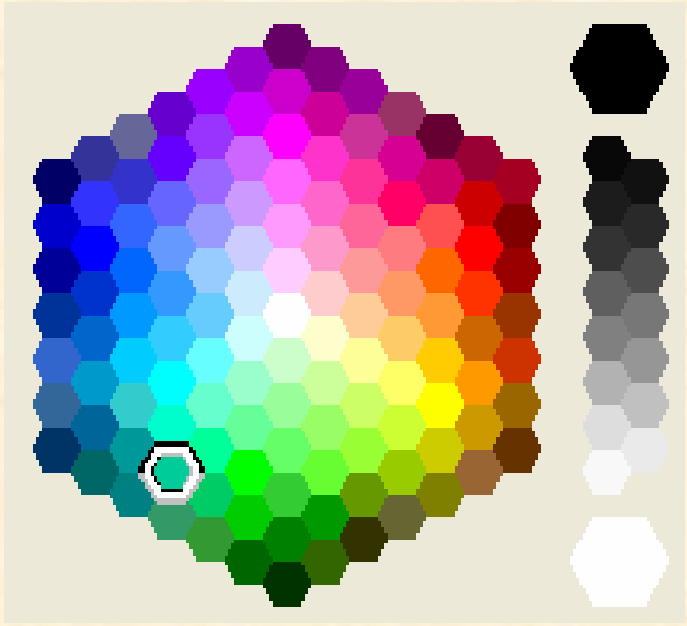
Processing of colour images

- Colour representation schemes
- Filtering of colour images



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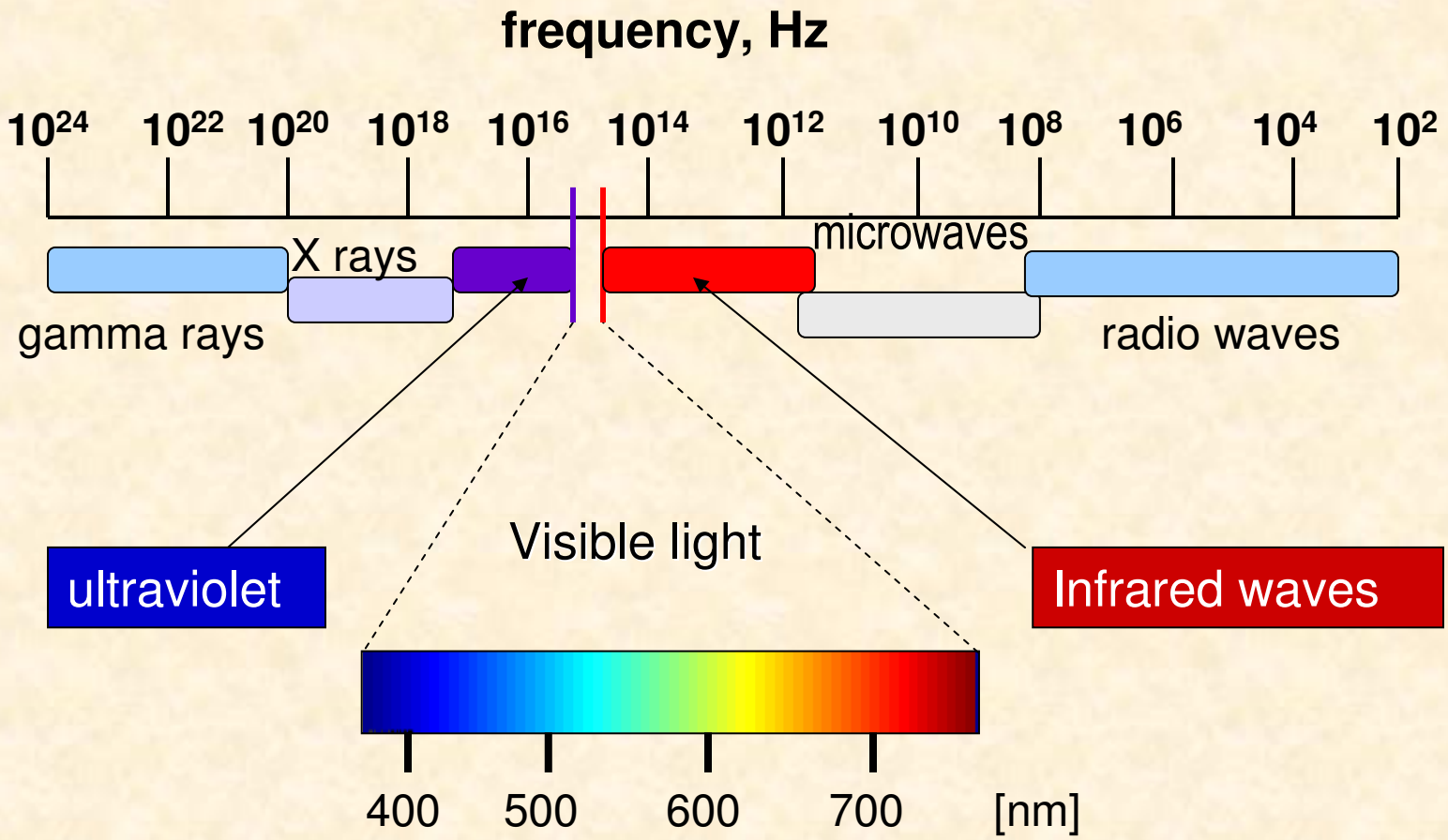
Electromagnetic spectrum



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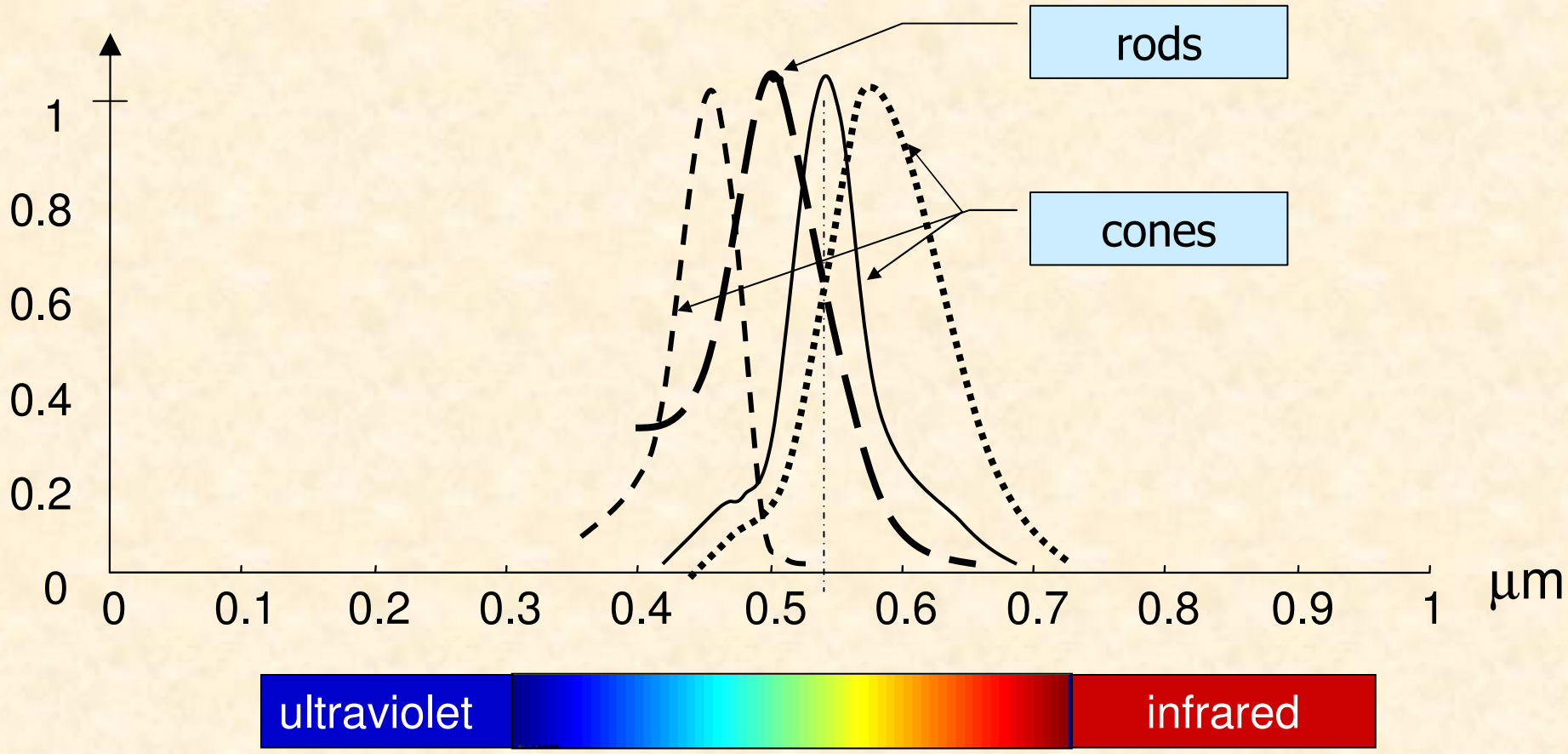
Eye sensitivity to colour components



