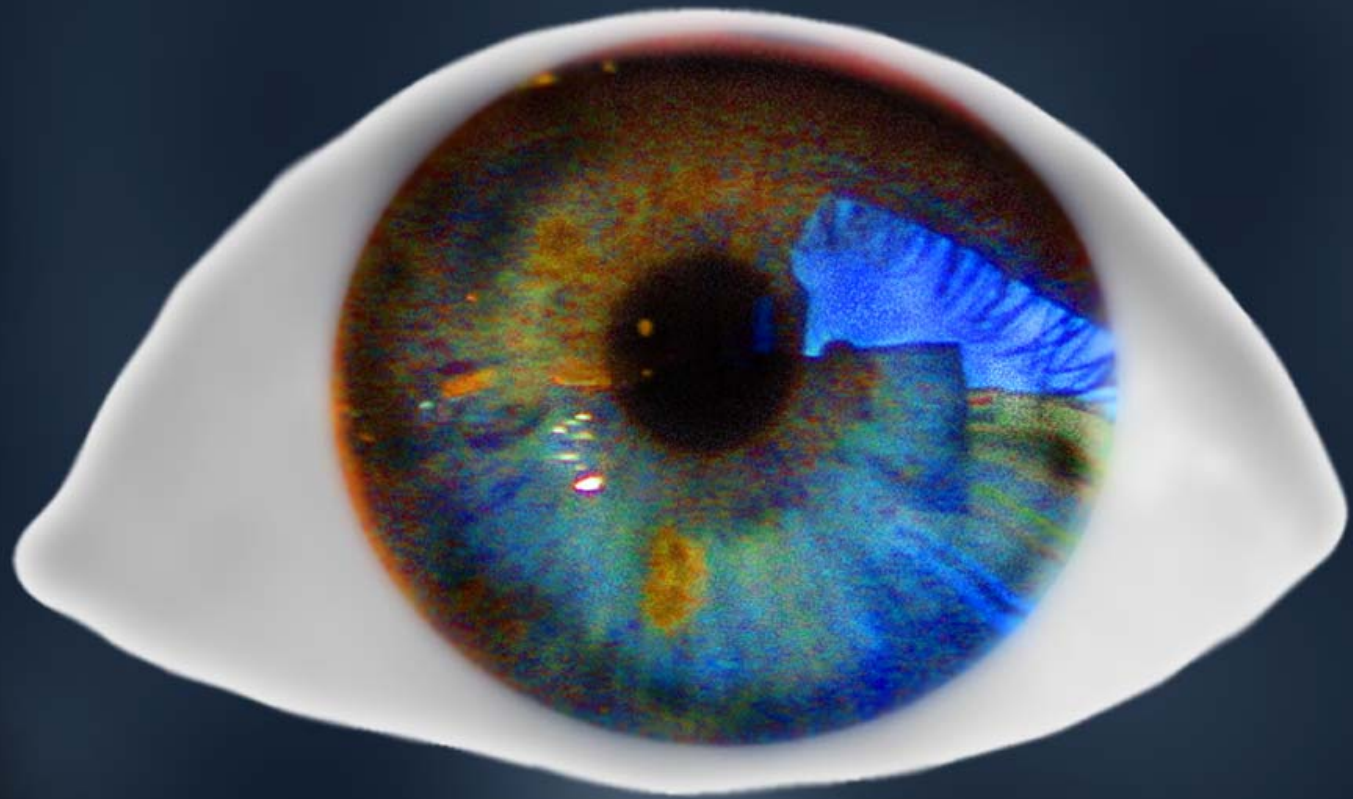
Extending Human Vision



Film and Sensors

Victoria RASCals Star Party 2003 – David Lee

Extending Human Vision
Film and Sensors

The Limitations of Human Vision

Physiology of the Human Eye

Film

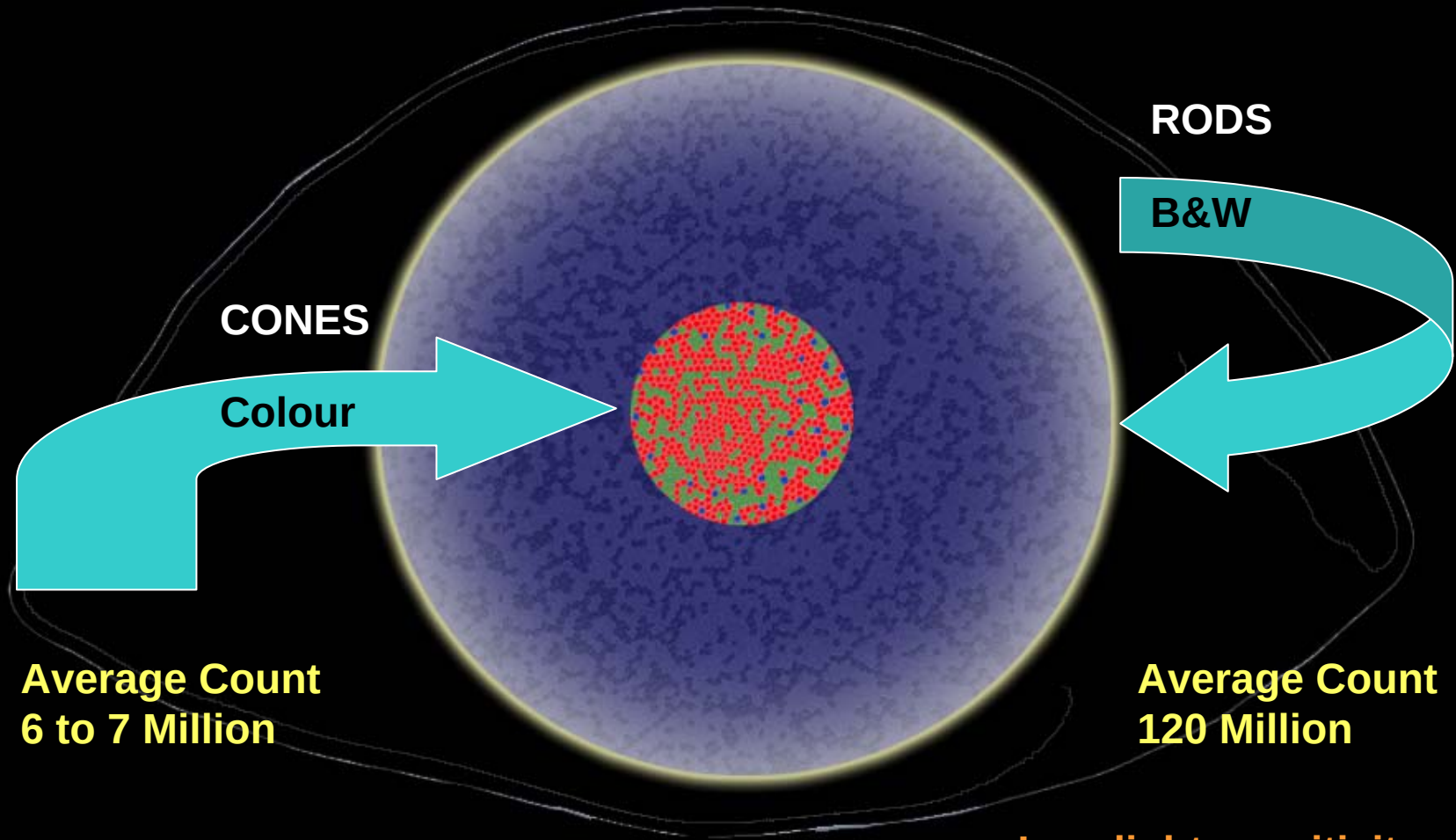
Electronic Sensors

The Digital Advantage

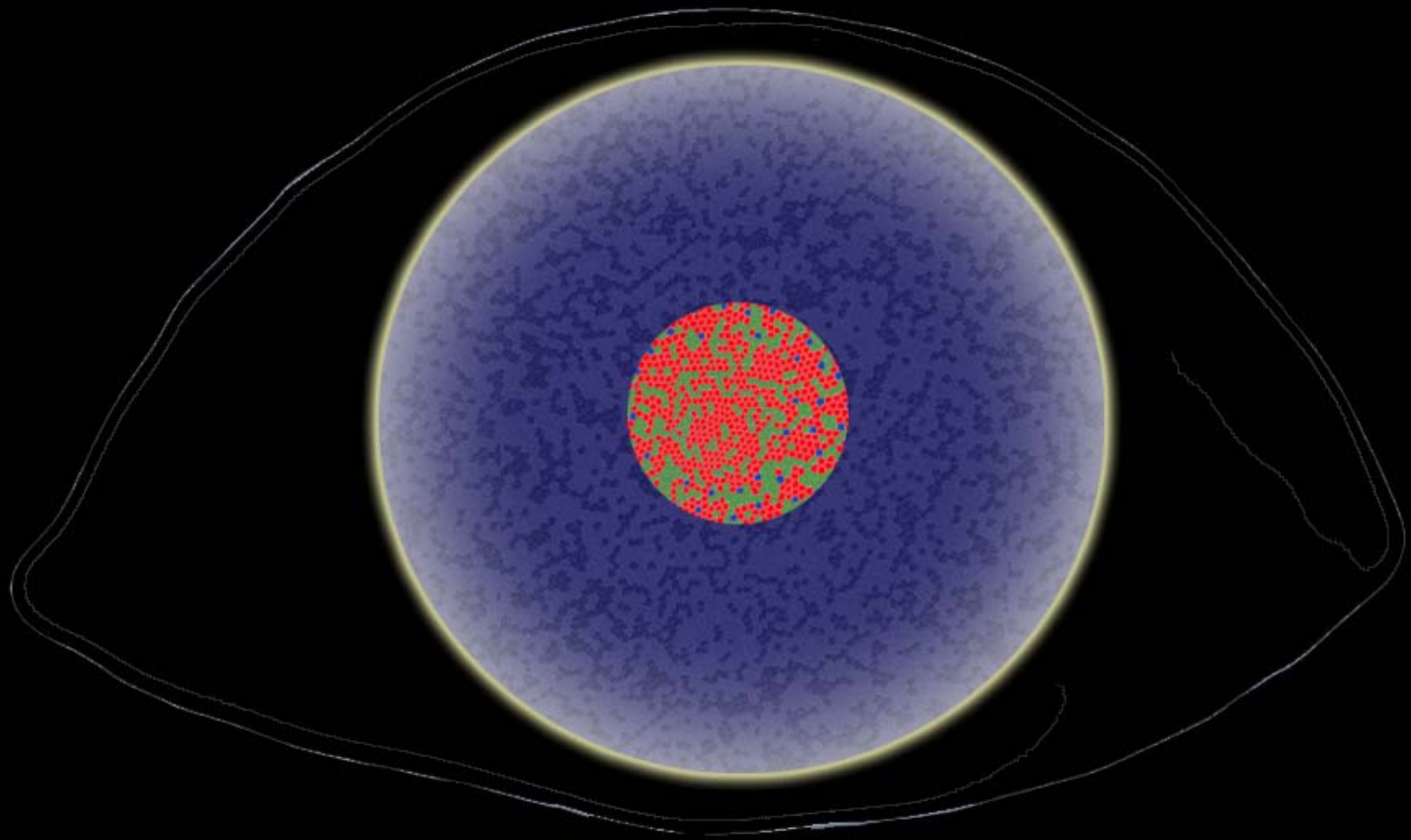
The Limitations of Human Vision

- Poor low light sensitivity, unable to accumulate light
