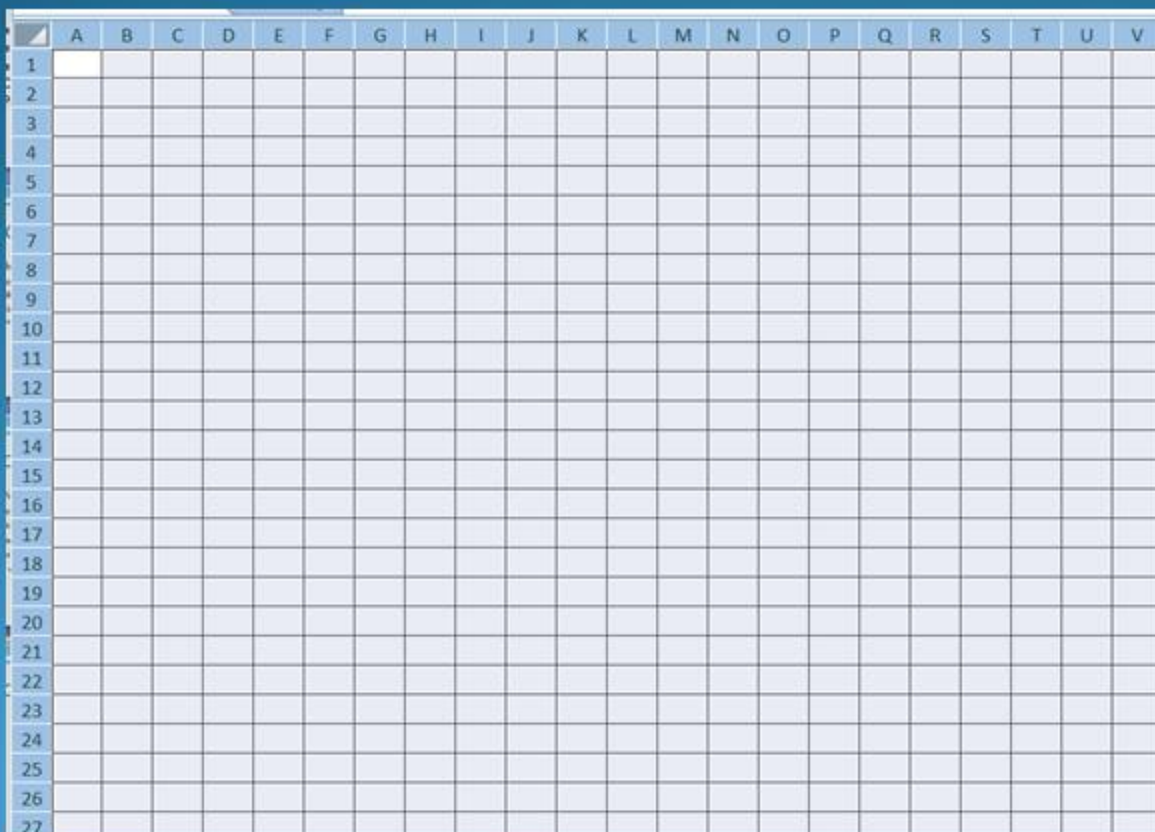
	CCD	CMOS
Convert light to electrons	Yes	Yes
Manufacture	Harder	Easy to mass produce
Cost	Expensive	Cheaper
Noise	More than CMOS	Less than CCD
Power Requirements	More	Less

Recommendations: **Buy a CMOS camera.**

- Best buy for the money (cost less than a CCD camera)
- Due to improvements in CMOS sensors, CCDs are no longer produced
    - CCD cameras are still available