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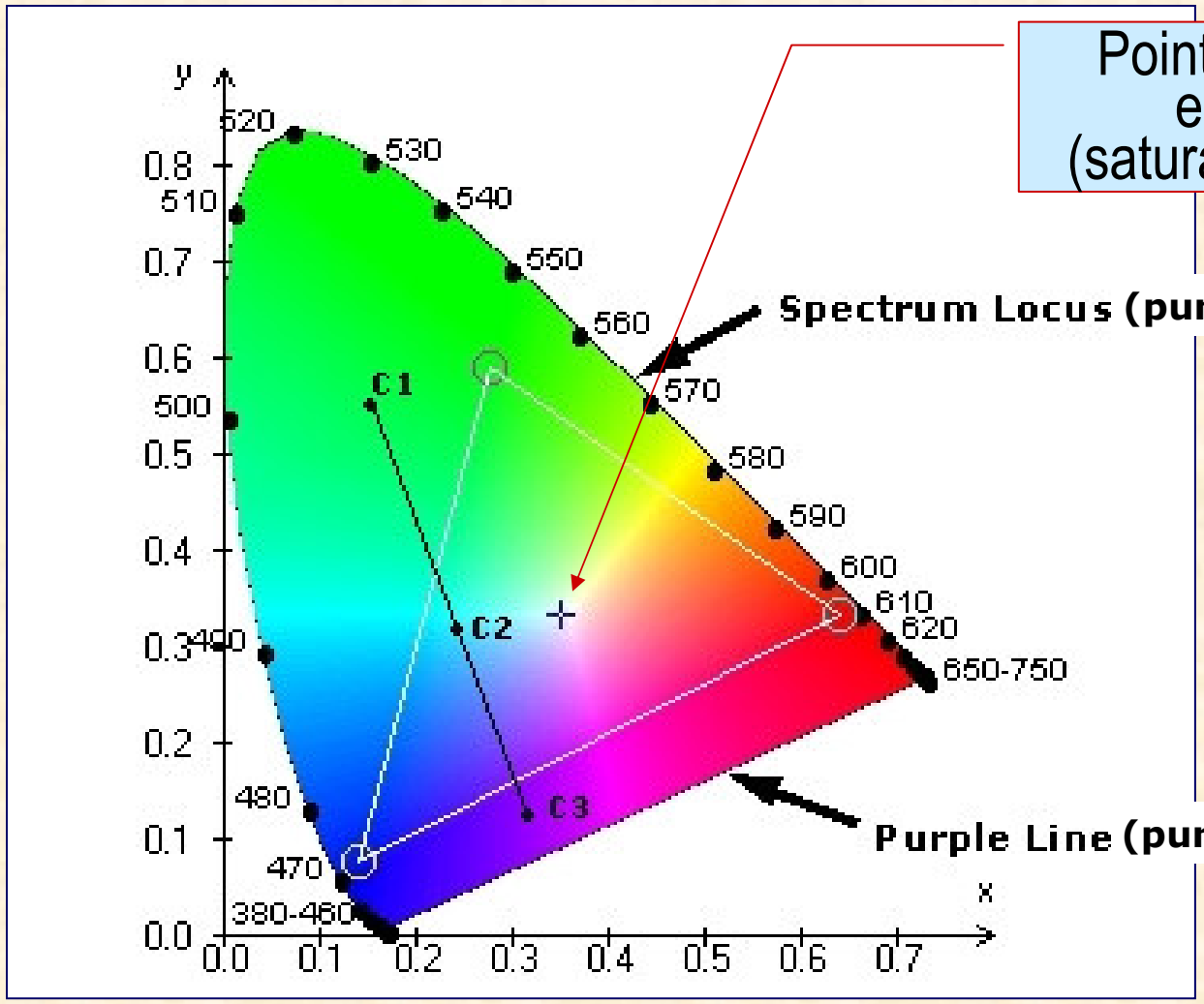
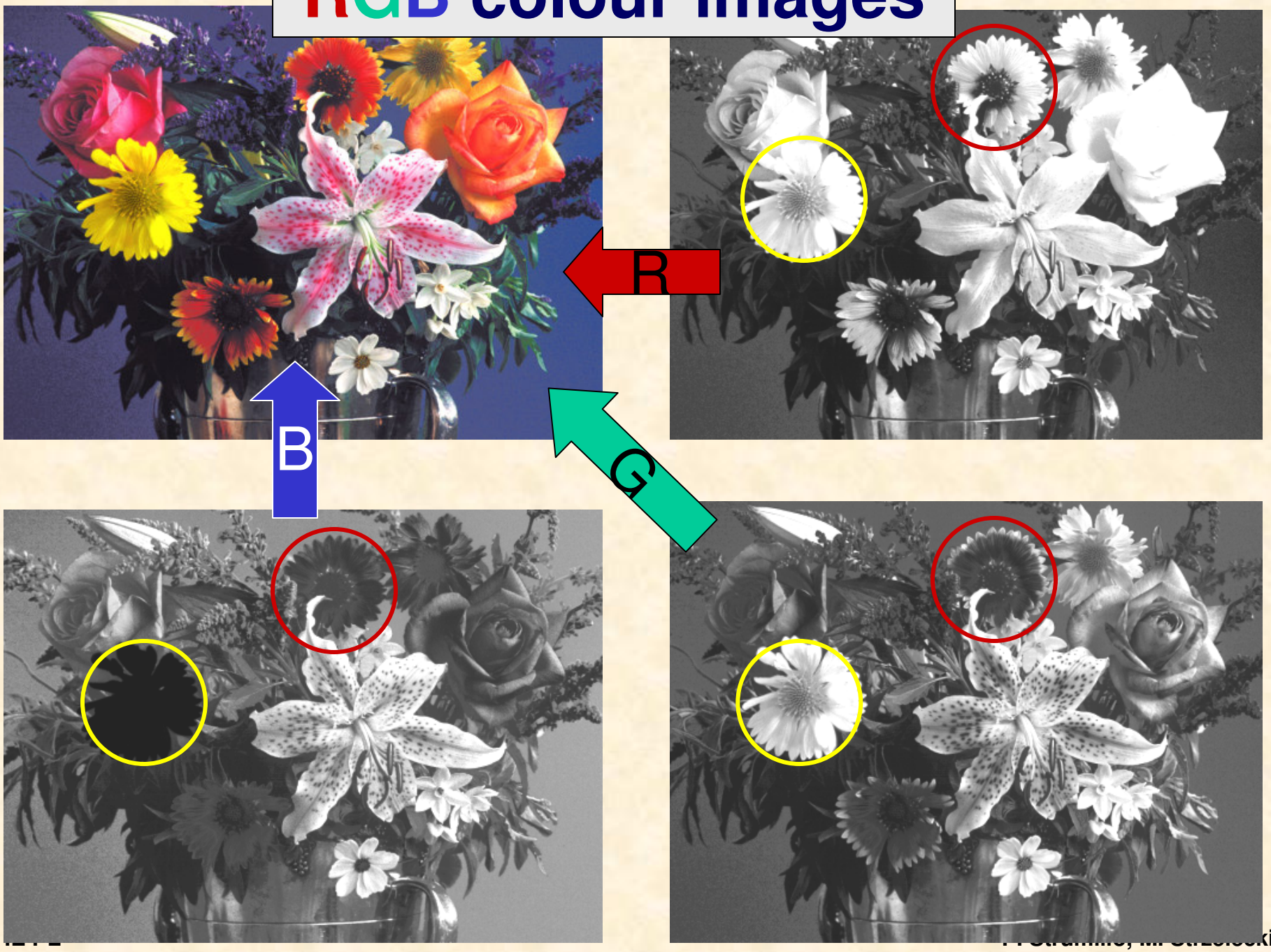
Commission Internationale de l'Eclairage (CIE)
Chromaticity Diagram

