ასტროფიზიკის და პლაზმის ფიზიკის ამოცანების მოდელირება - 2

ლექცია 6

Visualization

N dimension – observer

M dimension – information

No Information Lost: N = M+1

2D visualization

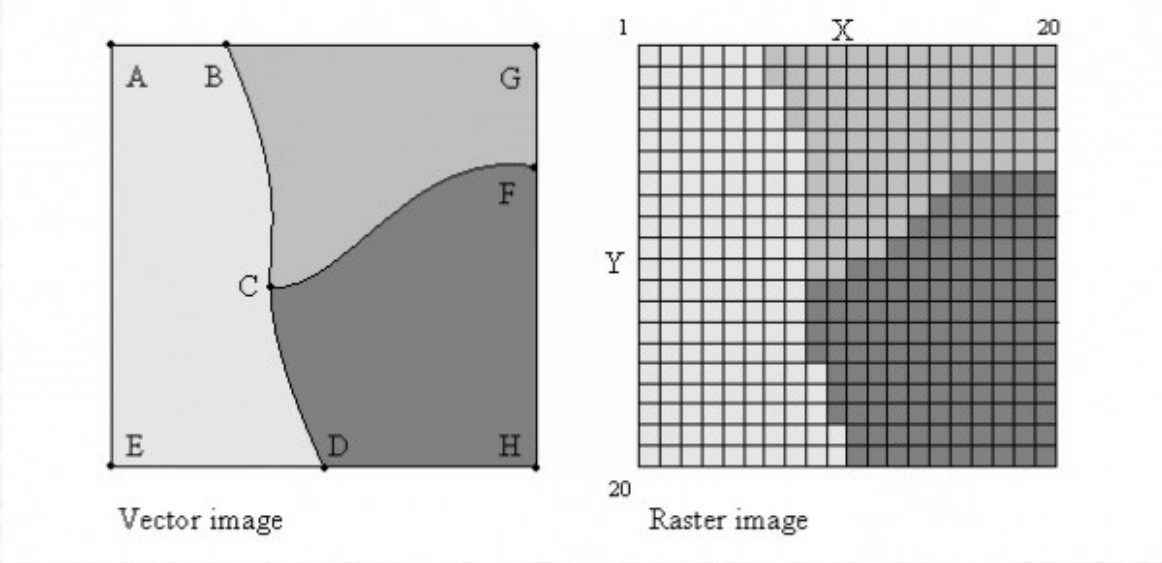
3D – intrinsic information loss;

choose important visual information (3D->2D)

Digital Images: Grayscale

Raster image:

X(M,N)



8 bit: 2^8=256 levels

0-255, normalized(1/255): 0-1

```
X = imread('your_image','jpg');
```

Astronomical images: 8bit, 16bit, 32bit;

Grayscale





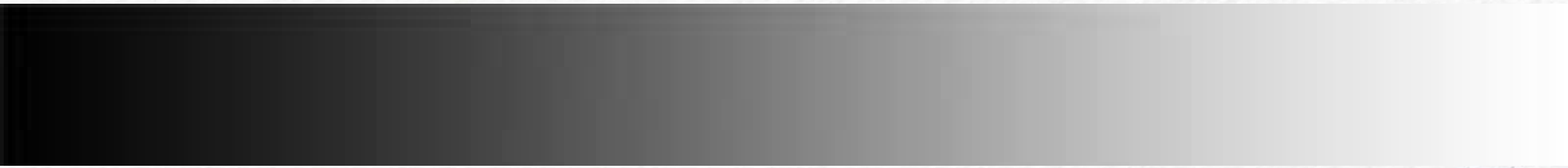
8 bit grayscale

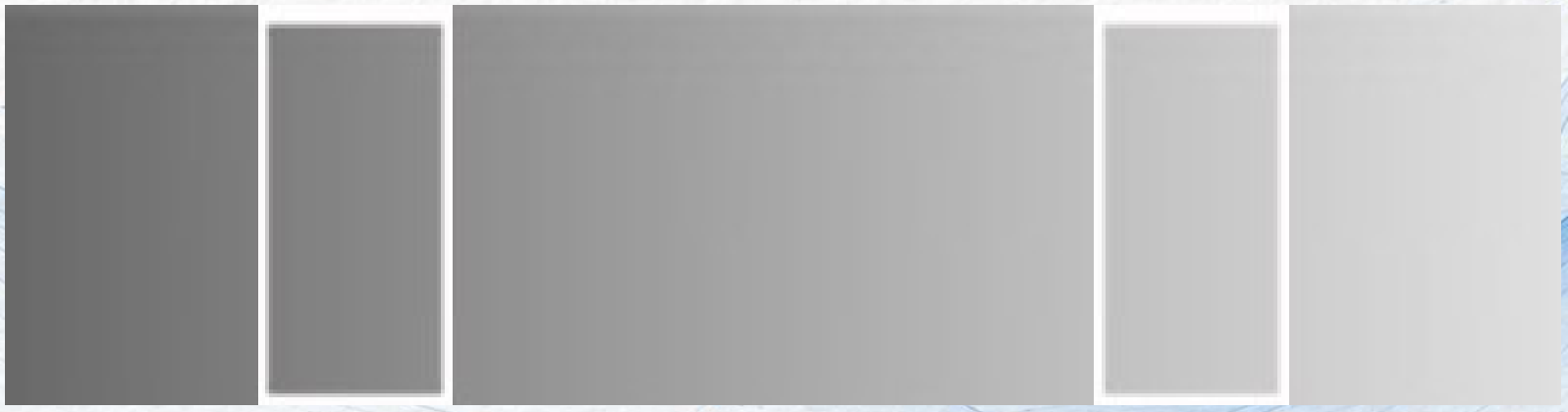
BW (1 bit)

Gray Perception

Human perception limits 1:

Levels in gray: 20?

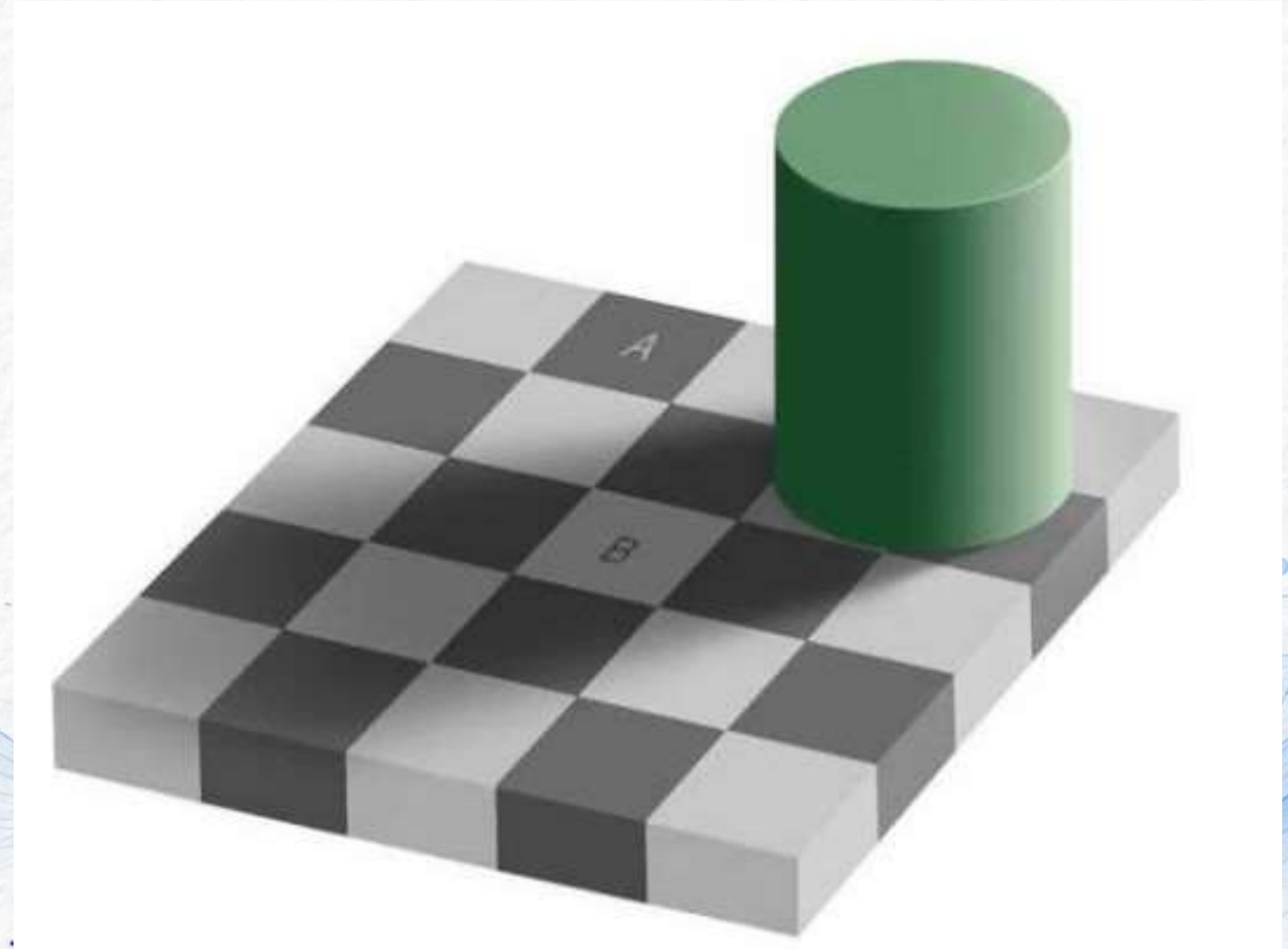




Gray Perception

Human perception limits 2:

smooth vs strong gradients in grayscale



Gray Perception

Human perception limits 2:

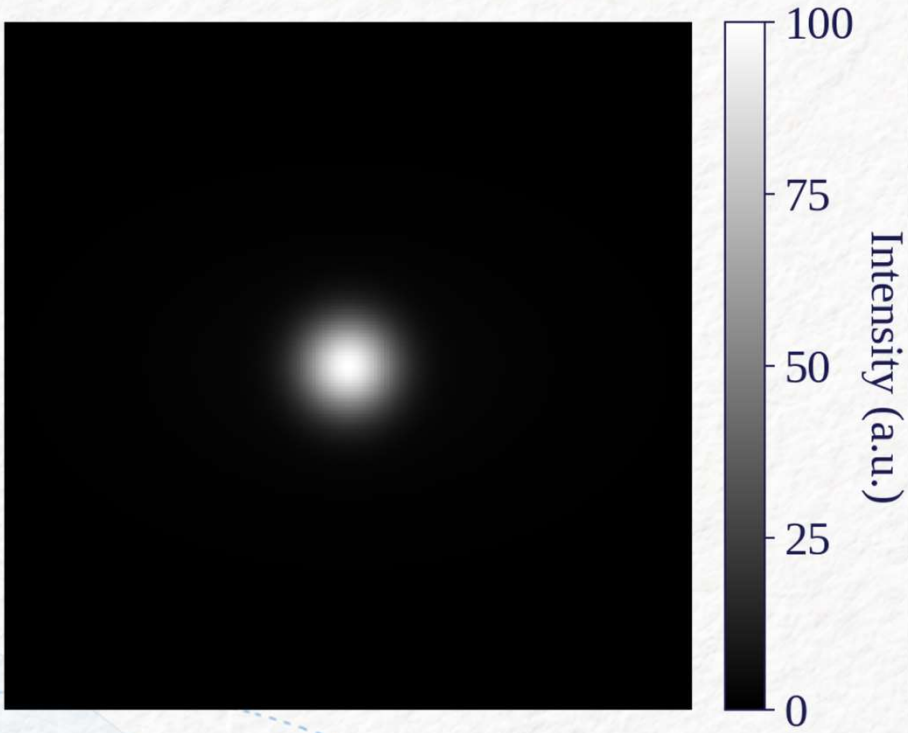
smooth vs strong gradients in grayscale



Display Range

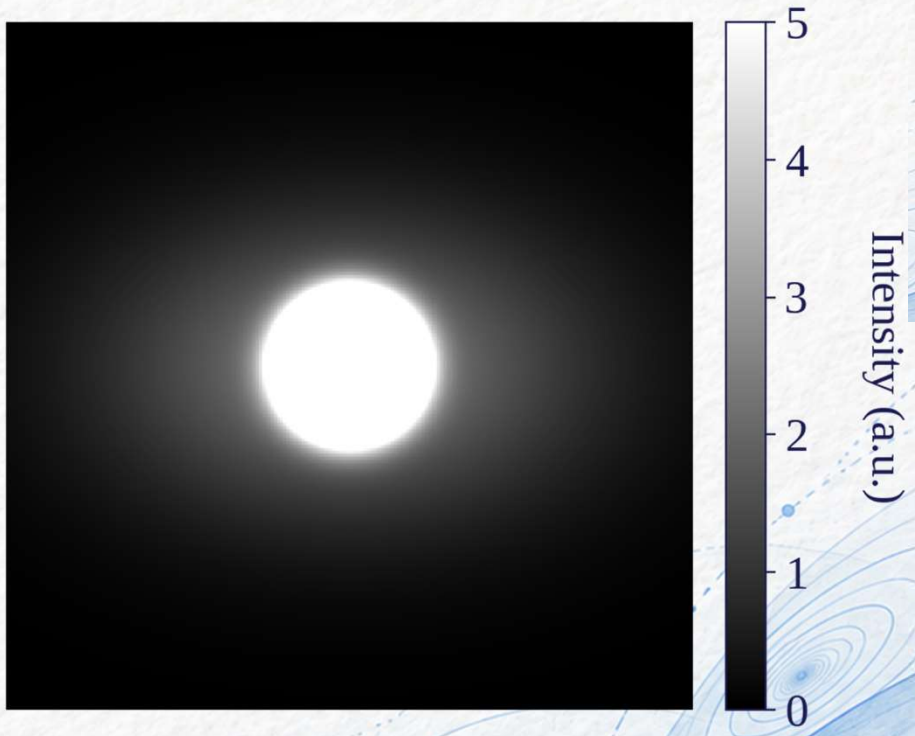
One simulated grayscale image with a bright core and a faint halo.