Sensor – a Highly Magnified View

Y - axis



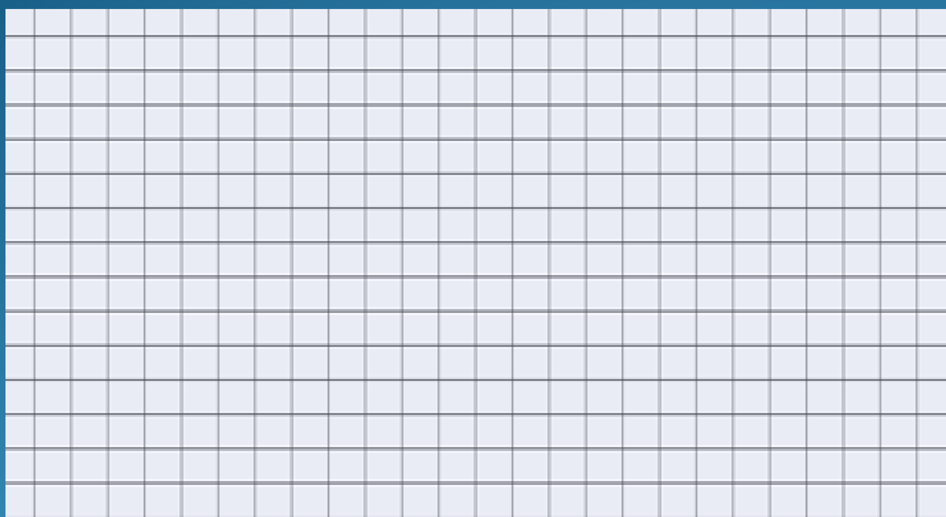
X - axis

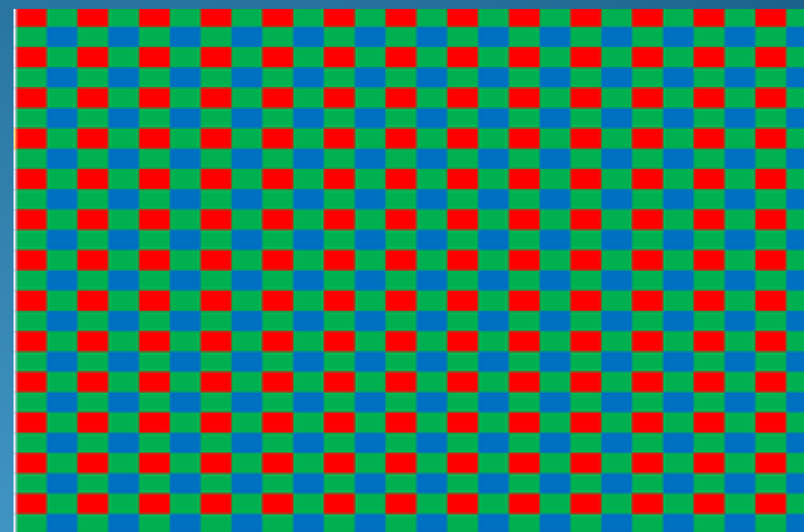
It's a grid of "pixels"

What is a pixel?

- A tiny light sensor.
- It captures photons and converts them into an electrical signal.

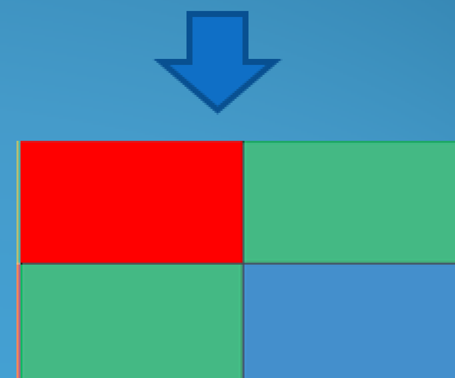
Monochrome vs Color





Each pixel has a R, G, or B filter in front.

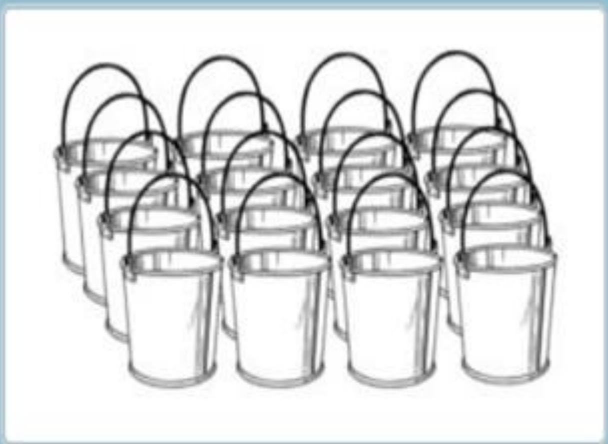
The combination of these 4 pixels make a single color pixel



Sensor Size

- Sensor size is measured in megapixels (millions of pixels).
  - A pixel array of 1280 x 960 = 1.2 Megapixels
  - Can go from 1.2 Mp to **60** Mp
- Sensor Diagonal
  - Measurement of the diagonal across the sensor.(mm/inches)
- Pixel Size
  - Size in microns of the pixels (µ). 2.3 µ to 9 µ.
    - For deep sky astrophotography, larger pixels are preferred.
    - For planetary imaging, a smaller pixel size are preferred.
    - My camera is 4.6 µ.