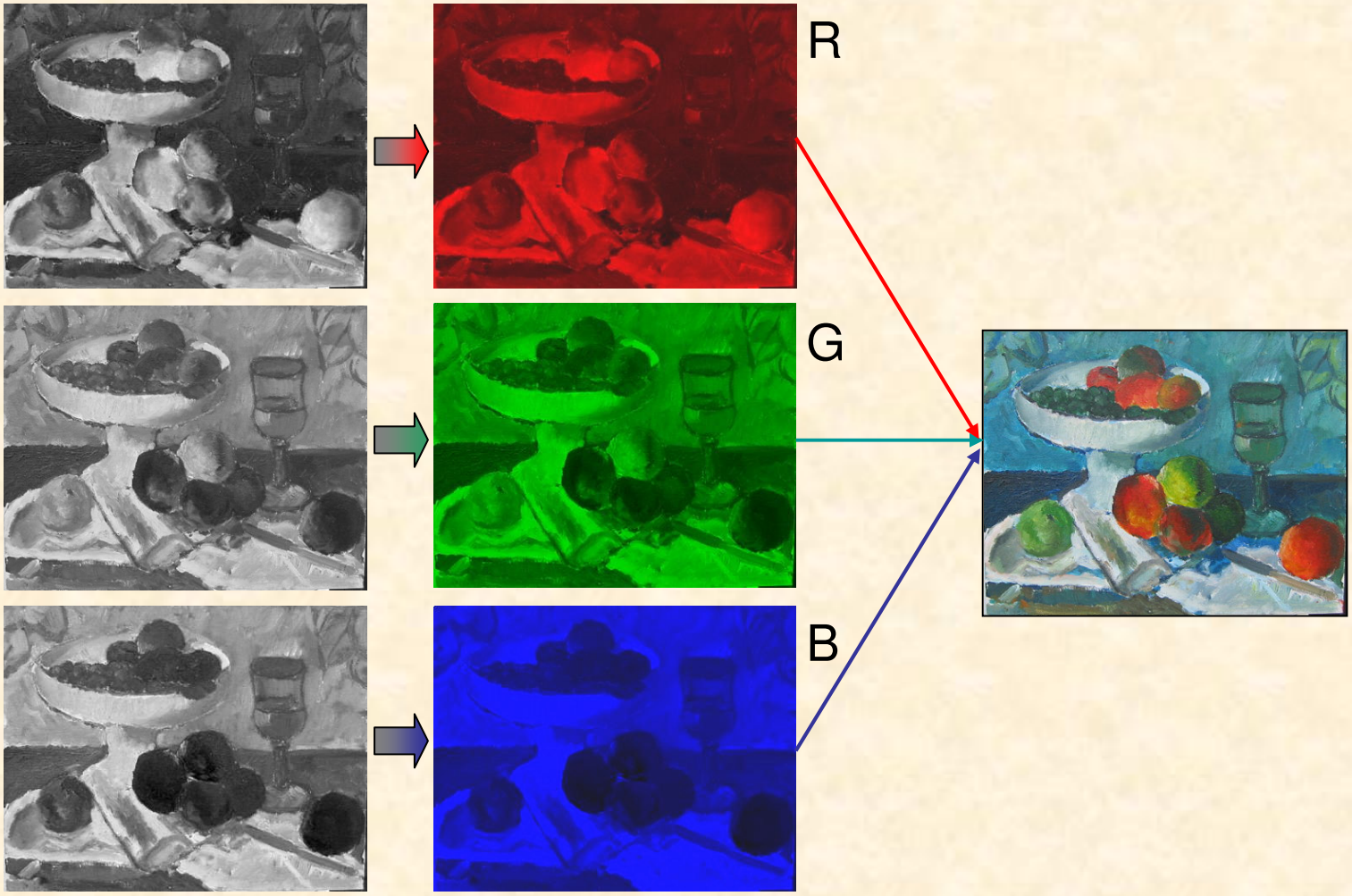


CIE diagrams all colours that can be humanly perceived

RGB colour images



RGB colour images



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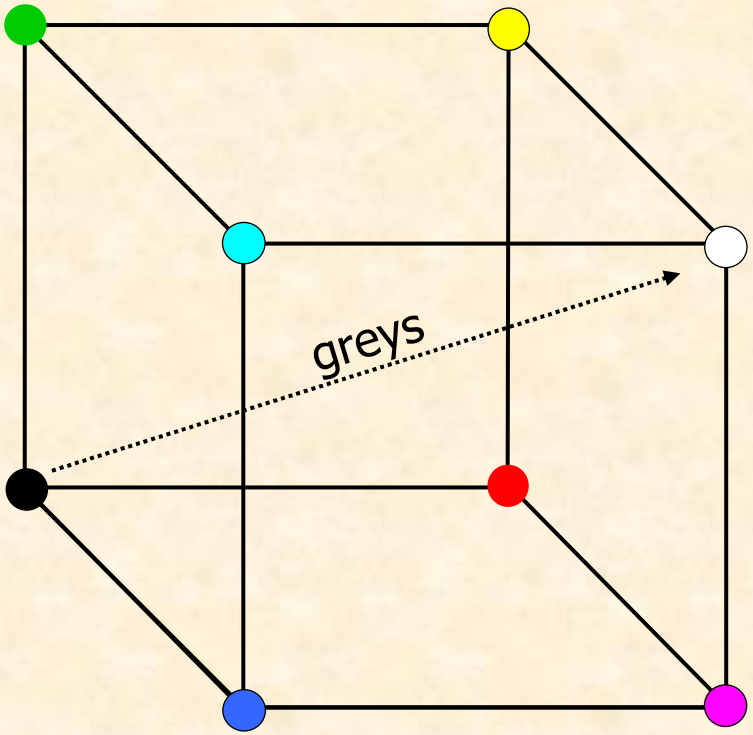
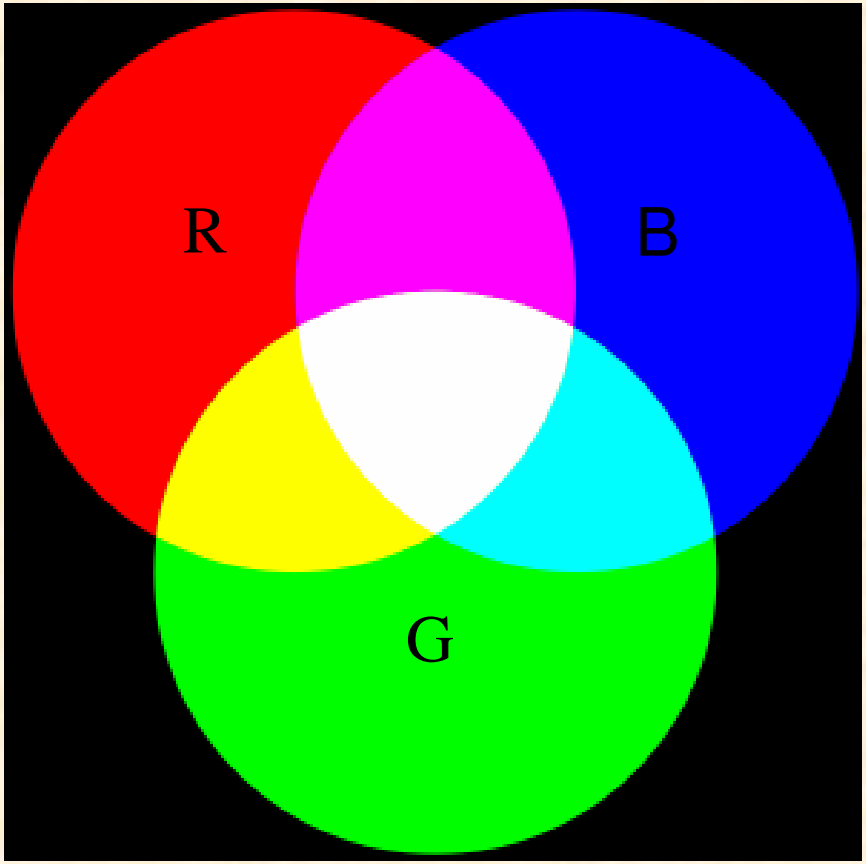
RGB colour space