Full range




```
imagesc(X,[0 100])
```

Narrow range




```
imagesc(X,[0 5])
```

The narrow range reveals the halo. Values at 5 or above appear white.

Digital Color: RGB

`X(M,N,3)`

Red Channel: `X(:,:,1)`

Green Channel: `X(:,:,2)`

Blue Channel: `X(:,:,3)`

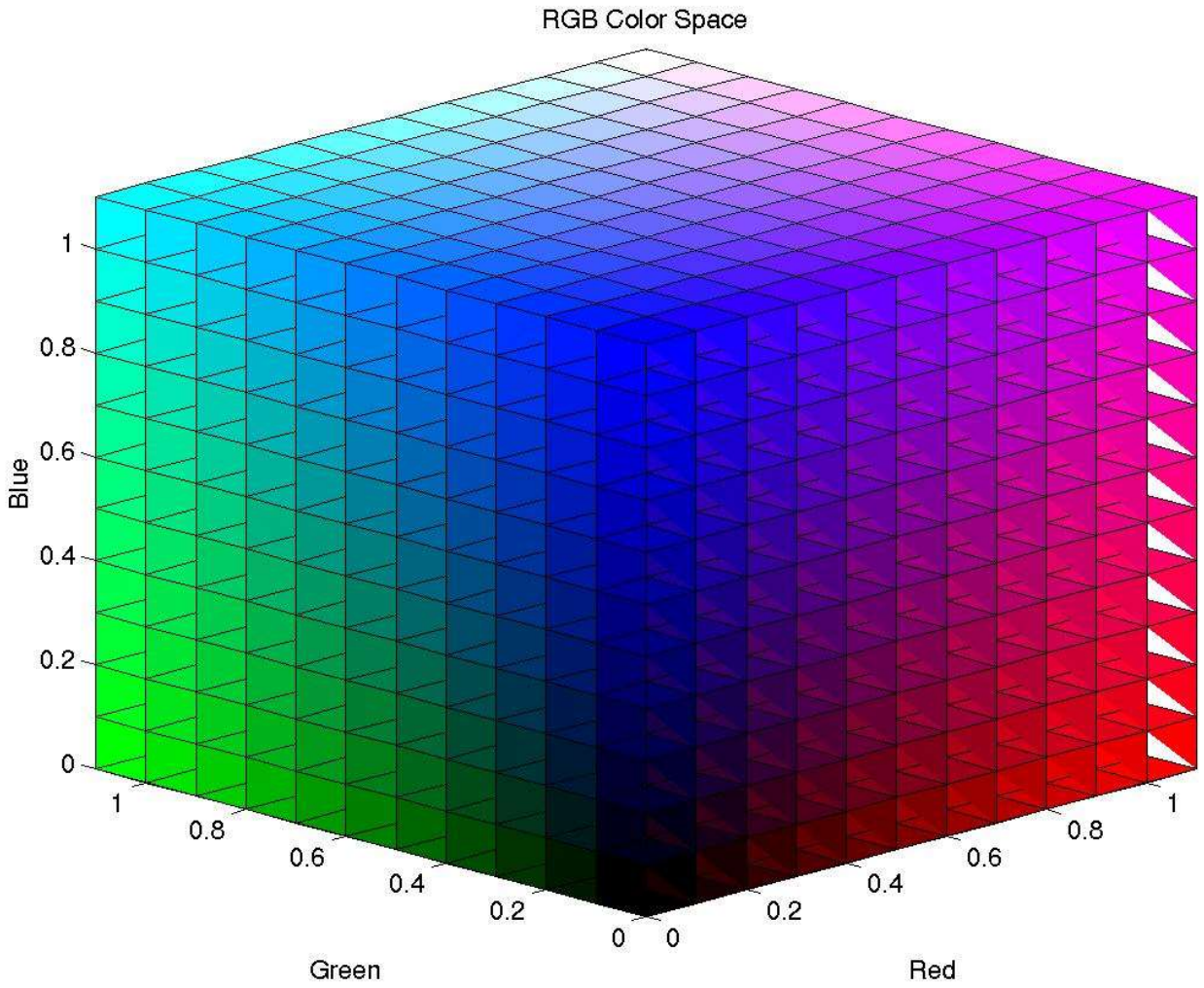
24 bit color: [8 red, 8 green, 8 blue]

Total number = 256^3 = 16 777 216 “colors”

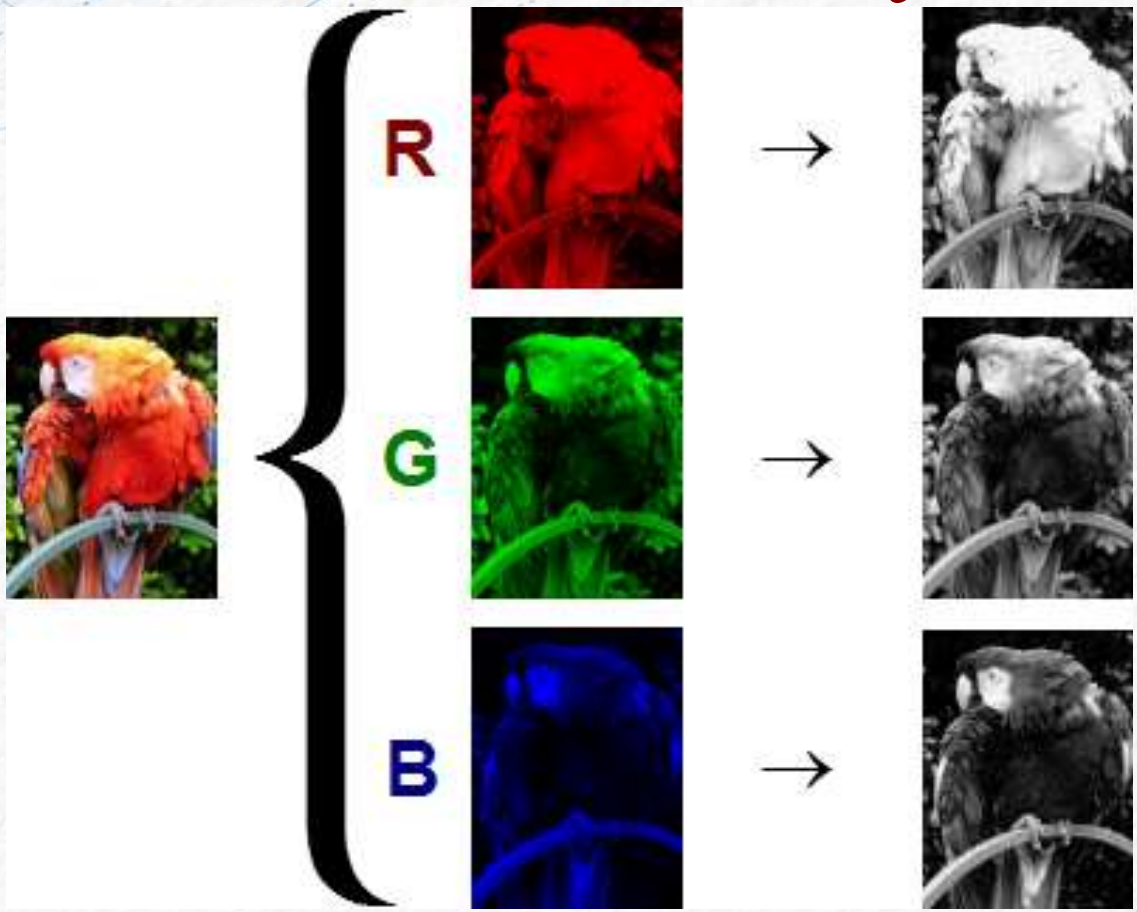
RGB

RGB Colorspace

Color Coordinates



RGB to Gray



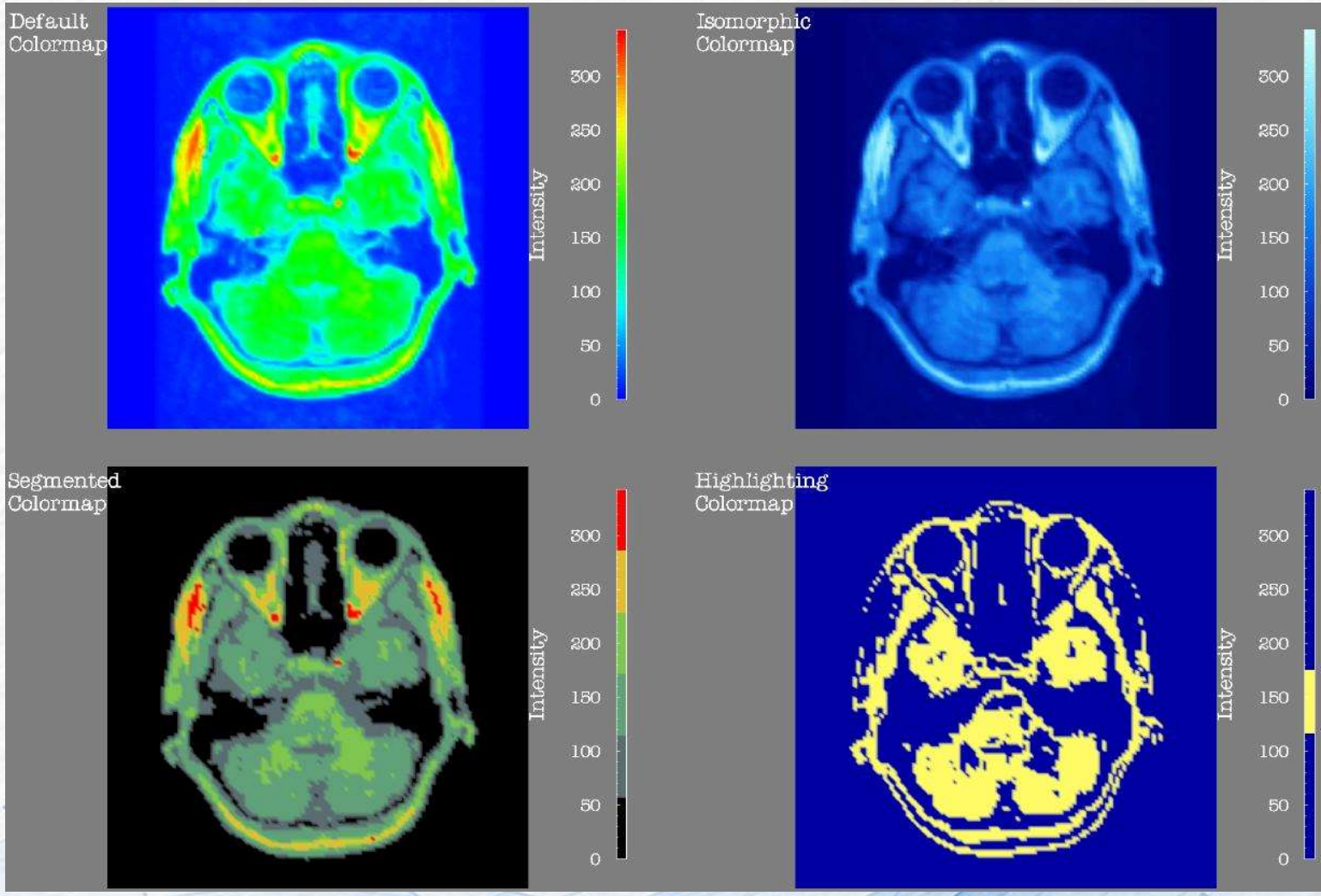
sensitivity response curve of the detector to light as a function of wavelength