Pixel Well Capacity



- A measure of how much light the pixel can absorb.
  - Values from 15,000e to 63,700e
- A higher capacity means longer exposures.
  - Each pixel is like a bucket.
  - When full, it stops collecting!

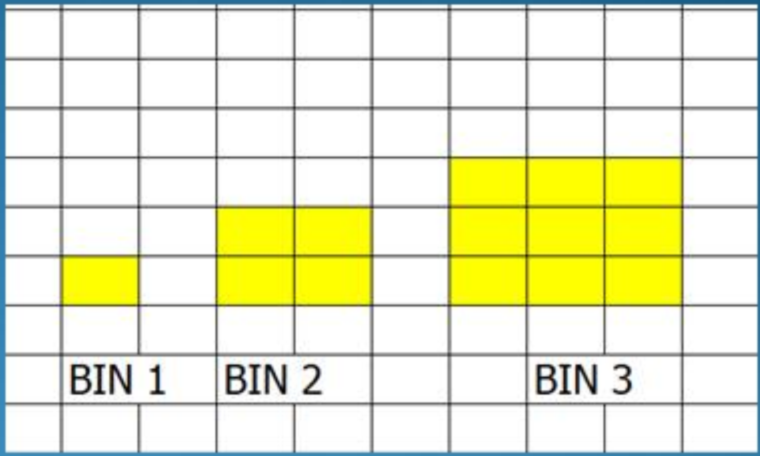
Bit Depth

- When the image is taken, the electrical signal in each pixel is converted to a number
- The "Bit Depth" is the possible range of numbers
  - 8 bit -> zero to 256
  - 10 bit -> zero to 1024
  - 12 bit -> zero to 4096
  - 14 bit -> zero to 16,384
  - 16 bit -> zero to 65,536

Higher bit depth produces smoother gradations between areas of varying brightness.

Binning

- Combining adjacent pixels to make a "super pixel"
- Increases signal-to-noise.
- Resolution decreases
  - 2 x 2 bin = ¼ the resolution
- Useful for framing/focusing
  - Gather light faster for faint objects



Which is better? Color or B&W

Color is prettier than B&W.

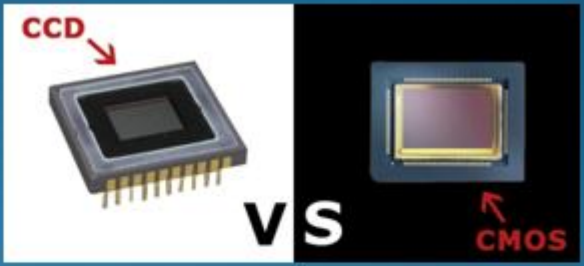
But

Color is much harder to process.

- White balance
- Hue and saturation
- Red, Green, and Blue colors

Noise in the Sensor

These are sensitive electronics.