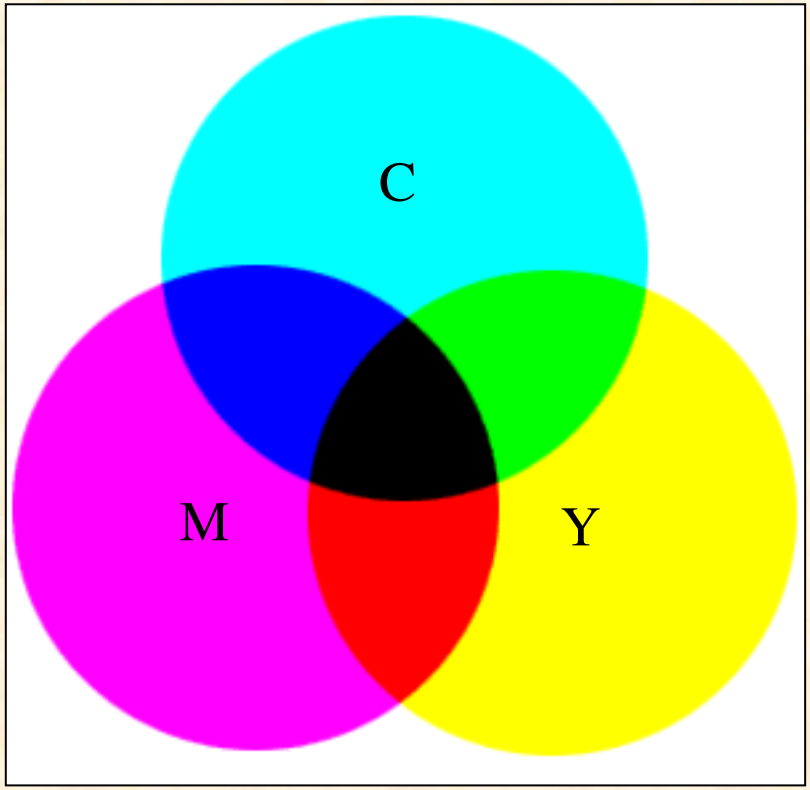


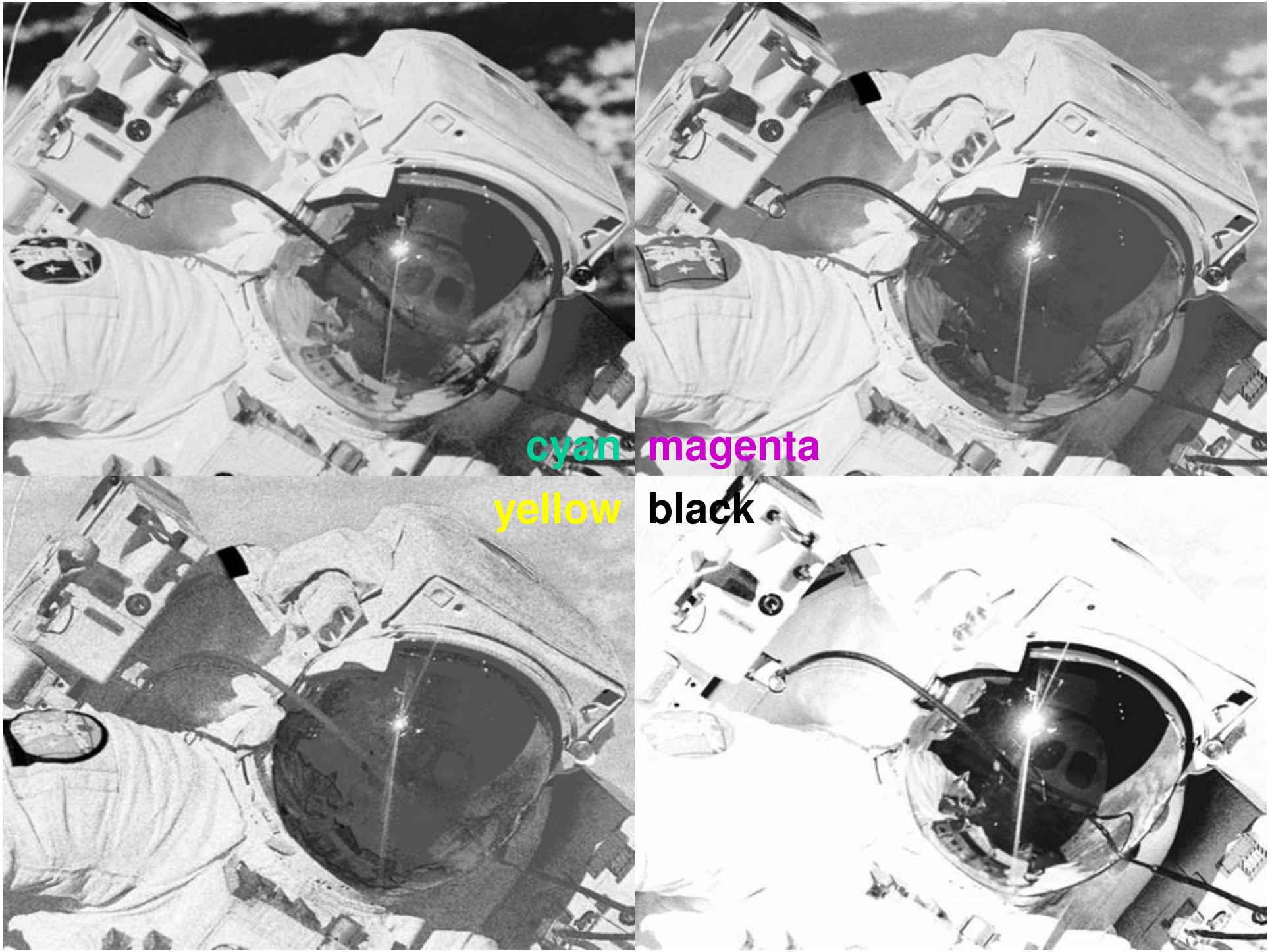
Each colour compoment (R,G,B) is registered and digitized in a separate video channel