- Difficulty in viewing through a constantly changing atmosphere … viewing from the bottom of a swimming pool
- Unable to see certain wavelengths of light

Physiology of the Human Eye



Rhodopsin – light absorbing pigment



With dark adaptation there is an increase in sensitivity up to the 500 nm wavelength

How do we optimize what we see at night?

- Dark adaptation – Rhodopsin builds in 20 to 30 minutes to give a magnitude difference of 2 to 6 magnitudes

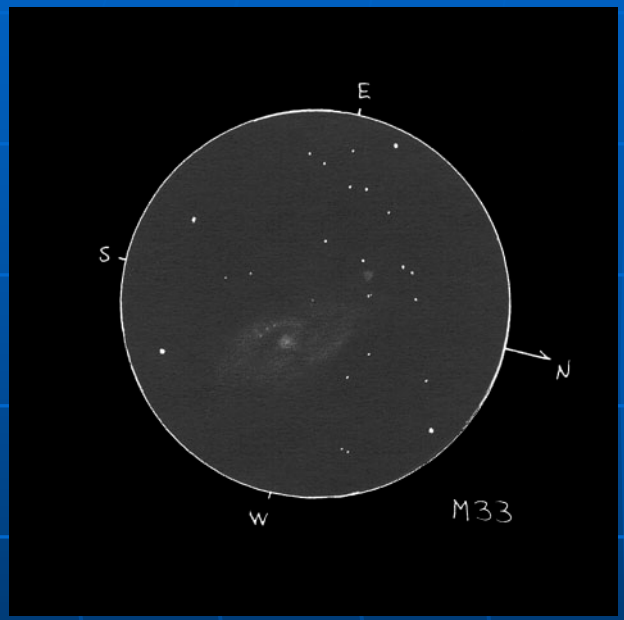