Craig's formula: GRAY = 0.3 R + 0.59 G + 0.11 B

Matlab function: `rgb2gray`

Colormaps

Choosing Colormap

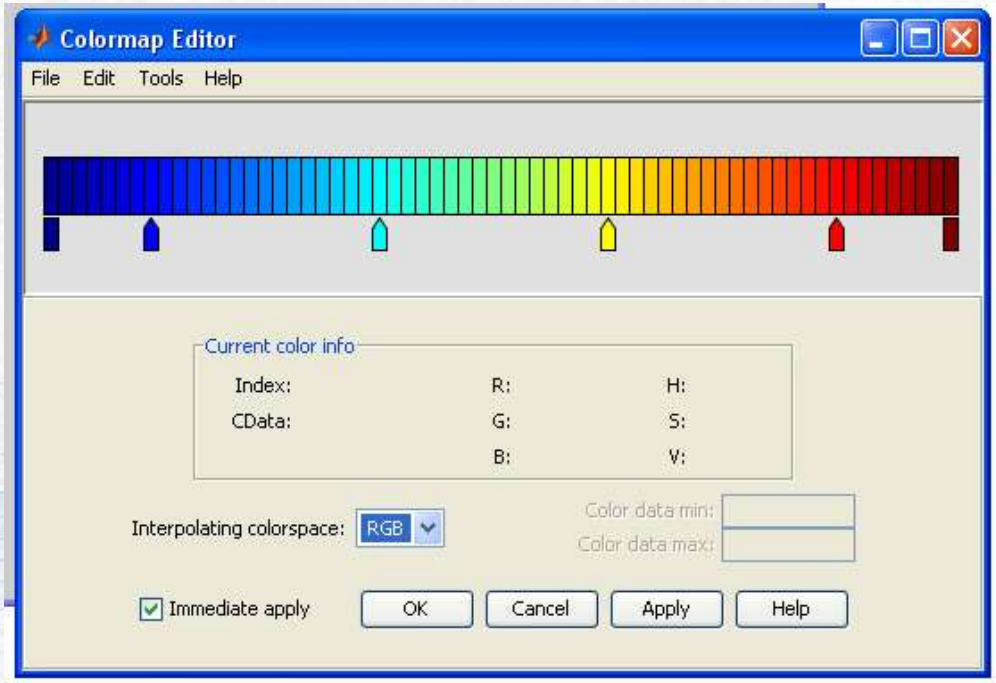


maximize eye sensitivity in target area

Colormaps

Matlab:

Standard colormaps



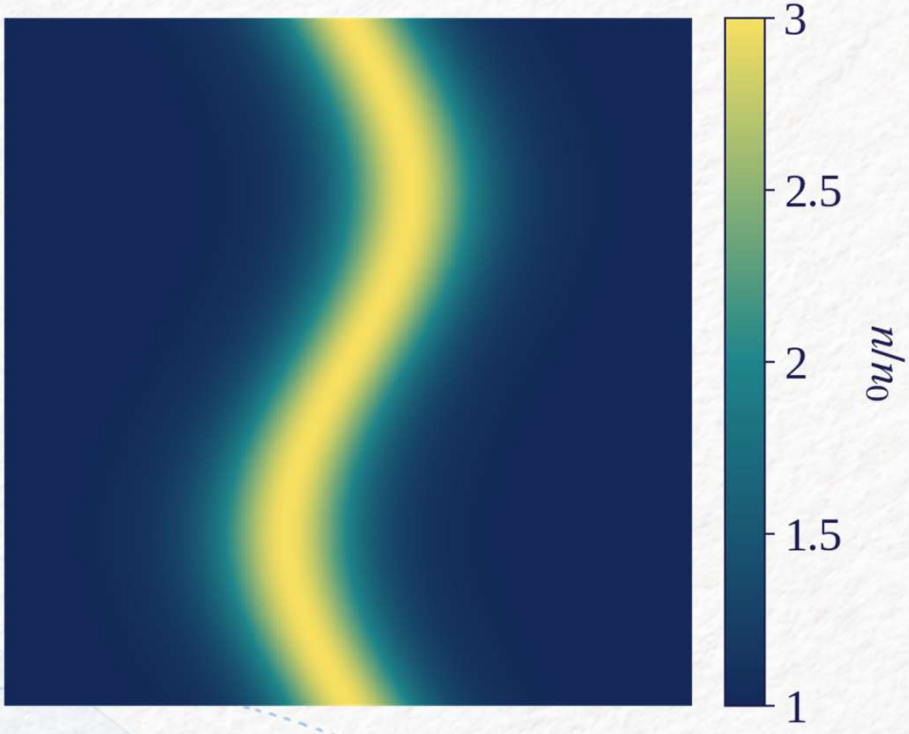


`colormapeditor`

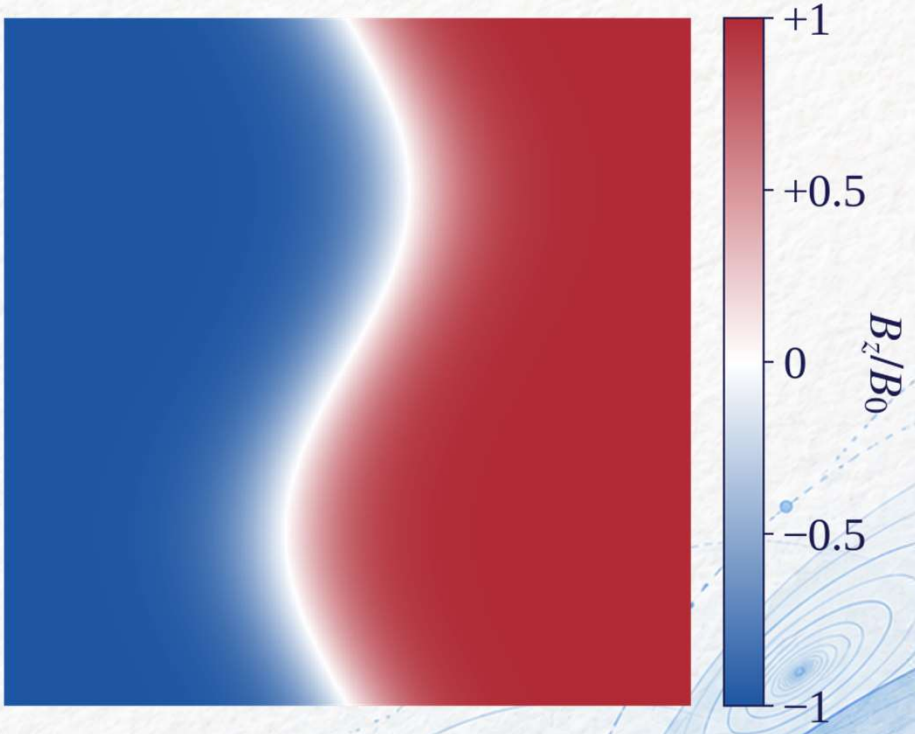
Choosing a Colormap

Density and magnetic field in a model plasma sheet.

Density



Magnetic field



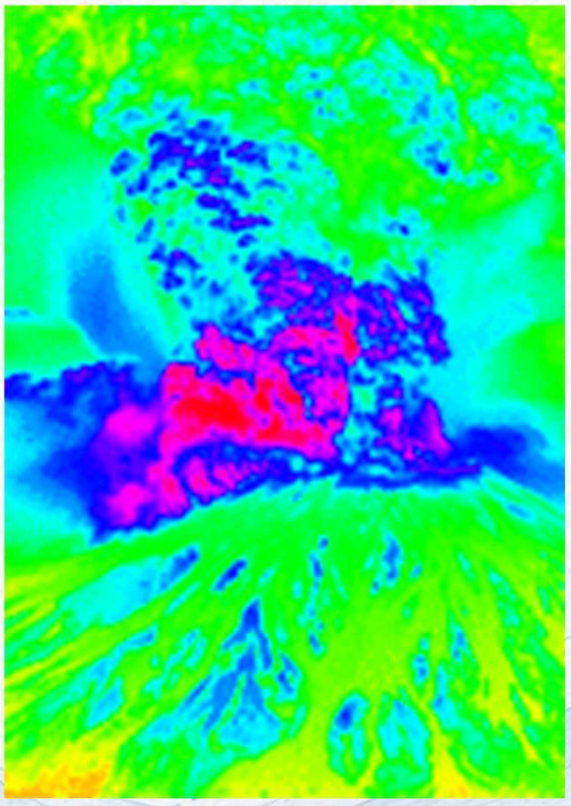
Lighter colors show higher density.

White marks zero. Blue and red show opposite signs.

Color Range

Maximize human perception gradients

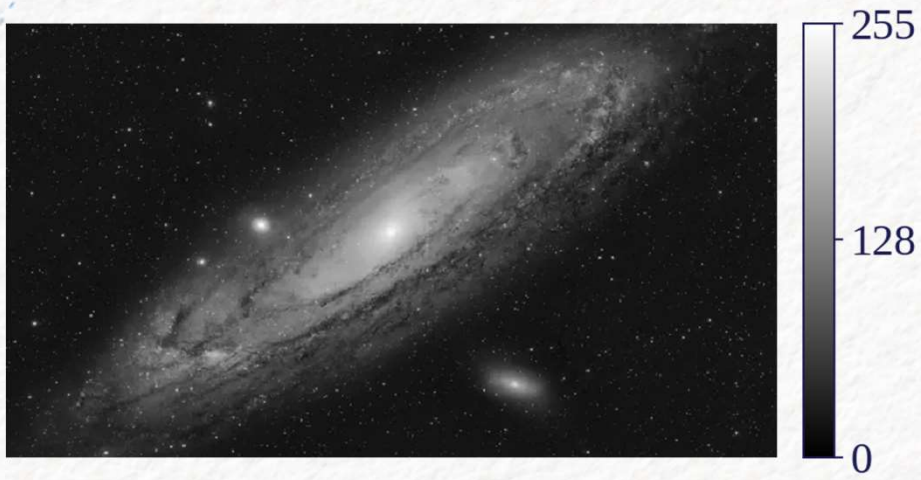




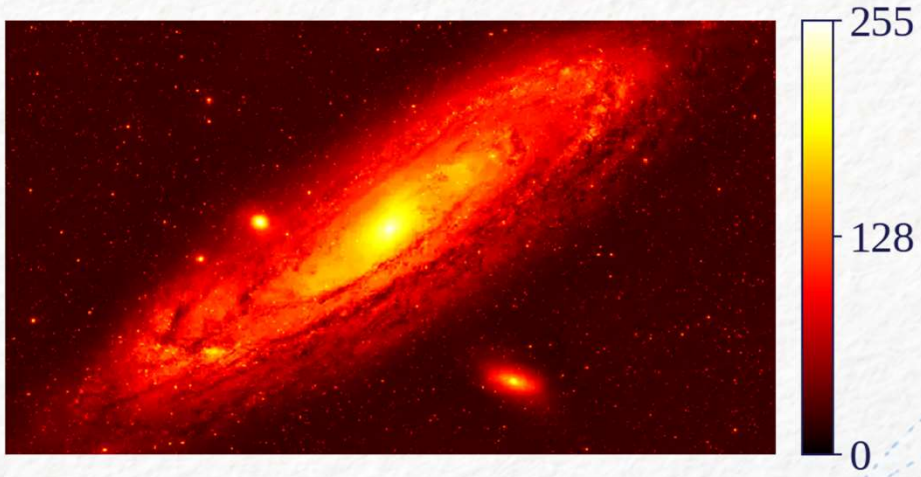
Colormap Editor

Andromeda (M31) on a shared 0–255 intensity scale.