RGB additive primaries

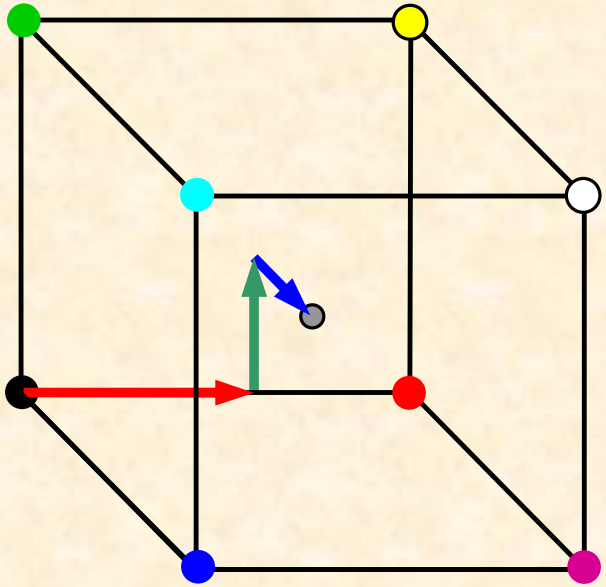


CMY subtractive primaries

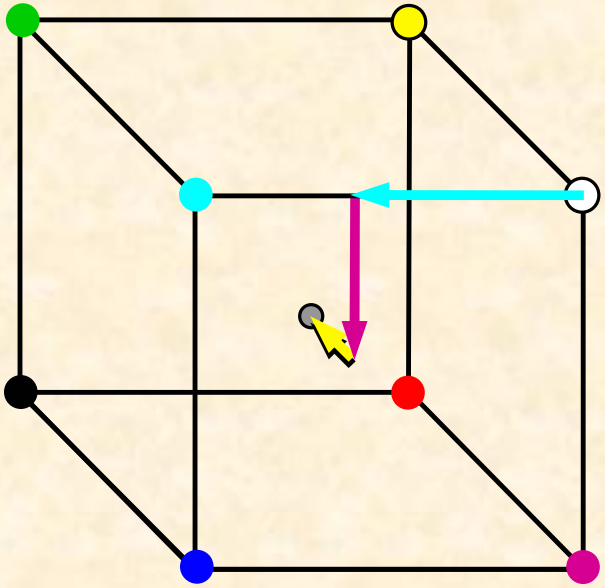



cyan
magenta
yellow
black

RGB and CMY colour systems

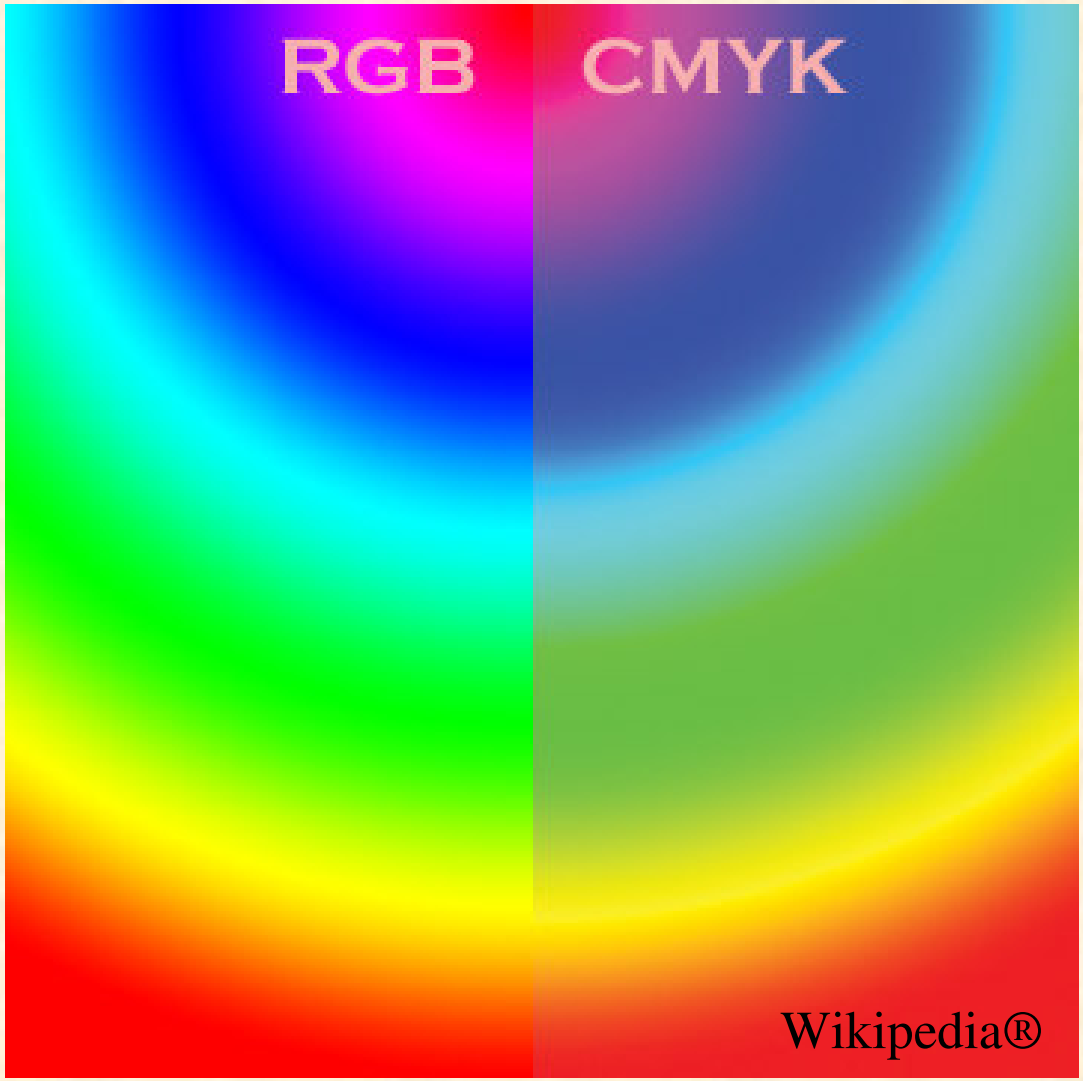


Adding additive primaries



Subtracting subtractive primaries

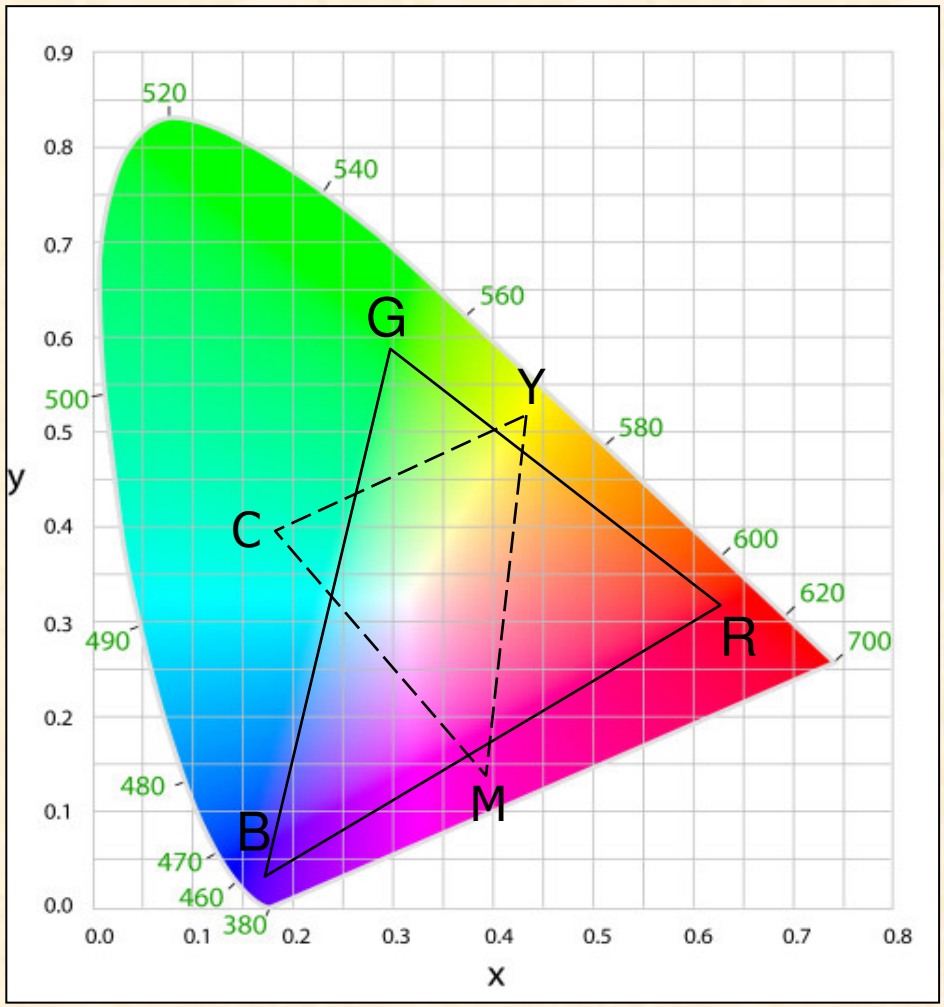
RGB and CMYK colour systems



K – stands for **black**, which is used as a fourth colour to improve the contrast of prints