- Averted vision – rod vision is 4 magnitudes more sensitive than cone vision

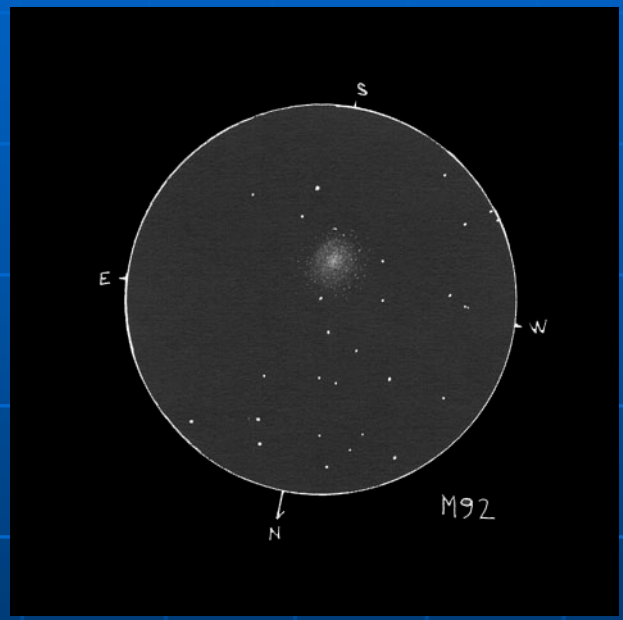
How do we optimize what we see at night?

- Attention – conditions in the night sky are variable and change rapidly, observing requires attention and time

- Practice – experience is what trains the brain to perceive detail

Sketching





Sketches by Richard Harvey

Film


SUPERIA
100
35mm FILM FOR COLOR PRINTS
SUPERIA
4th Color Layer
100
24 EXP.