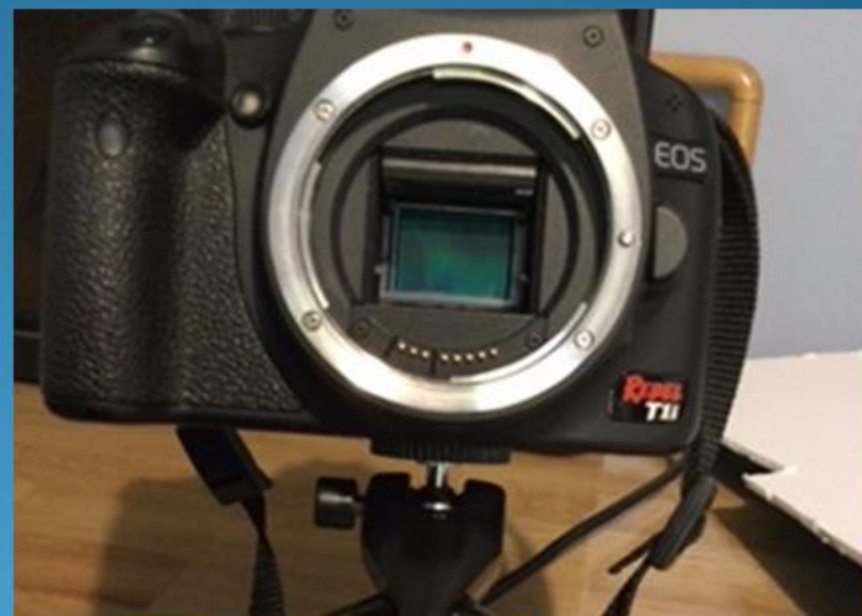


- **Noise** – electrons in pixel not from light
  - Measured in electrons per pixel (1.2e , 4e- per pixel)
    - Lower is better.
  - Generated in the camera's electronics.
    - Even in total darkness!
    - Warmer temperatures generate more noise.
      - Cameras can be cooled to counter the effect.

Part Two: Cameras

- Types of Cameras
  - DSLR
  - Smartphones
  - Dedicated Astro Cameras
    - Cooled and Uncooled

My First Astro Camera



My old Canon Rebel has a large color sensor.
- 15 megapixels, 22 mm by 15 mm

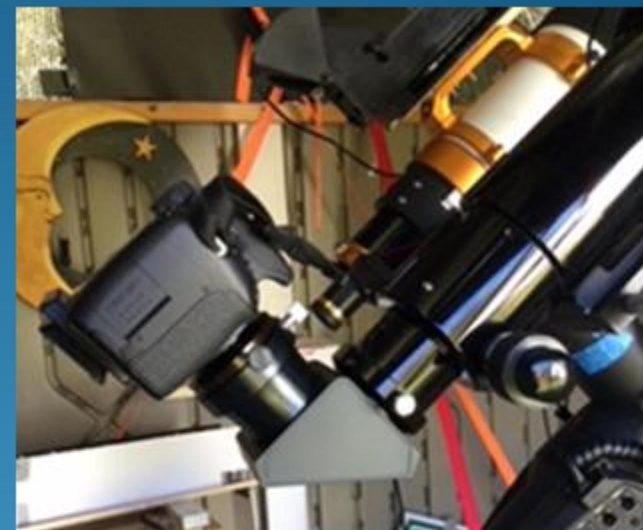
Connecting a DSLR to a telescope

T Ring for a Canon EOS camera

1.25" T Mount adapter

This camera can now be connected to a telescope.

Newtonian scopes may not have enough eyepiece travel to accommodate the camera.



Refracting telescopes usually have enough travel.

Smartphone Adaptors

Allows you to connect the Smartphone to the eyepiece of the scope.

Some have bluetooth remote controls.

Smartphones in general

Smartphones **vary tremendously** in their ability to capture images.

- They can photograph bright objects (i.e., moon), but not deep-sky objects very well.
- In low light,
  - Images are not as sharp
  - Colors are not as clear

Dedicated Astro Cameras

These cameras require capture software and a computer.

On one website, I counted 191 dedicated astro cameras for sale!

From $130 to $24,000 !

Confusing, Yes, but….