RGB and CMY colour systems

RGB colours produced by typical CRT device (RGB colour gamut) and CMY colour printers (CMY colour gamut)



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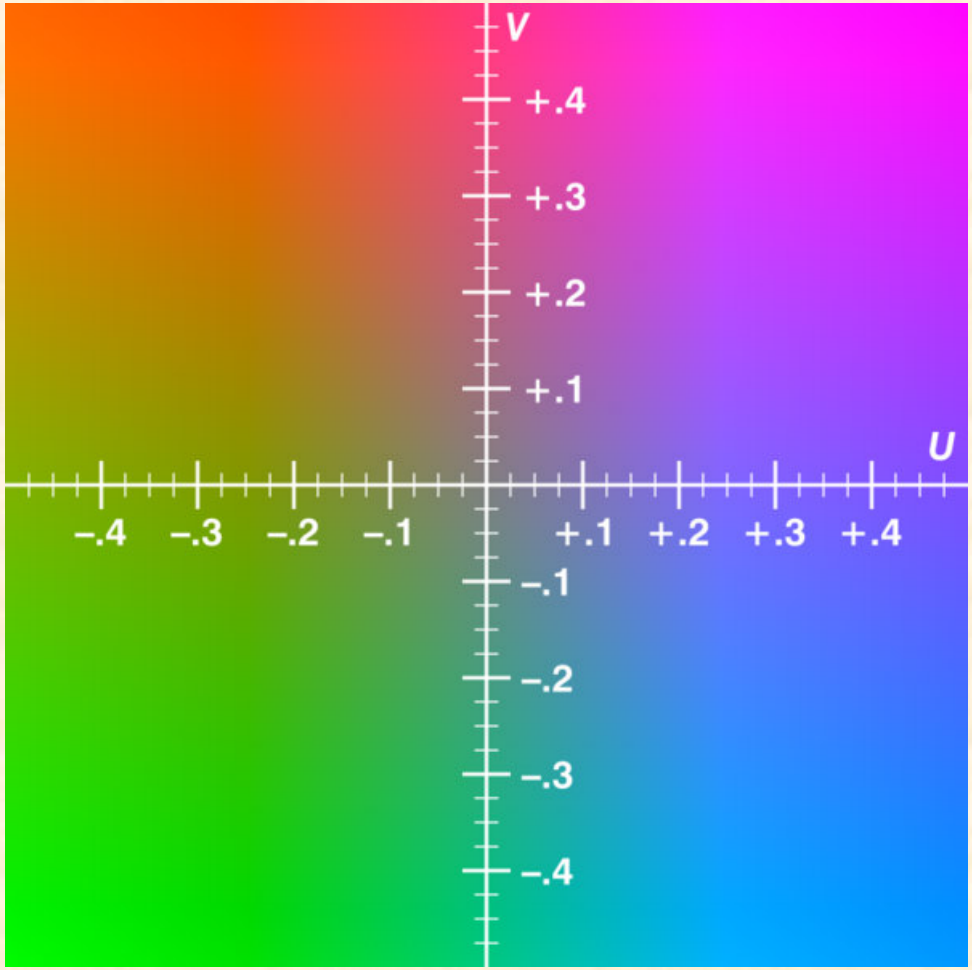
YIQ (YUV) colour space

Y is a luminance component and is a linear combination of (R,G,B)
(I,Q) are the chrominance (colour)components.



Y – luminance,

I – inphase,

Q – quadrature

NTSC system

YUV ≠ YCbCr

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Equivalence of colour spaces

There exist a one-to-one mapping between RGB and YIQ systems.

$$Y=0.299R + 0.587G + 0.114B \qquad R=Y + 0.956I + 0.621Q$$

$$I = 0.596R - 0.274G - 0.322B \qquad G=Y - 0.272I + 0.647Q$$

$$Q=0.211R - 0.523G + 0.312B \qquad B=Y - 1.106I + 1.703Q$$

For a human eye perception a better approach is is to code separately luminance and chrominance components (S-Video)

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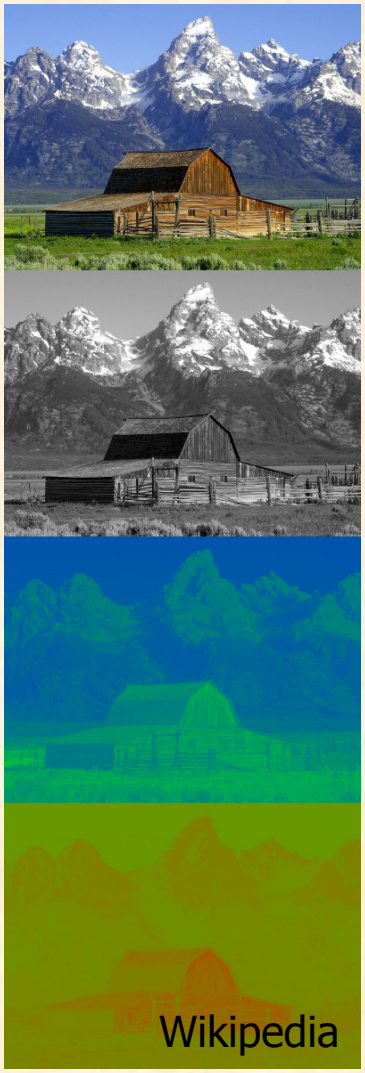
YUV and YCbCr

YUV – used in NTSC TV system



Y=0.299 *R + 0.587*G +0.114 *B

luminance

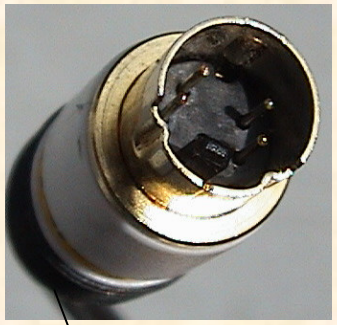
chrominance

U = 0.49*(B – Y)

V = 0.88*(R – Y)