Gray



Hot



MATLAB

```
RGB = imread('M31.png');
X = rgb2gray(RGB);
imagesc(X,[0 255])
axis image off
colormap(gray(256))
colorbar
colormapeditor
```

In the editor

Select Hot from the palette menu.

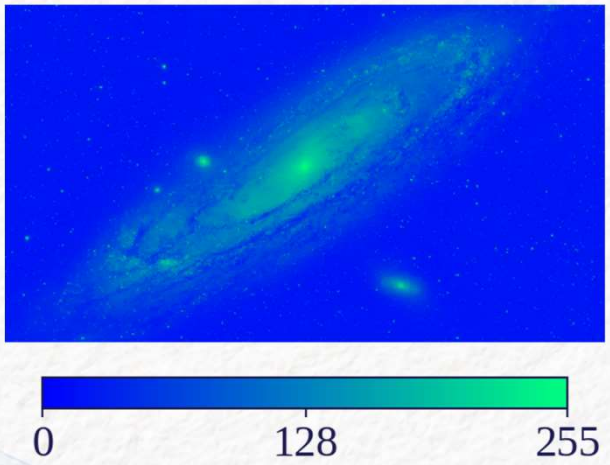
Open Specify Color.
Drag a marker to shift a transition.

Compare the bright bulge and the dark dust lanes.

Standard Colormaps

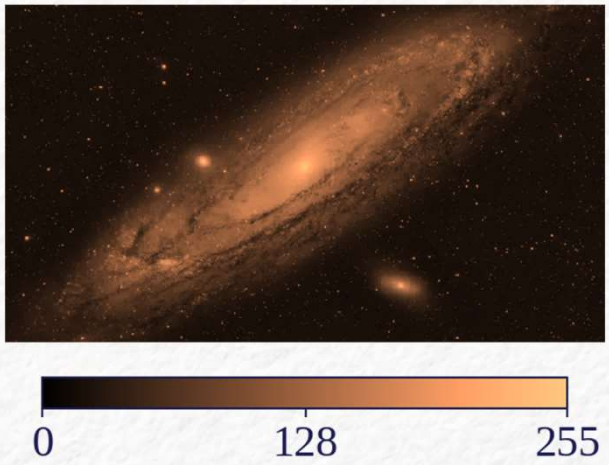
Andromeda (M31) in three more palettes on the 0–255 scale.

Winter



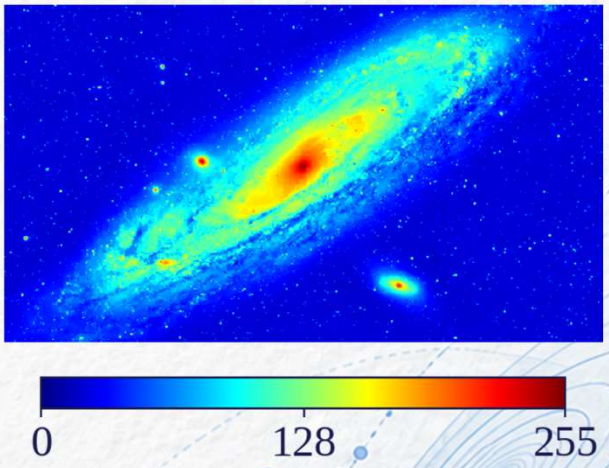
`colormap winter`

Copper



`colormap copper`

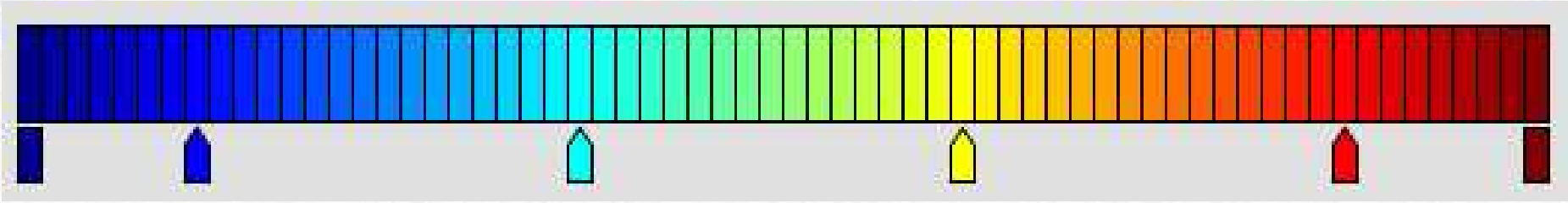
Jet



`colormap jet`

Editing the Colormap Bar

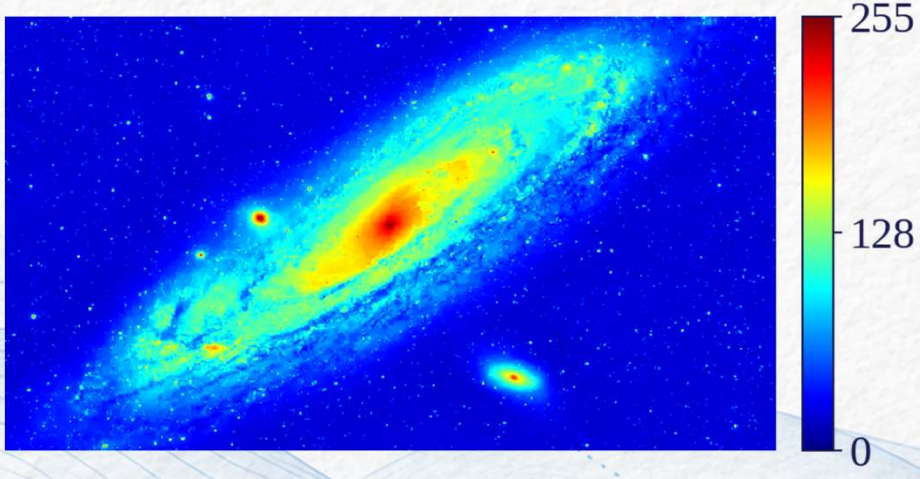
Choose Jet and open Specify Color in the editor: `colormapeditor`



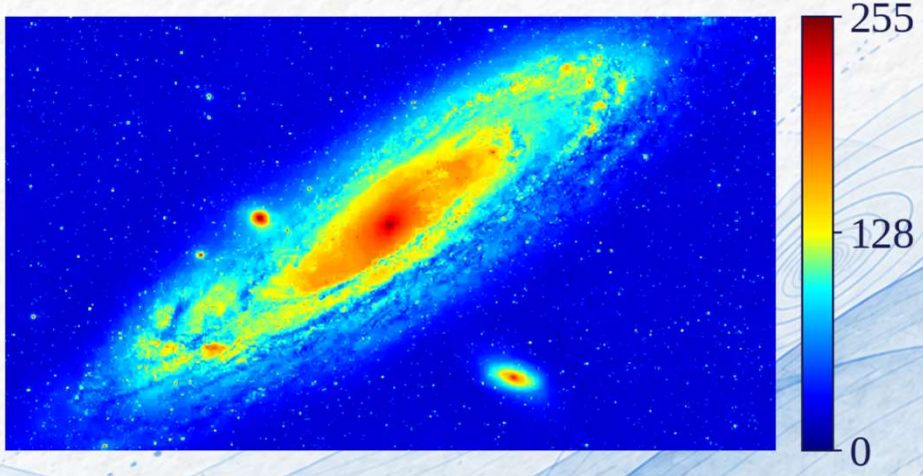
Yellow marker

Drag the yellow marker left.

Original Jet



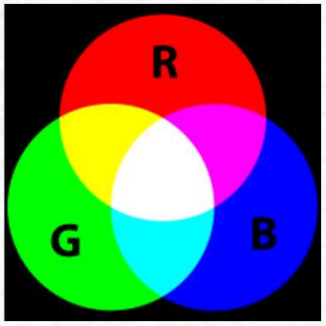
Example after the move



Pure yellow moves from grayscale value 159 to 127.

Color Spaces

RGB (pc, digital format)



CMYK (cyan, magenta, yellow key black)
printers



NTSC (TV)

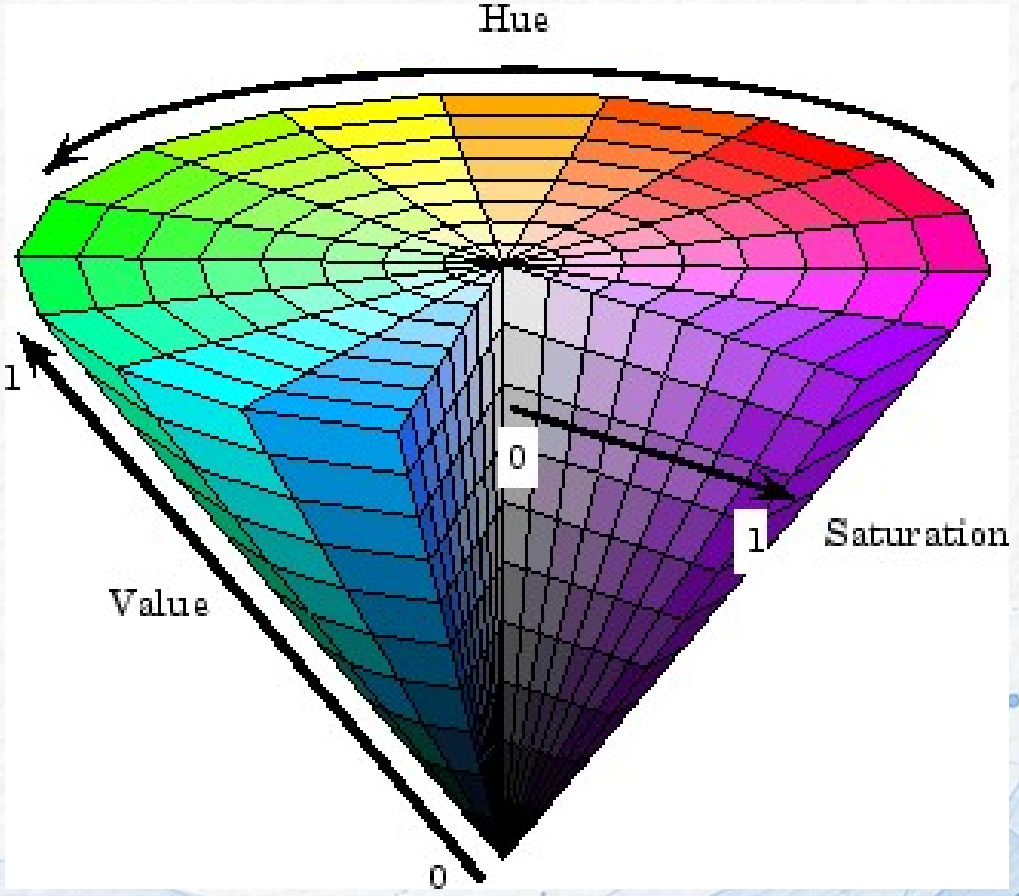
HSV (Hue, Saturation, Value)