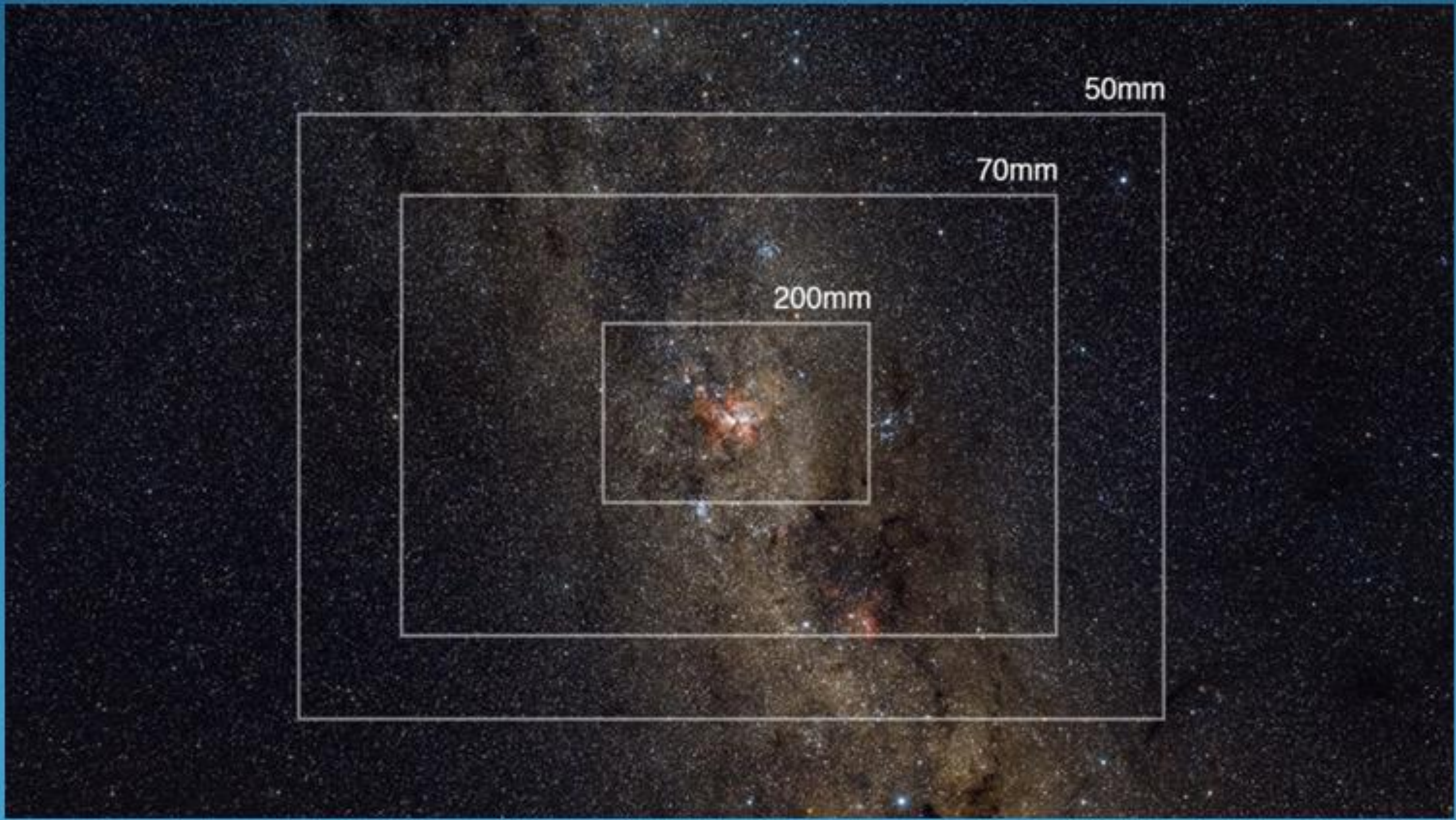
- There are two big sensor manufacturers:
  - Sony (CMOS) and Kodak (CCD)
- You will see the same sensor used by different camera makers.
  - For example: QHY 5-III 462C = ZWO ASI462MC
- An expensive camera is no guarantee of great results.
  - **It's all in the image processing**.

Cooled Cameras

- They have built-in cooling unit.
  - The chip can be cooled 35ºC below the ambient temperature.
    - This reduces thermal noise and improves the image on a hot night.
  - But, it adds $$$$ to the cost.

Field of View (FOV)

How much of the sky can your camera & scope cover.



There are two factors in the calculation: size of sensor and fl of scope.

Field of View Calculation

1. The size of the sensor (in mm)
   For example: ZWO ASI 120, the size = 4.8 mm = D
2. The focal length of telescope (in mm)
   For example: Celestron 8" SC, the fl = 2032 mm = L

Use this formula: (3400 * **D**) / **L**

This gives the field of view (in arc minutes) for the telescope and camera.

Therefore: (3400 * 4.8)/2032= 8 arc minutes of sky

With 8 arc-min, what can we image?

~ 1 arc minutes

3 arc minutes

11 x 8 arc minutes

30 arc minutes

180 x 60 arc minutes

Let's change the scope

1. Same camera (ASI 120MM) the size = 4.8 mm = **D**

2. AstroTech 70mm f/6 refractor, the fl = 420 mm = **L**

Use this formula: (3400 * **D**) / **L**

Therefore: (3400 * 4.8)/420 = 39 arc minutes of sky

With 39 arc-min, what can we image?