YUV and YCbCr

A standard diffrent from YUV in chrominance components

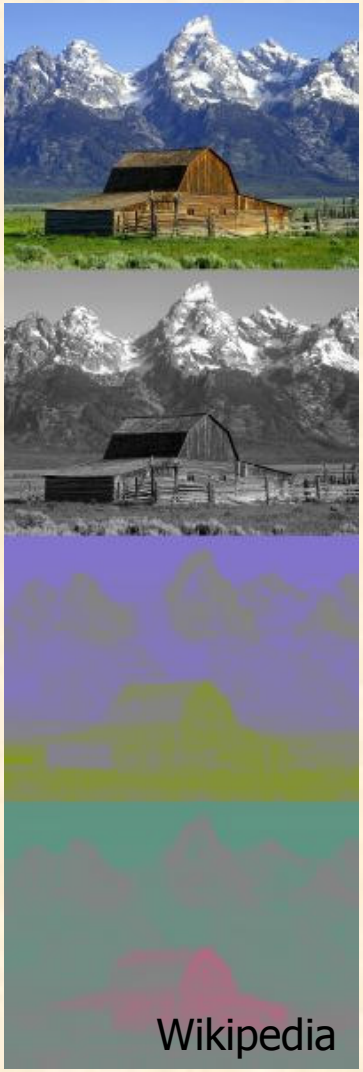


S-video

Y=0.299 *R + 0.587*G +0.114 *B

Cb = -0.17 *R - 0.5*G +0.5*B

Cr = 0.5 *R - 0.42*G -0.08*B



RGB

Y

Cb

Cr

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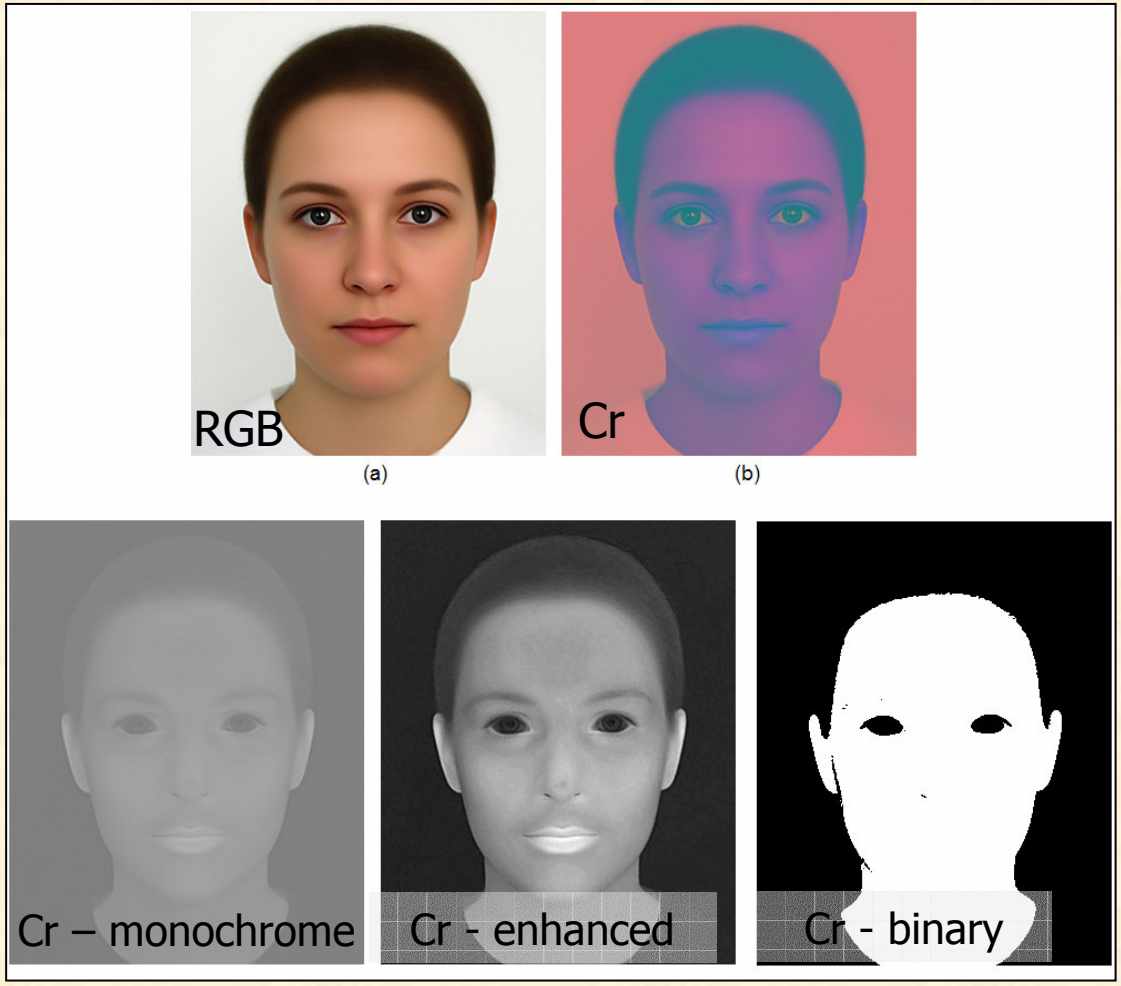
YCbCr

Use of **Cr** colour component for detection of skin regions in images (not dependent on skin colour)



PhD work of A. Królak at the Medical Electronics Division

Filtering of colour images in spatial domain

Another possible approach:

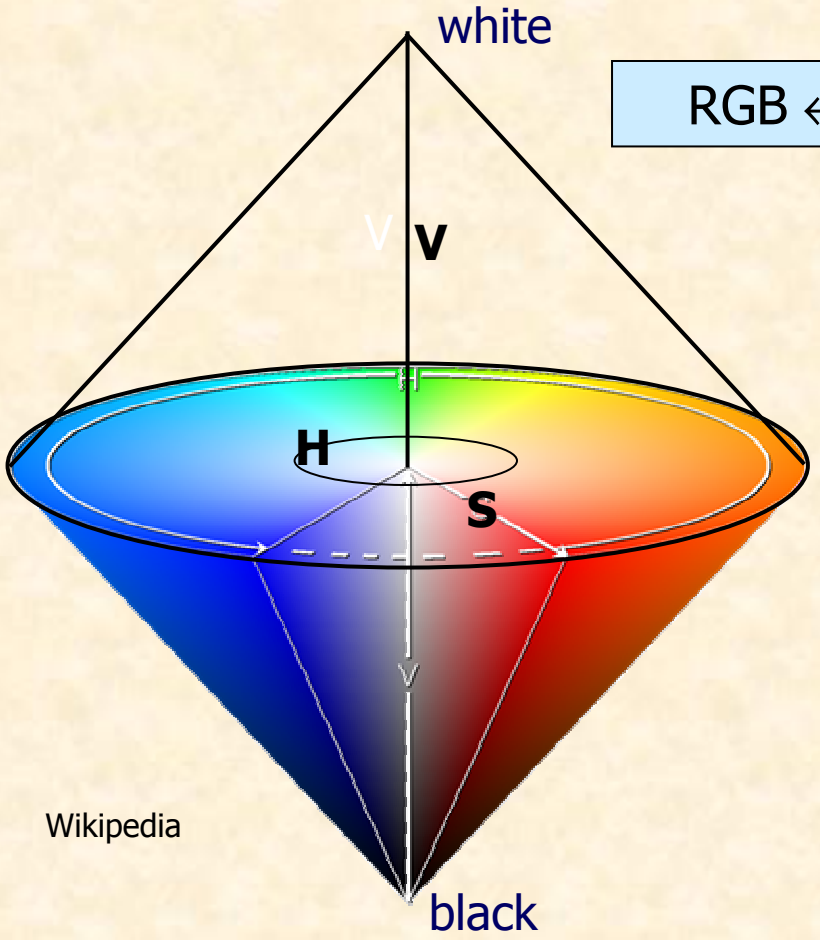
1. Convert from RGB to YCbCr
2. Filter the Y (luminance) component and keep the colours (Cb,Cr) unchanged
3. Convert back to RGB

High pass filtering of the Y component


```
%Matlab
h=fspecial('unsharp');
ys=filter2(h,y);
```