HSV

Human Perception Color Space

R G B

H S V

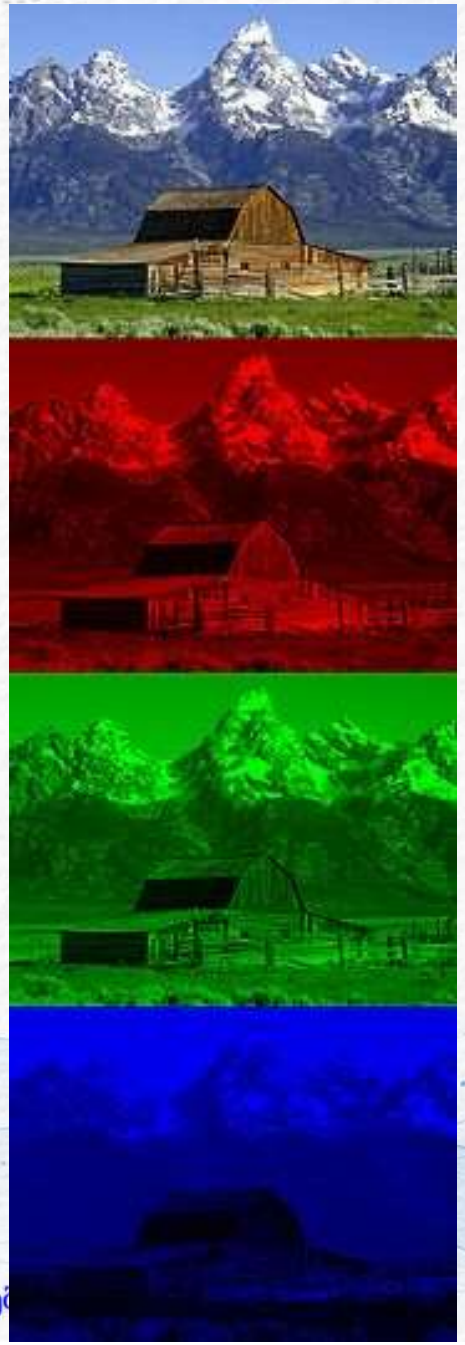


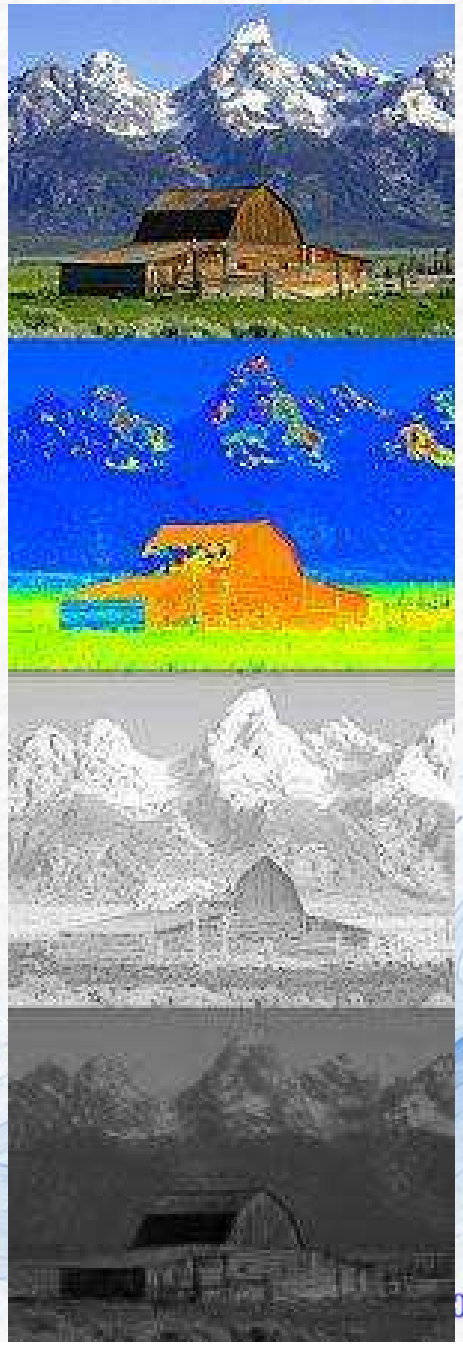
Matlab: `rgb2hsv, hsv2rgb`

RGB vs HSV

Sensitivity max:

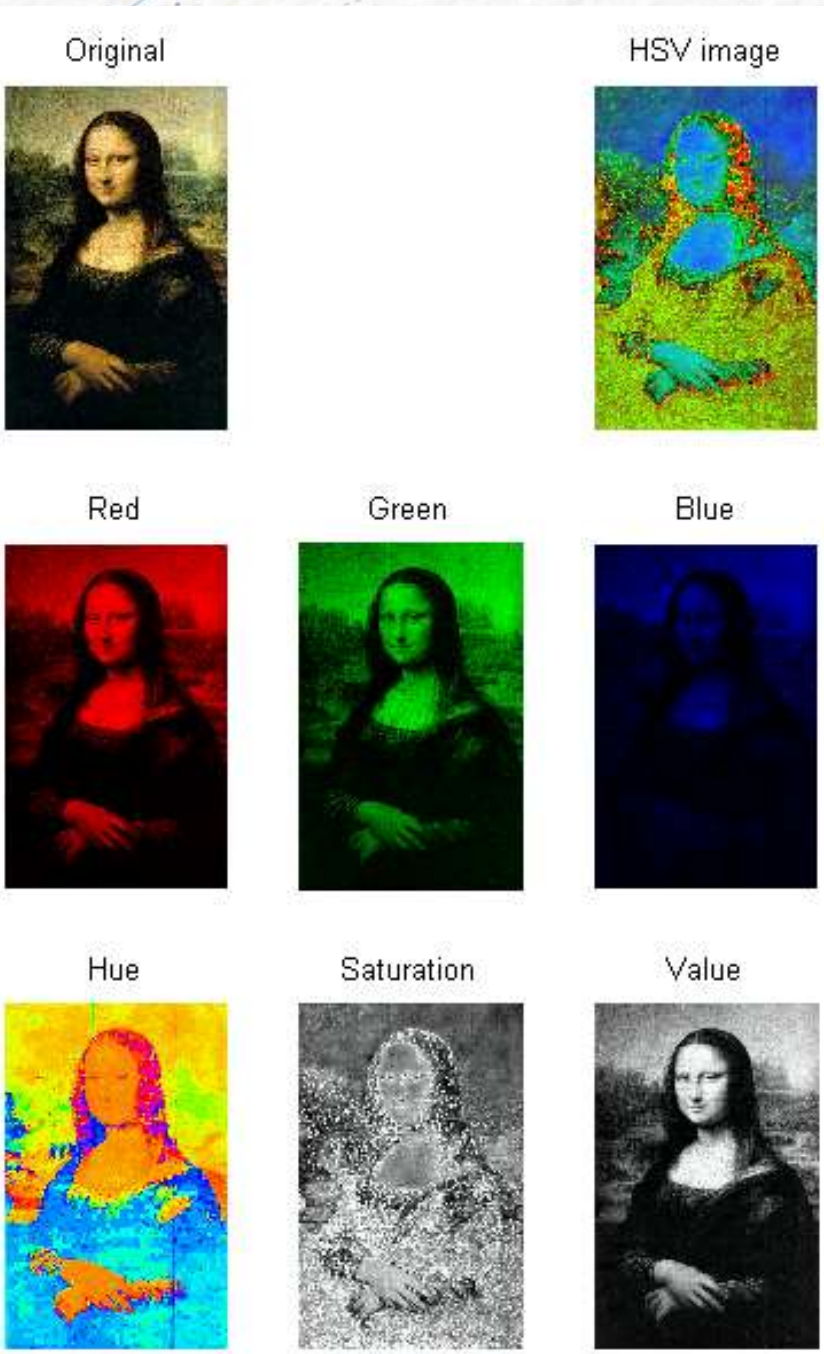
Hue





- Reduce bitrate
- Filter
- Track
- Recognition

RGB vs HSV



Selecting Color with HSV

Hue identifies the color. Saturation tells how vivid it is.

Pixel sample	Green	Nearly gray	Blue
Hue H	0.33	0.33	0.67
Saturation S	0.75	**0.05**	0.75
Hue only	Keep	**Keep**	Drop
Hue + saturation	**Keep**	**Drop**	**Drop**

MATLAB

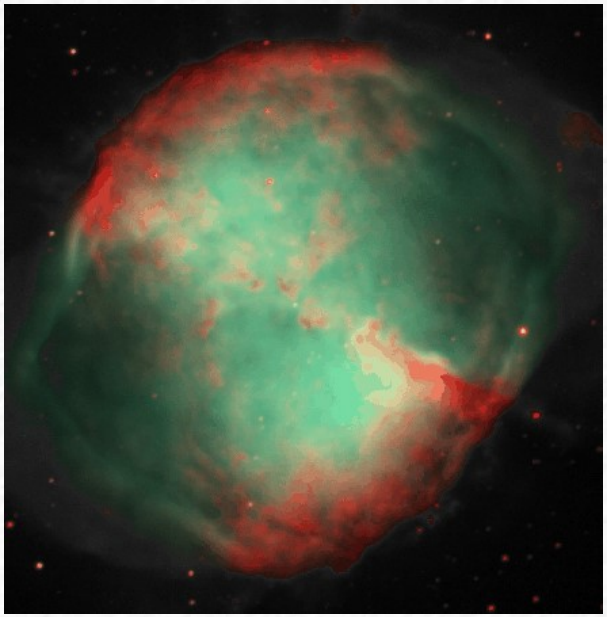
```
HSV = rgb2hsv(X);
H = HSV(:,:,1);
S = HSV(:,:,2);
mask = (H >= 0.25) & (H <= 0.45) & (S >= 0.30);
```

Each true element of mask marks a selected pixel.

Selecting Green in a Nebula Image

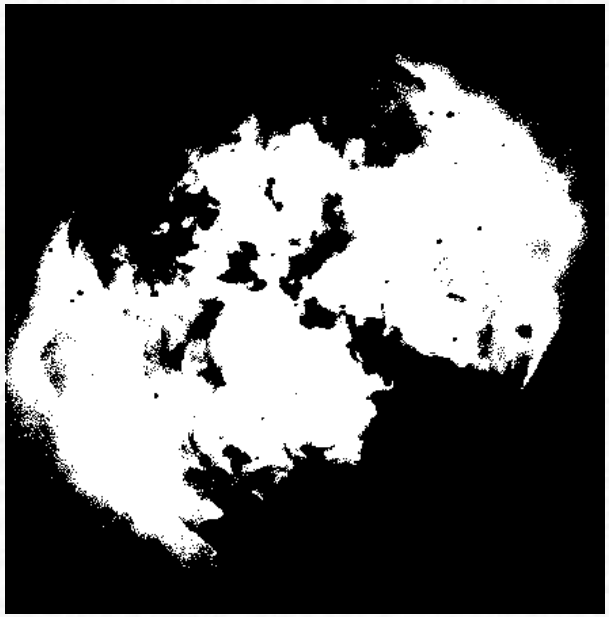
White pixels pass the selection test.

Original RGB



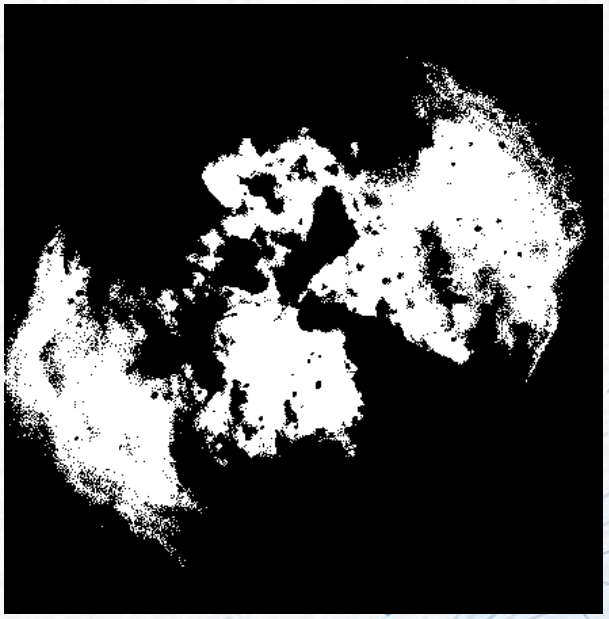
442 × 450 pixels

Hue only



36% selected

Hue + saturation



24% selected

MATLAB

```
hueMask = (H >= 0.25) & (H <= 0.45);
mask = hueMask & (S >= 0.30);
```