FUJIFILM
NEW
800
4th Color Layer Technology
NEW
FUJICOLOR
PRESS
800
for Professionals
4th Color Layer Technology
CZ135 36 EXP X20

The Structure and Characteristics of Film

- Film is a light sensitive material that can be used to capture a virtual image from optics
- Composed of silver crystals that change when exposed to light
- Chemicals are used to produce dense areas of metallic silver where light is

The Structure and Characteristics of Film

- Sensitivity, granularity and colour sensitivity are characteristics of film
- Films with large silver crystals will be more sensitive but will suffer from higher granularity and a lessening of detail
- Every film has a colour signature, sensitivity to specific wavelengths vary

Film Vision

- By substituting film we are able to accumulate light for dim objects
- Although light can be accumulated reciprocity law failure sets it, this varies with each type of film
- Enhance the detection of wavelengths the human eye is less sensitive to

Film Vision

- Film can be hypered to remove moisture, increasing the sensitivity
- Chilling film for increased sensitivity has also been used

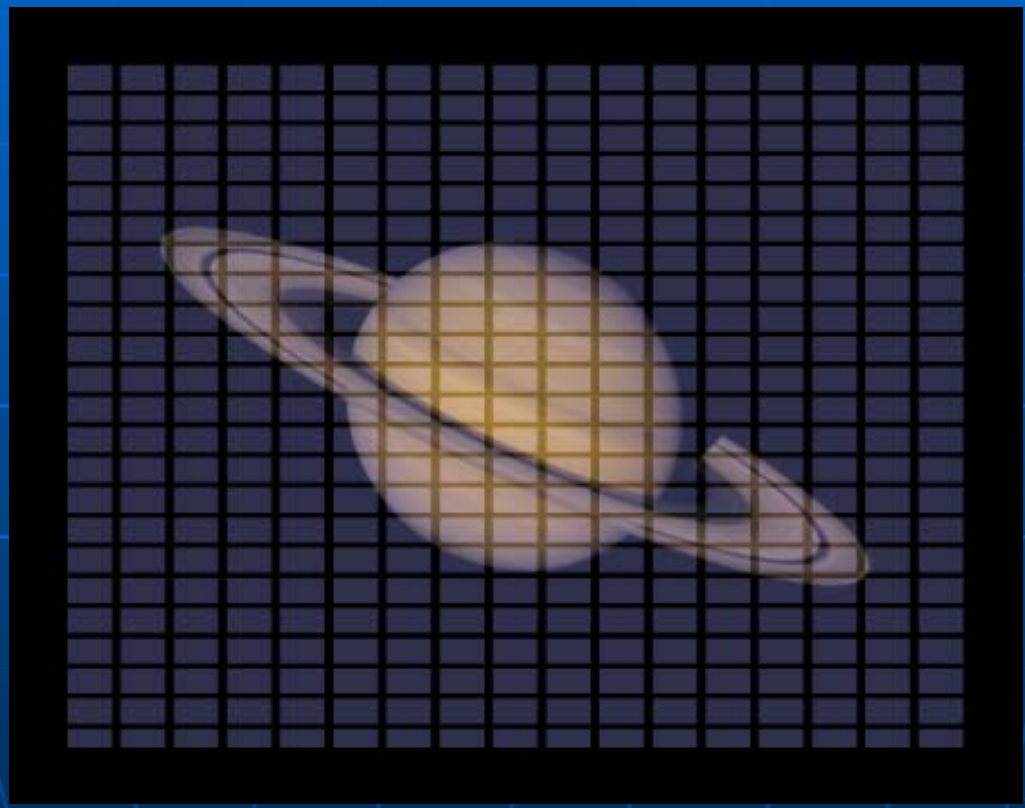
Aurora

Comet Hale-Bopp

Constellations

Star trails – Orion's Belt

Electronic Sensors

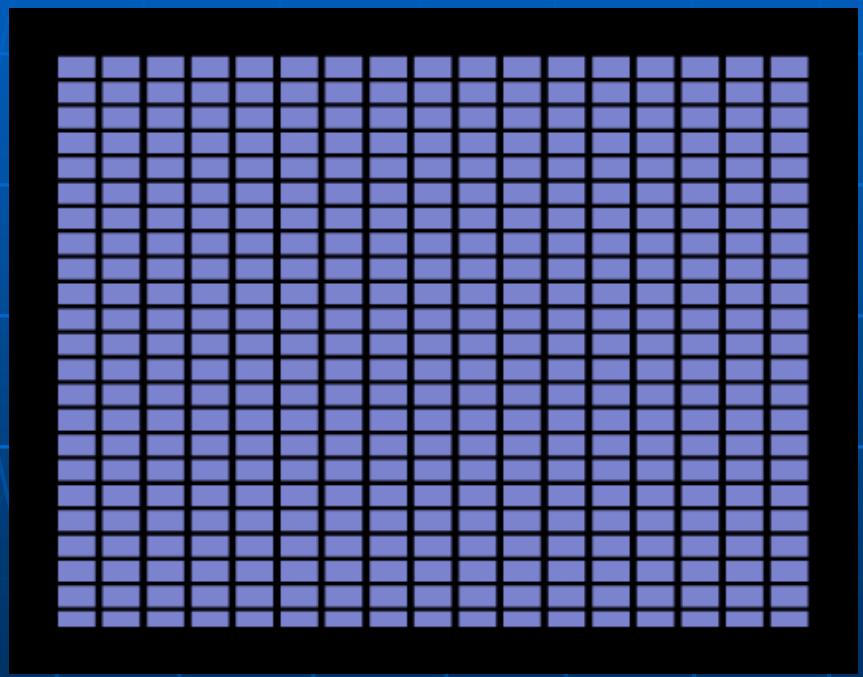


Electronic Sensors

- CCD (Charged Couple Device) sensor
- CMOS (Complementary Metal Oxide Semiconductor) sensor
- Monochrome vs. Colour Mosaic