1 arc minutes

3 arc minutes

11 x 8 arc minutes

30 arc minutes

180 x 60 arc minutes

Let's change the camera

1. Using DSLR, the size = 22 mm = D
2. Astro Tech 70mm refractor , the fl = 420 mm = L

Use the formula: (3400 * **D**) / **L**

Therefore: (3400 * 22)/420 = 178 arc minutes

With 178 arc-min, what can we image?

1 arc minutes

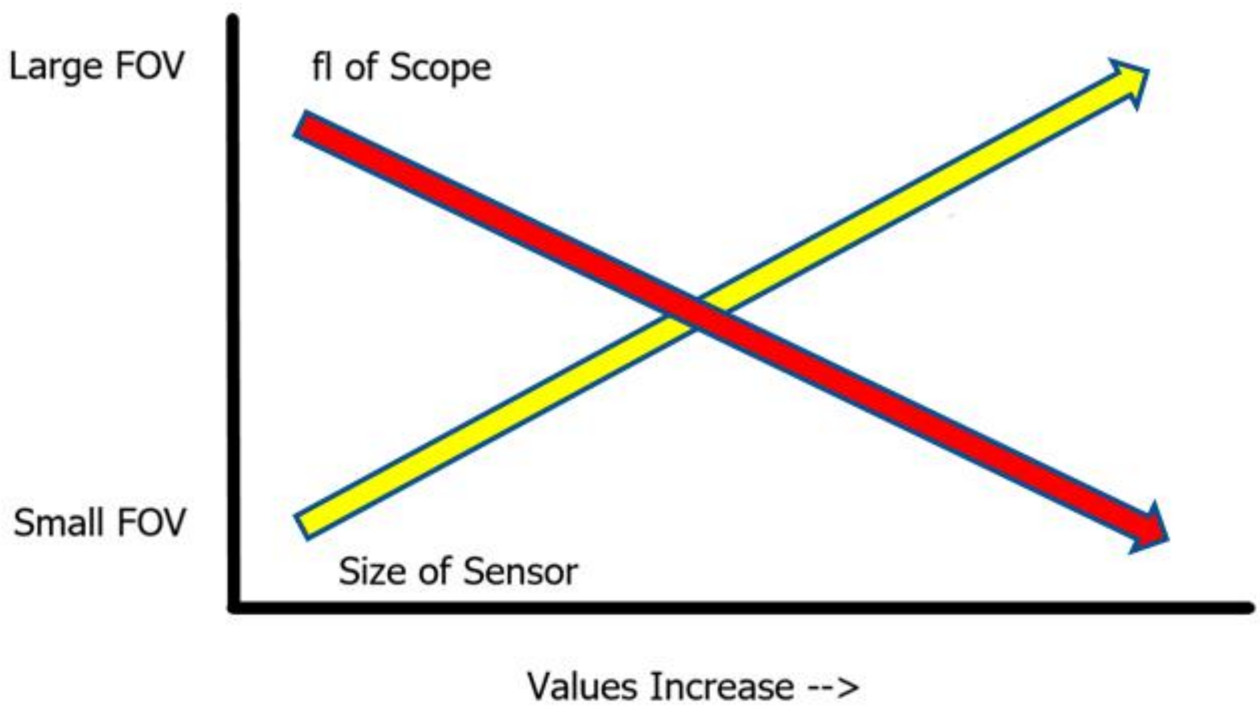
3 arc minutes

11 x 8 arc minutes

30 arc minutes (small)

180 x 60 arc minutes

FOV: Sensor Size vs Focal Length



General Rule of Thumb

- Planets and Planetary Nebulas are small
  - Need a telescope with a long focal length
  - Can use barlow lenses to increase focal length
- Globular Star Clusters are bigger
  - Intermediate focal length needed
- Nebulas and Galaxies are large
  - Telescope with short focal length
  - Camera with a big sensor

Last Thoughts….

- If you have a DSLR, use that.
- If you want to buy a dedicated astro camera
  - ZWO ASI 120MM
    - Not too expensive ($180)
    - Monochrome and uncooled
    - 1.2 Megapixels
  - Color cameras cost less
- Utilize a "focal reducer" or barlow lens