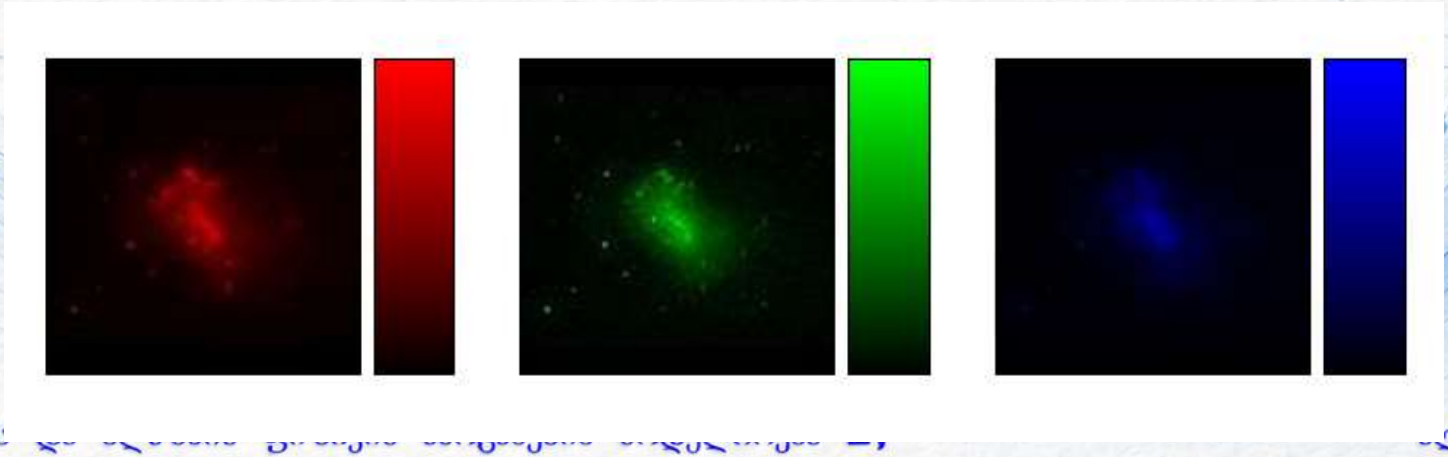
False-color

image + image + image = color image

Color Image: [λ(red) , λ(green) , λ(blue)]

False-Color: [λ1 , λ2 , λ3]

λ1, λ2, λ3

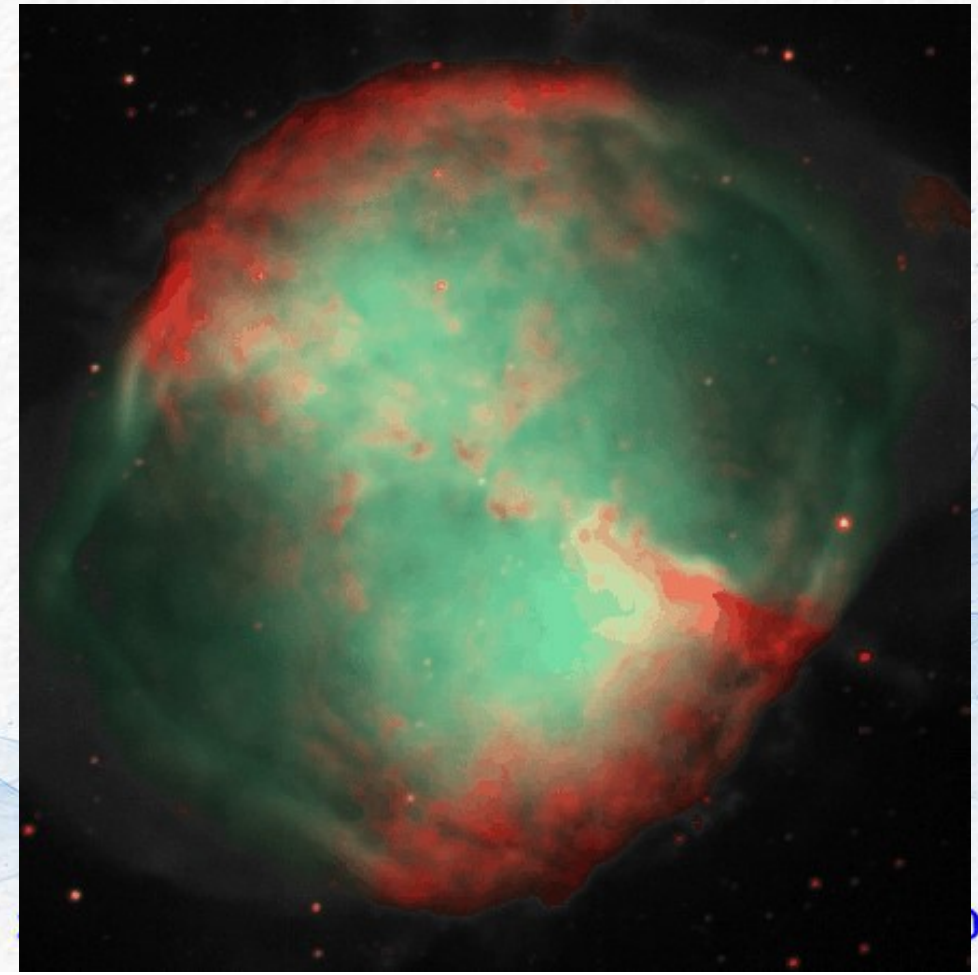


False-color

NGC 6720 (the Ring Nebula)



NGC 6720 (the Ring Nebula)

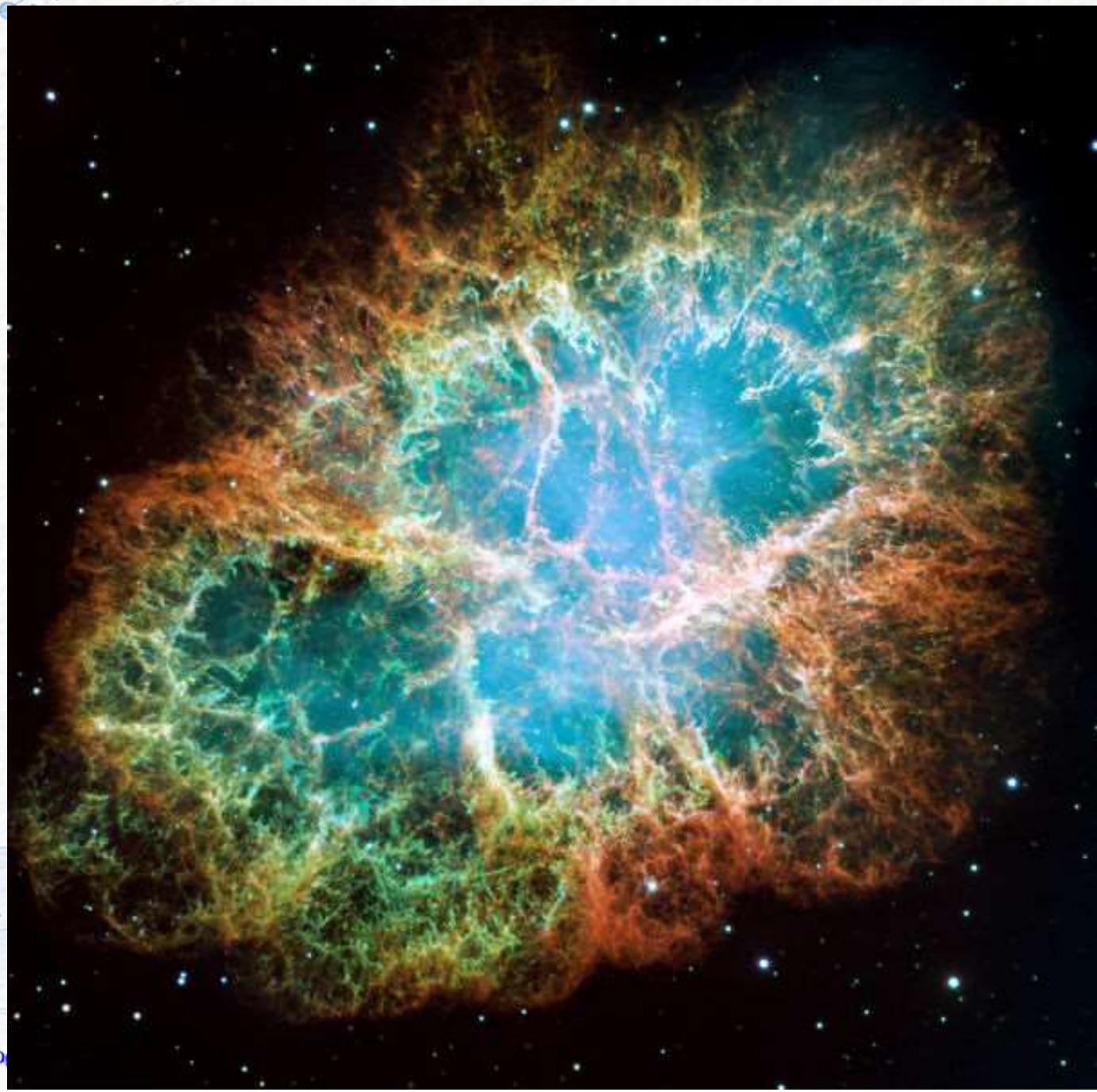


False-color

Crab nebula

multi band

emission



False-color

Galaxy dust



Pseudo-color

image + idea + … + idea = color image

technique for artificially assigning colors

visualize ideas

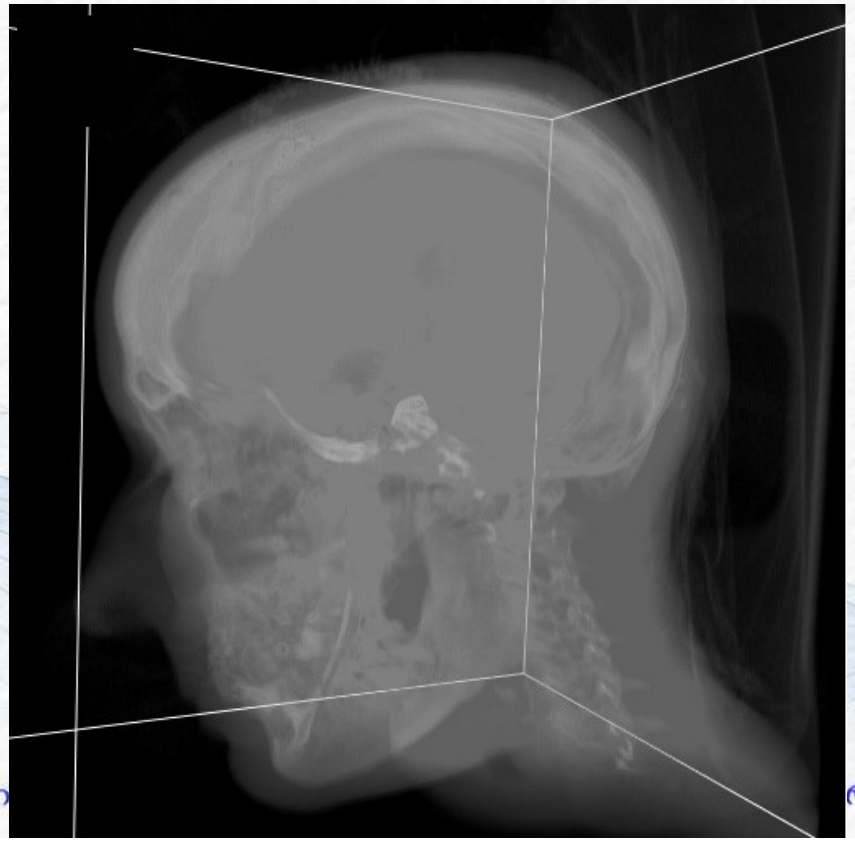
Image_gray -> Image_color

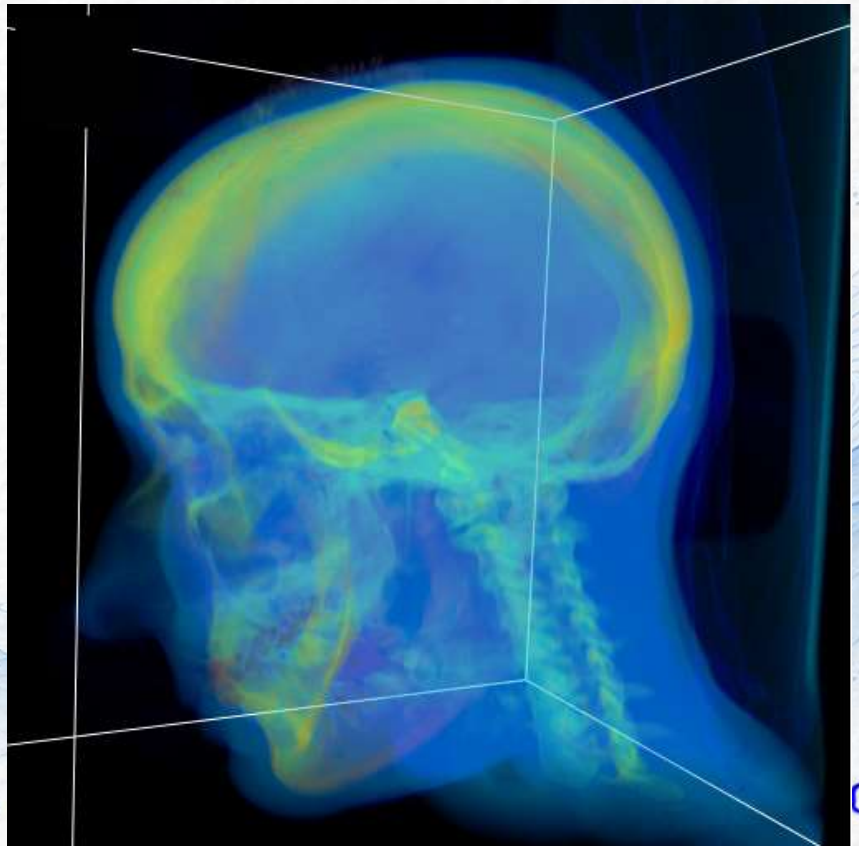
```
rgb2gray(Image_color) = Image_gray
```

Pseudo-color

Goal: increasing the distance in color space between successive gray levels.

changing the colors in order to ease image understanding





Pseudo-color

Grayscale image

Ideas:

Strong gradient: blue

Smooth gradient: red

Morphology coloring (pixel based filtering, pixel geometry, blobs, holes, etc.)