Electronic Sensors

- CCD – charged coupled device



Found in video cameras, webcams, digital cameras

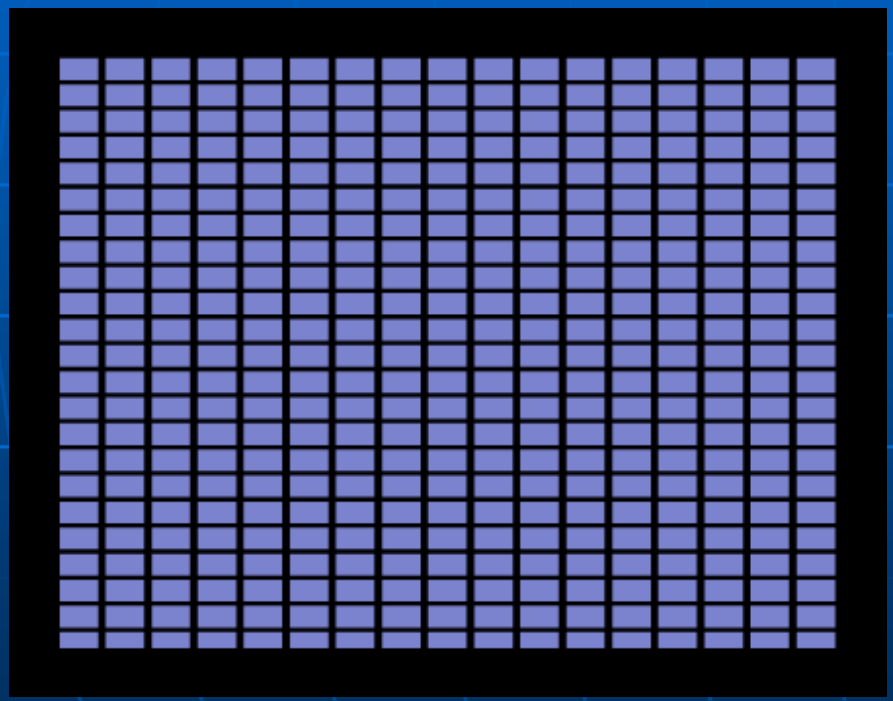
Composed of a grid of photosites
that are light sensitive

Photosite size varies and accounts
for different levels of sensitivity between sensors

Larger photosites have less noise

Electronic Sensors

- CMOS Sensor



CMOS sensors are manufactured using the same methods as computer microprocessors and are less expensive because of this

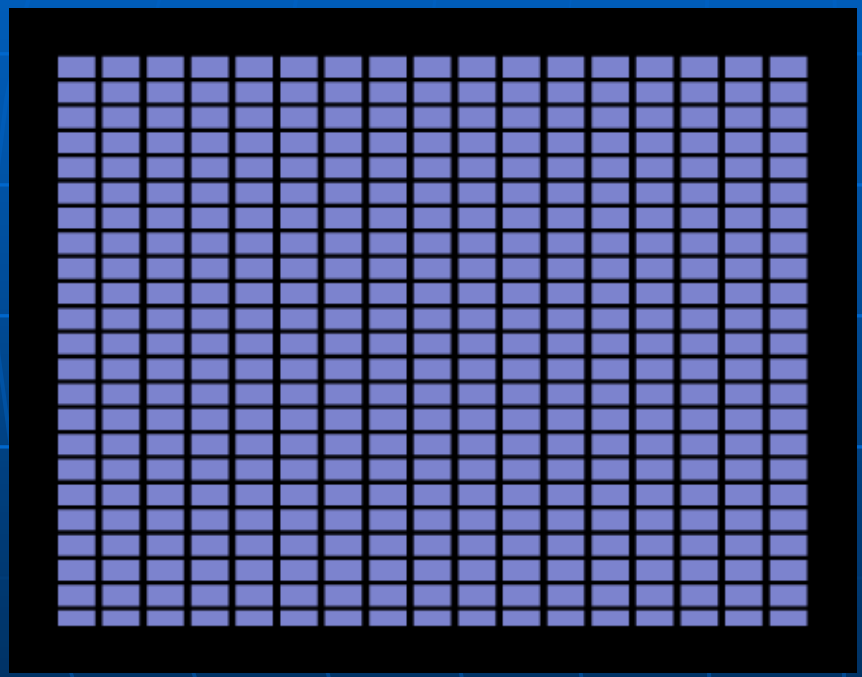
Lower power consumption

Traditionally more noisy and less sensitive than CCD

New technology has made recent CMOS sensors on par with CCD quality

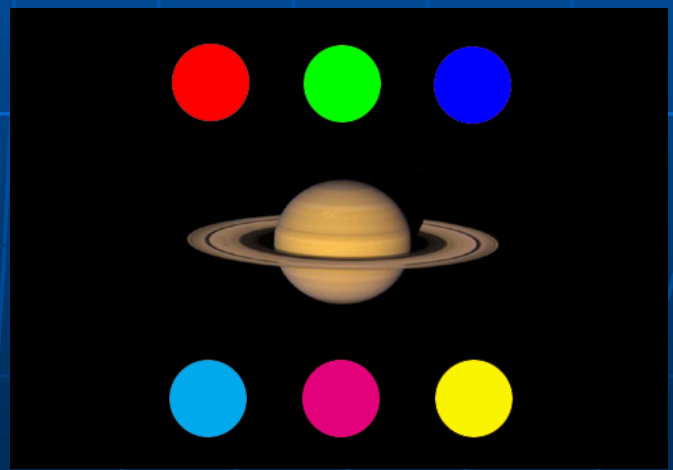
Electronic Sensors

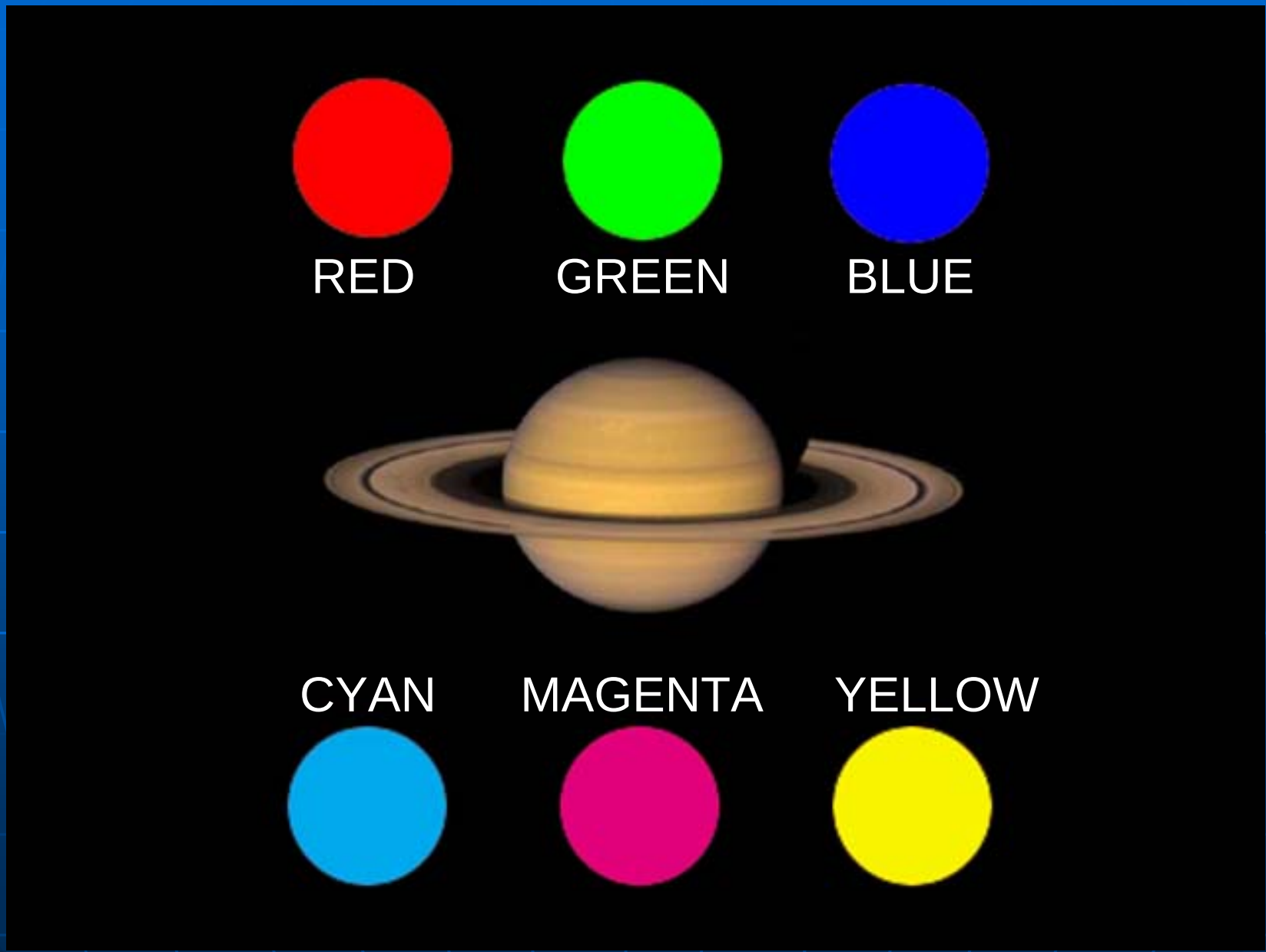
- Monochrome

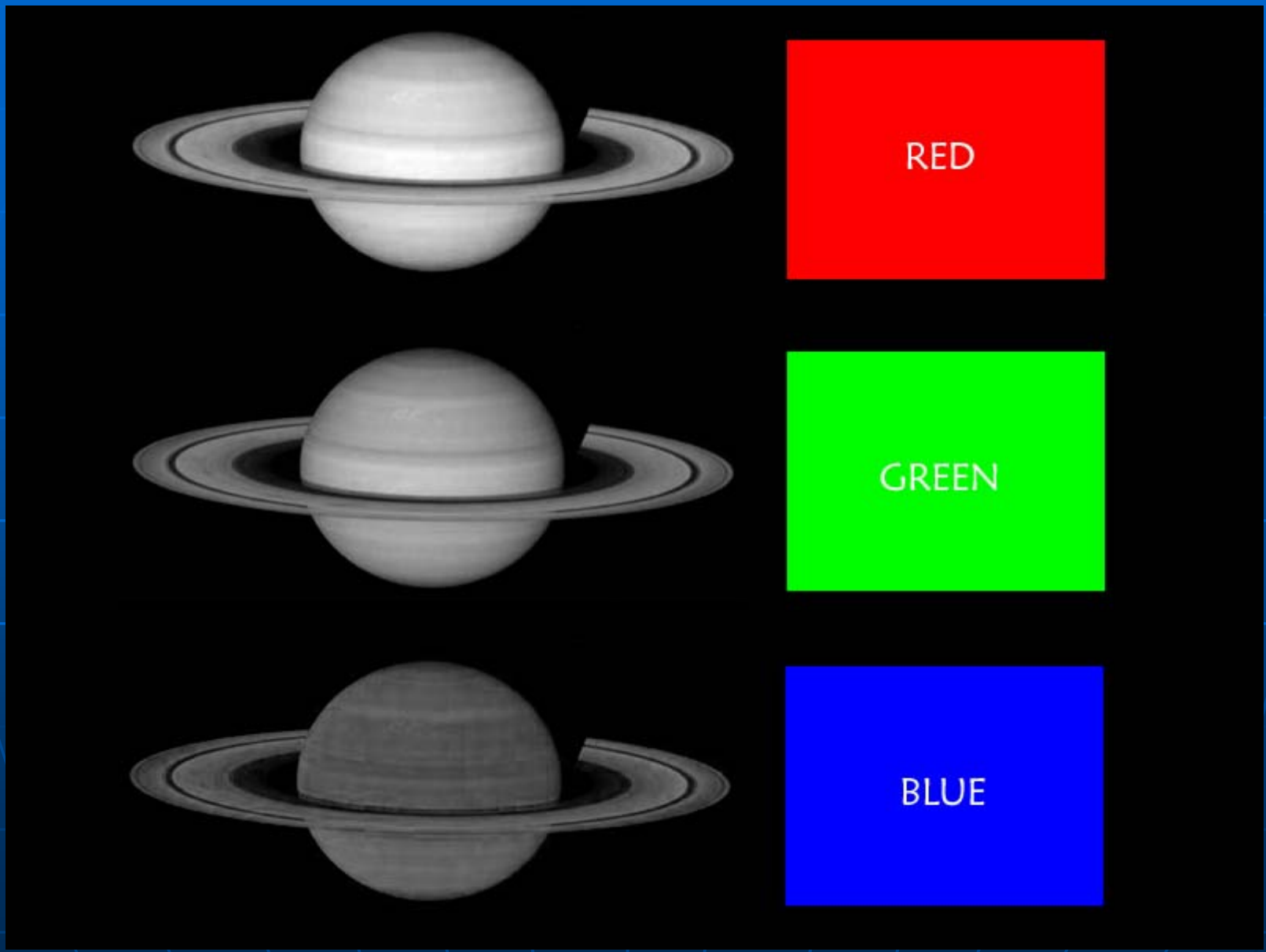


Some sensors are monochromatic

Colour images must be created using individual RGB or CMY filtered exposures

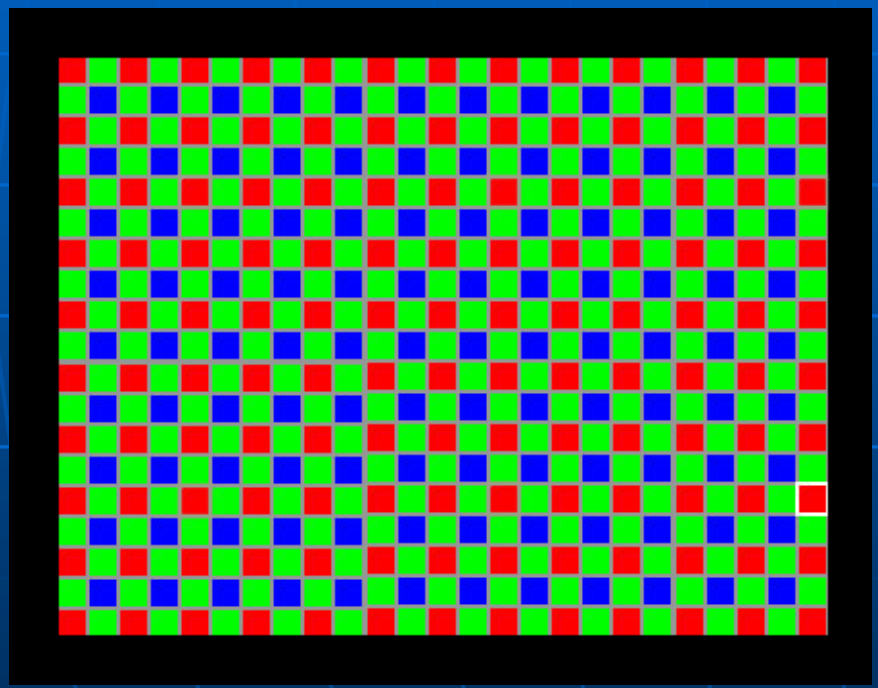



RED
GREEN
BLUE
CYAN
MAGENTA
YELLOW


RED
GREEN
BLUE

Electronic Sensors

- Colour mosaic



Sensors can be made colour sensitive by applying a colour mosaic to the sensor

This is done by applying filters
to each photosite in a set pattern

The most common pattern is the Bayer pattern

Processing is required to determine a photosite's colour

Sensor Vision

- Sensors have the same ability to accumulate light for dim objects