Egde detection: (harder edges, outer glow, inner glow …)

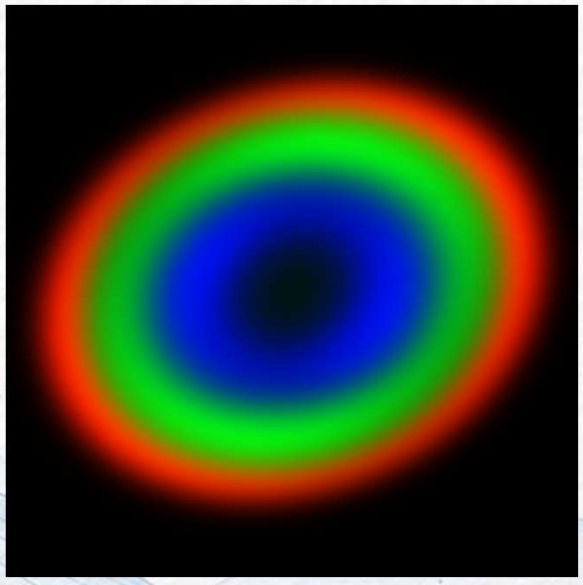
Color Image

False Color and Pseudo-color

Three simulated infrared images of the same nebula.

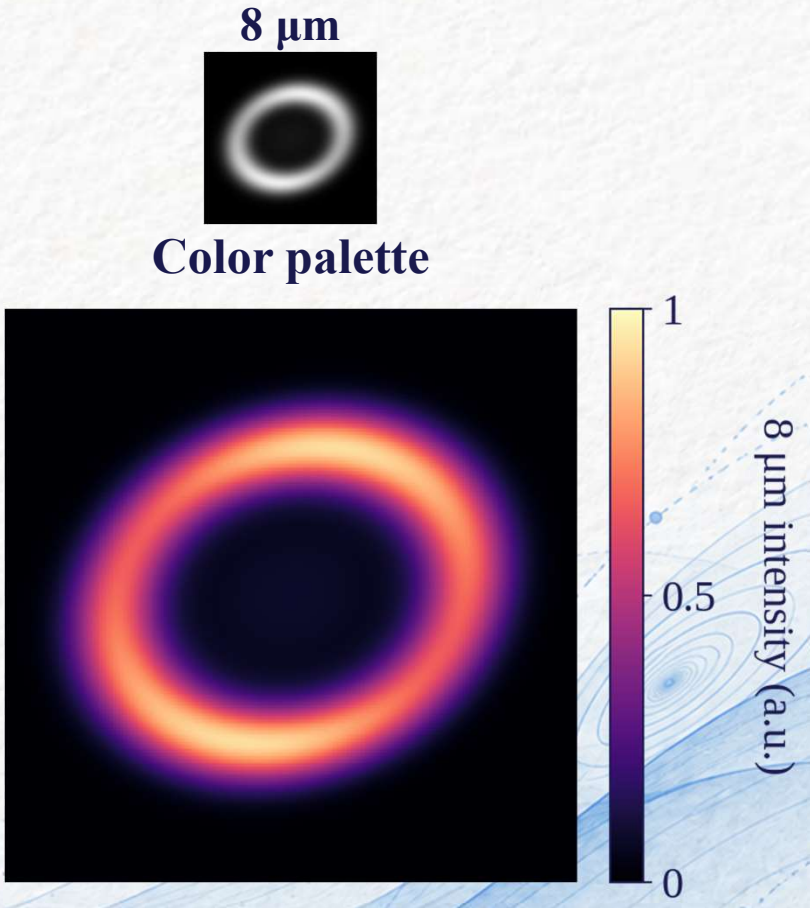
False-color composite





One band per RGB channel

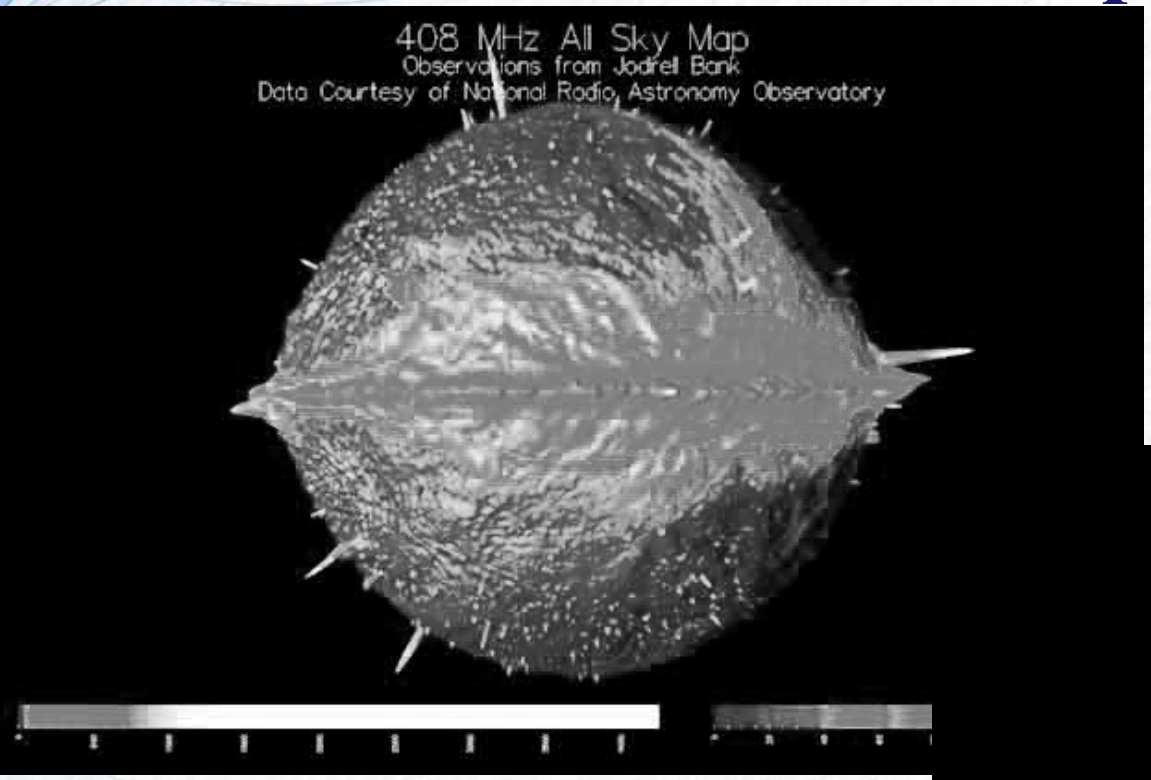
Pseudocolor map

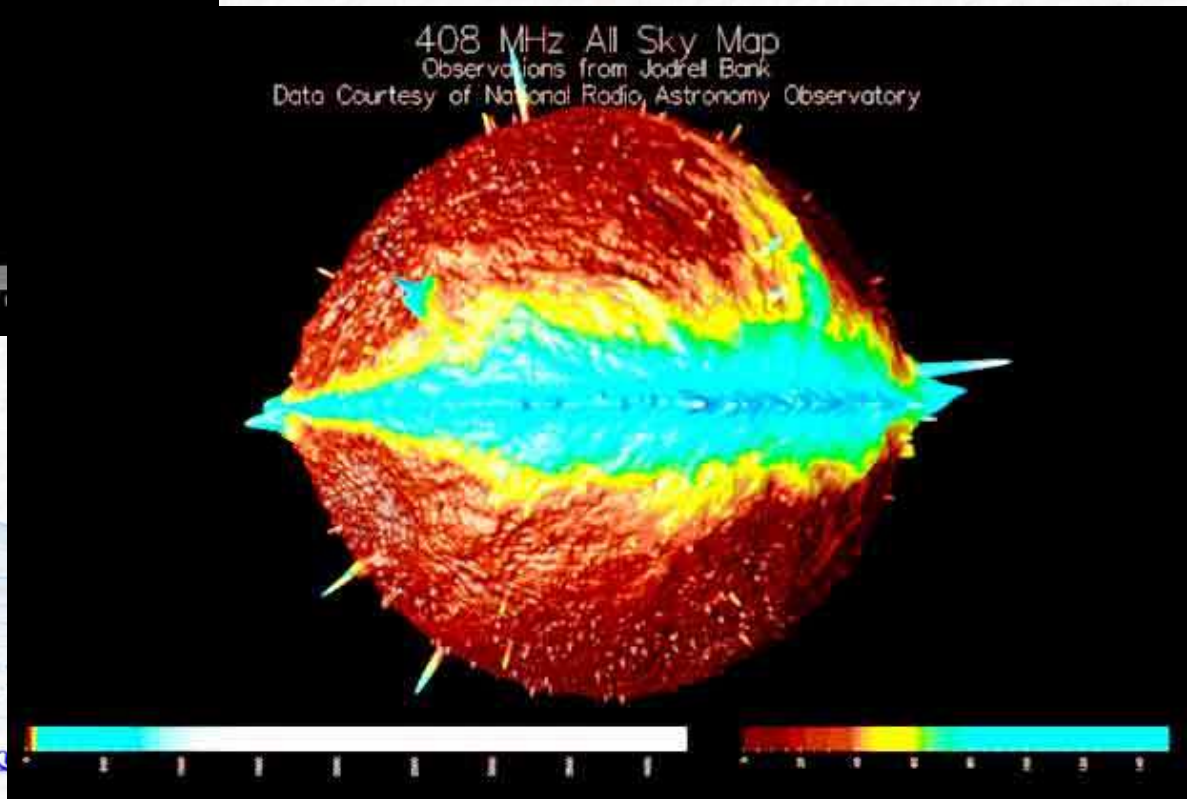