- In addition to accumulating light the response is linear as opposed to film's characteristic of diminishing returns (reciprocity failure)
- Increased electronic noise is a factor in long exposures

Sensor Vision

- Sensors with colour mosaics may have artifacts associated with the translation of the colour pattern especially in areas of colour transition
- Processing times are dependant on the device the sensor is attached to
- All sensors are subject to photosite defects such as permanently on or permanent off photosites often mapped out by the device manufacturer

Sensor Vision

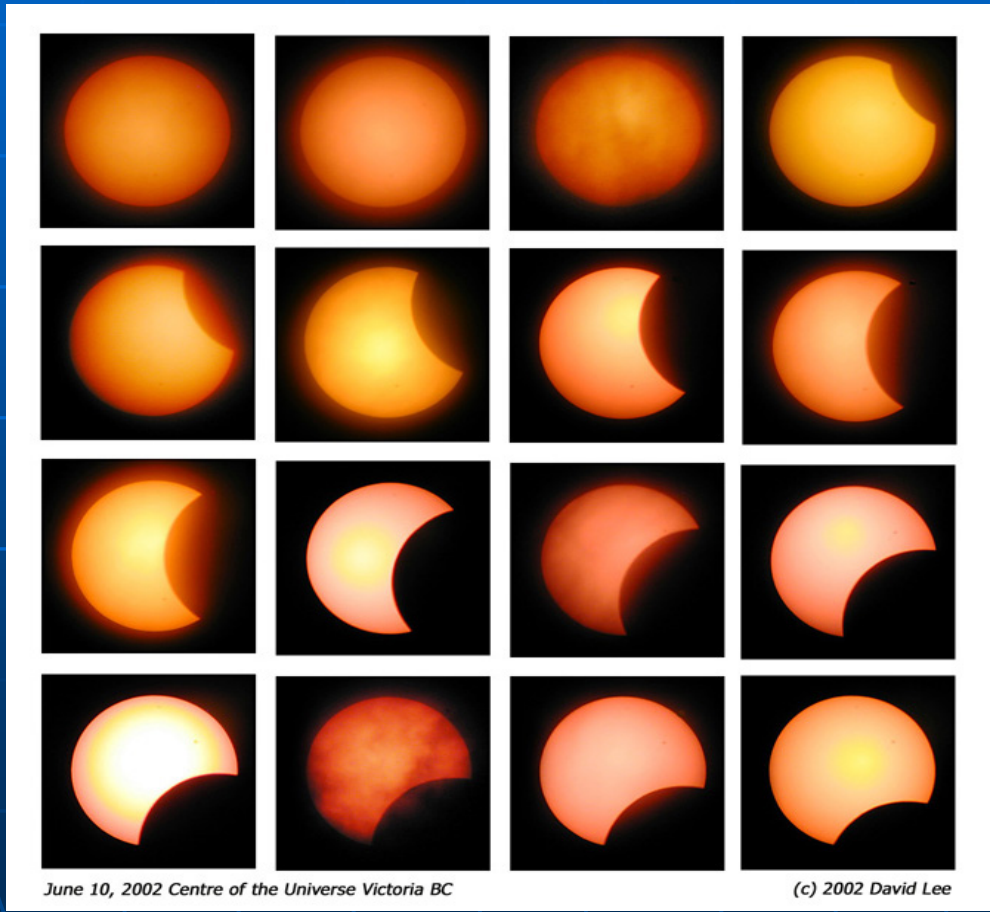
- Sensor images are inherently soft and require post-capture processing
- Sensors are heat-sensitive and for best results require cooling, noise reduction processing during or after capture … or all of the above
- Sensors by nature are statically charged and attract dust, this is a maintenance problem especially with devices where the sensor is exposed while being attached to optical systems

The Digital Advantage

- Why use electronic sensors with all their problems?
- Immediate feedback
- Ability to have a large number of images in a cost effective manner … so you only keep the good ones
- Image processing can reduce noise to reveal detail
- “Grain” structure in high sensitivity settings can be superior to the equivalent speed in film

Conjunctions

Partial Solar Eclipse



Pleiades

Andromeda Galaxy

The Digital Workflow for Long Exposures and Uncooperative Subjects

- Systemic electronic noise – remove with noise reduction or dark frame subtraction
- Systemic optical defects – remove vignetting and dust in the optical system with flat frames
- Capture large sample of images – cull for the best
- Remove random noise to reinforce “good” signal – stack images in registration

Questions and Contact Information

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