One intensity selects a color

Pseudo-color

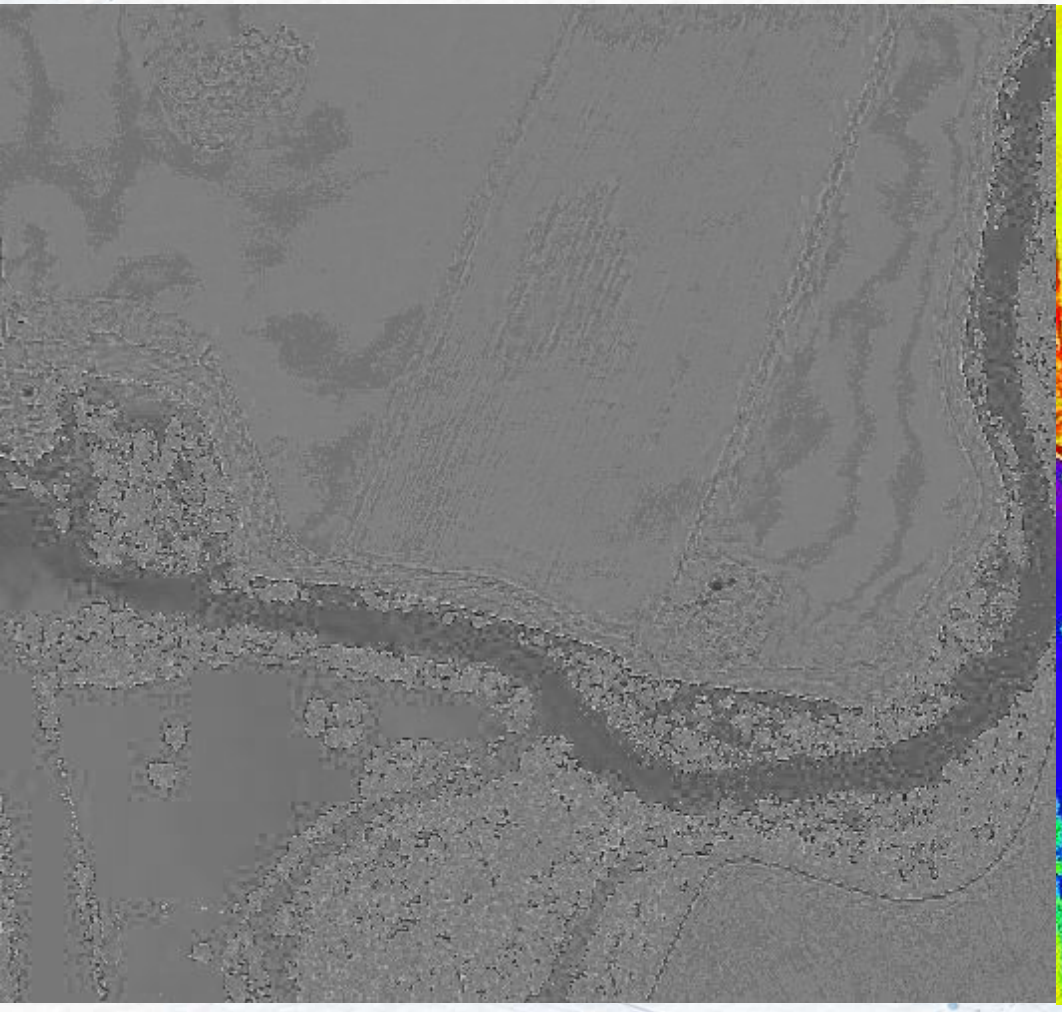
Radio sphere

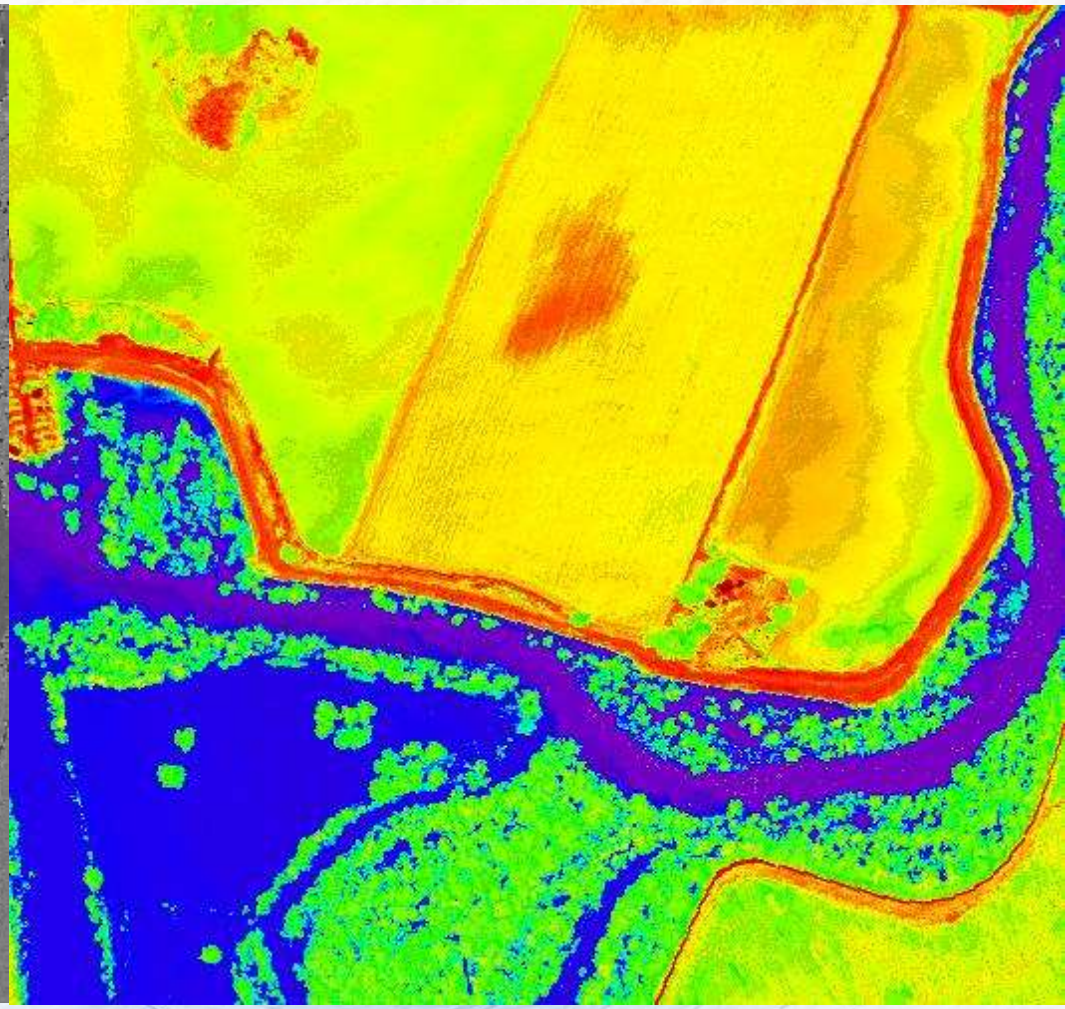




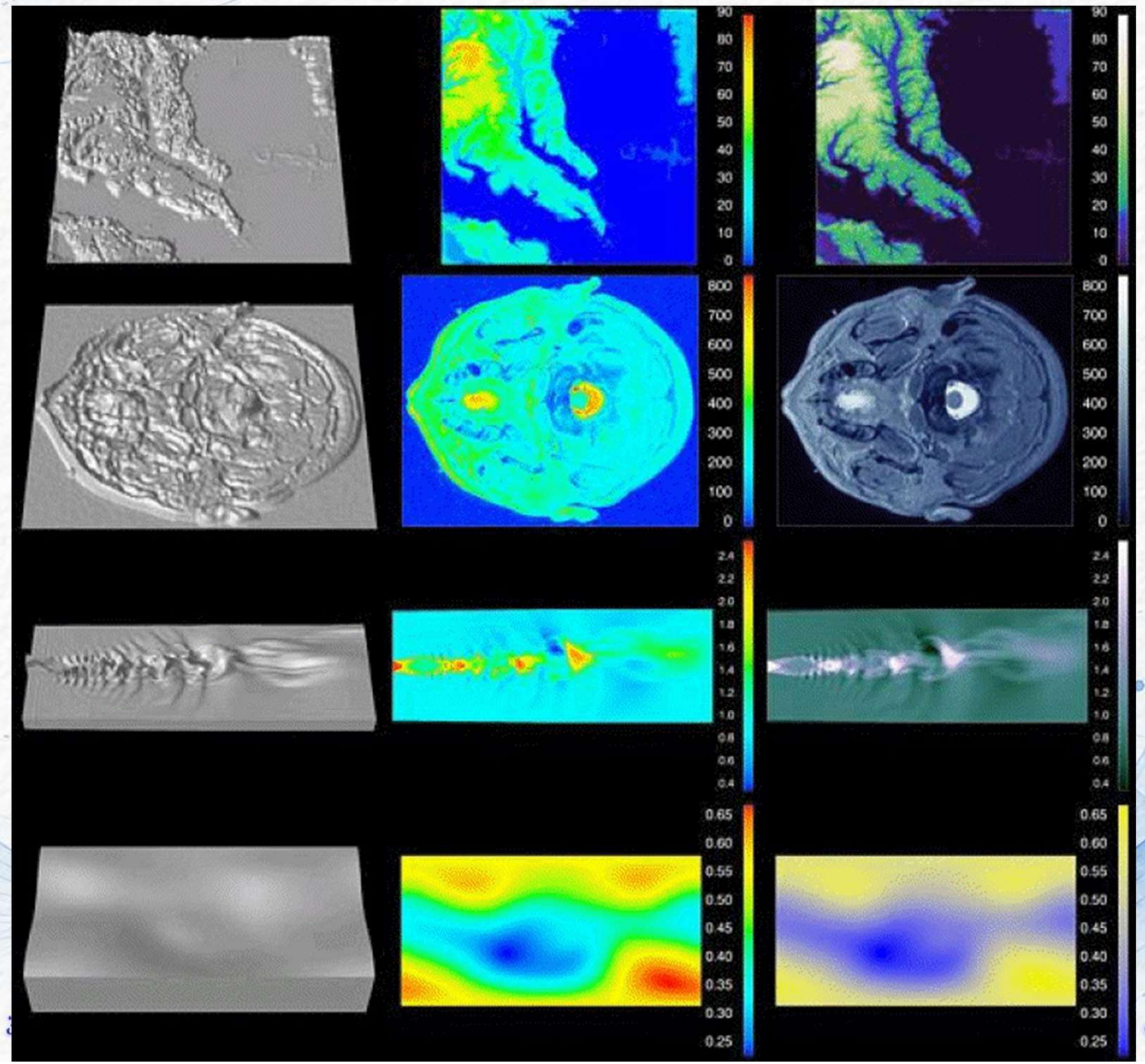
Pseudo-color

Morphologic enhancement





Pseudo-color



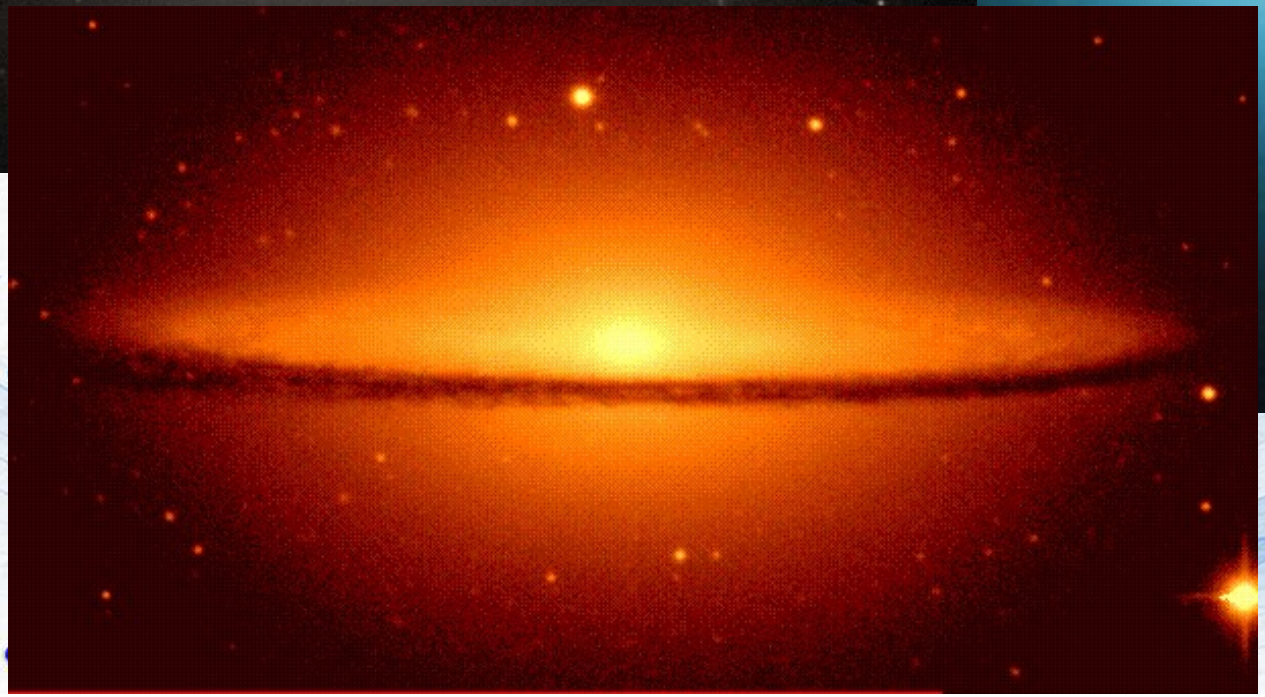
False vs Pseudo

False-color





Pseudo color



end

www.tevza.org/home/course/modelling-II_2026/