HSI (HSV) colour system

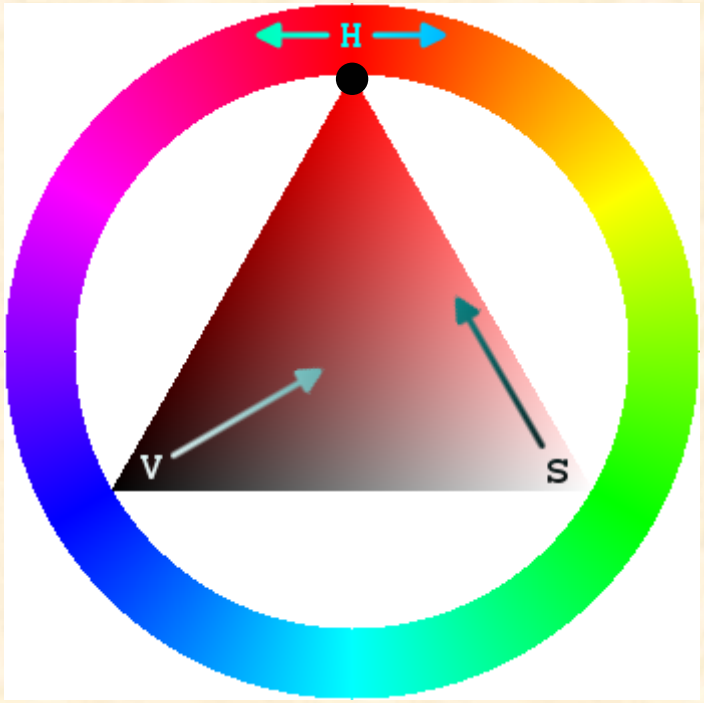
H - hue, S - saturation, I - intensity



Wikipedia

RGB ↔ HSI

Useful in designing colour graphics



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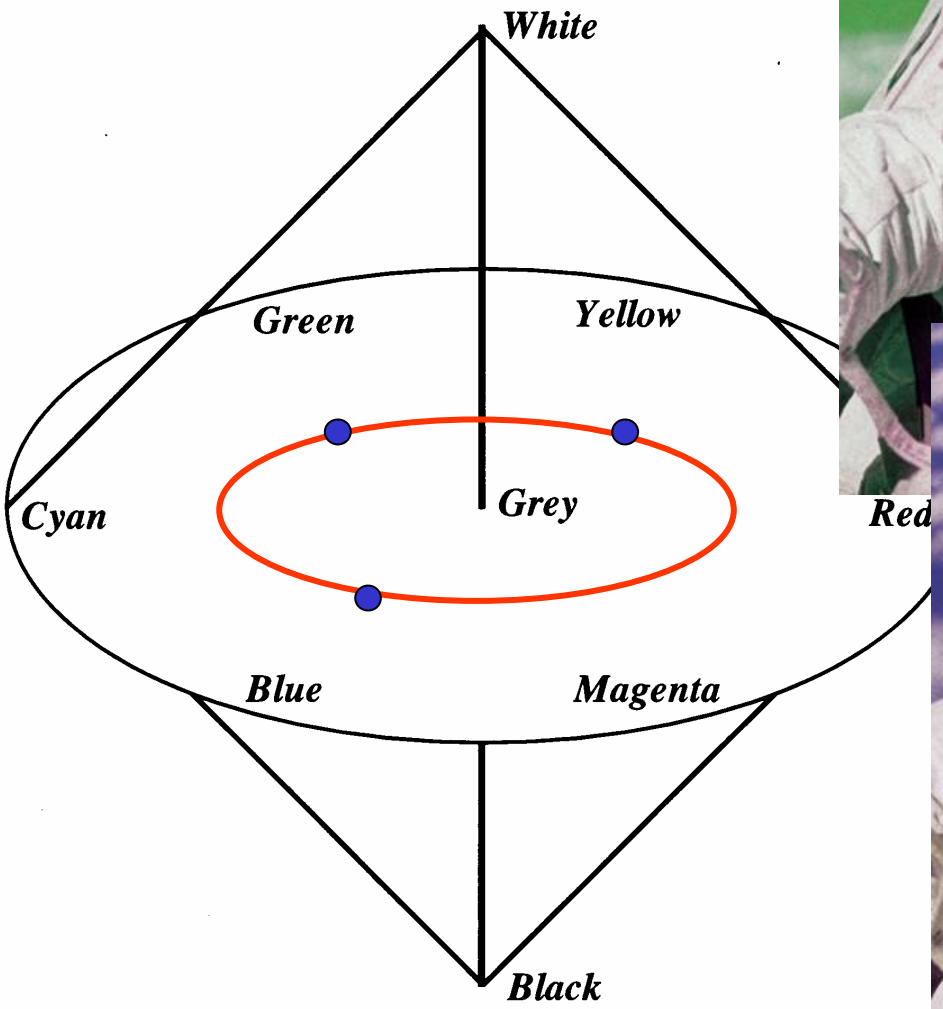
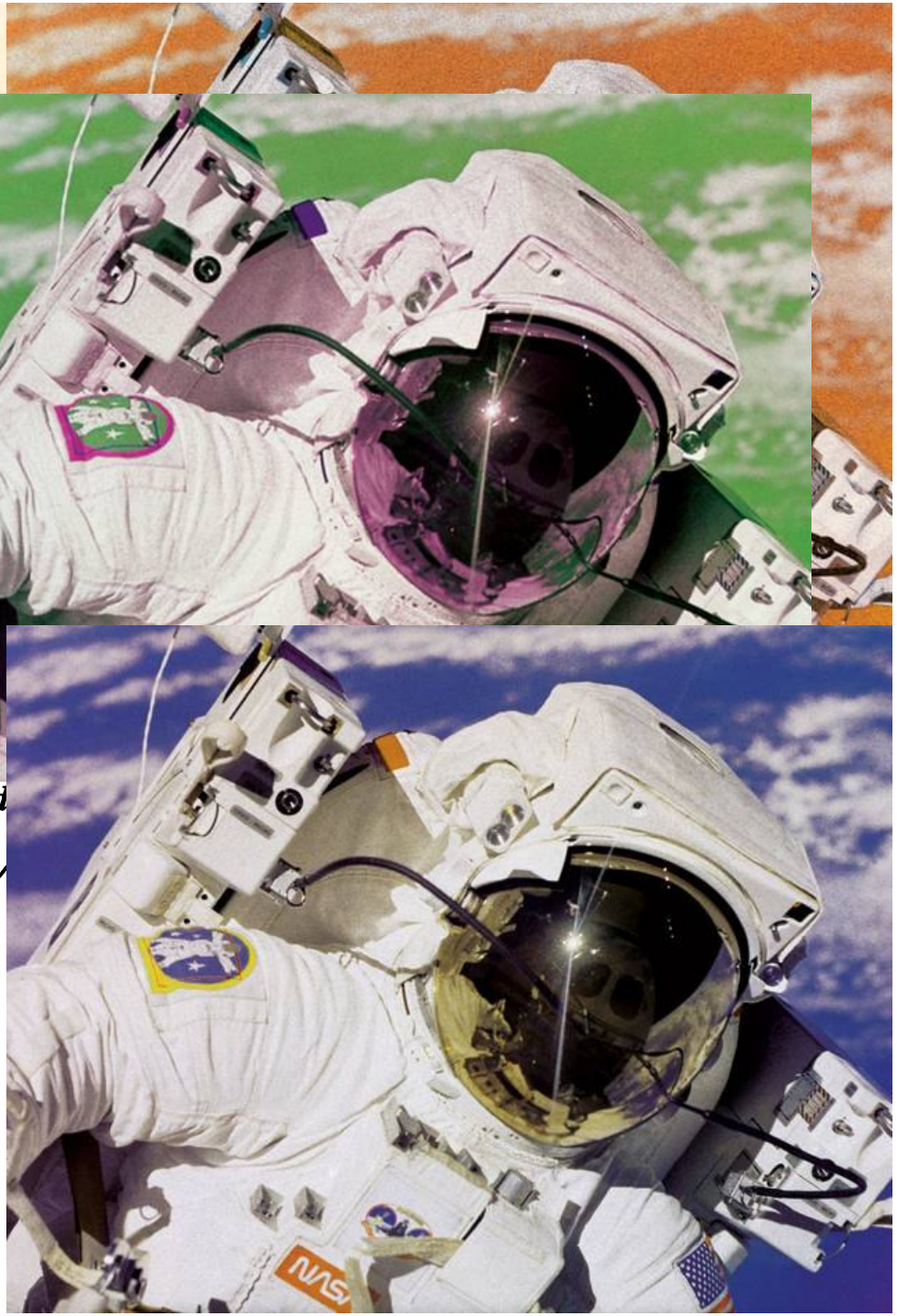
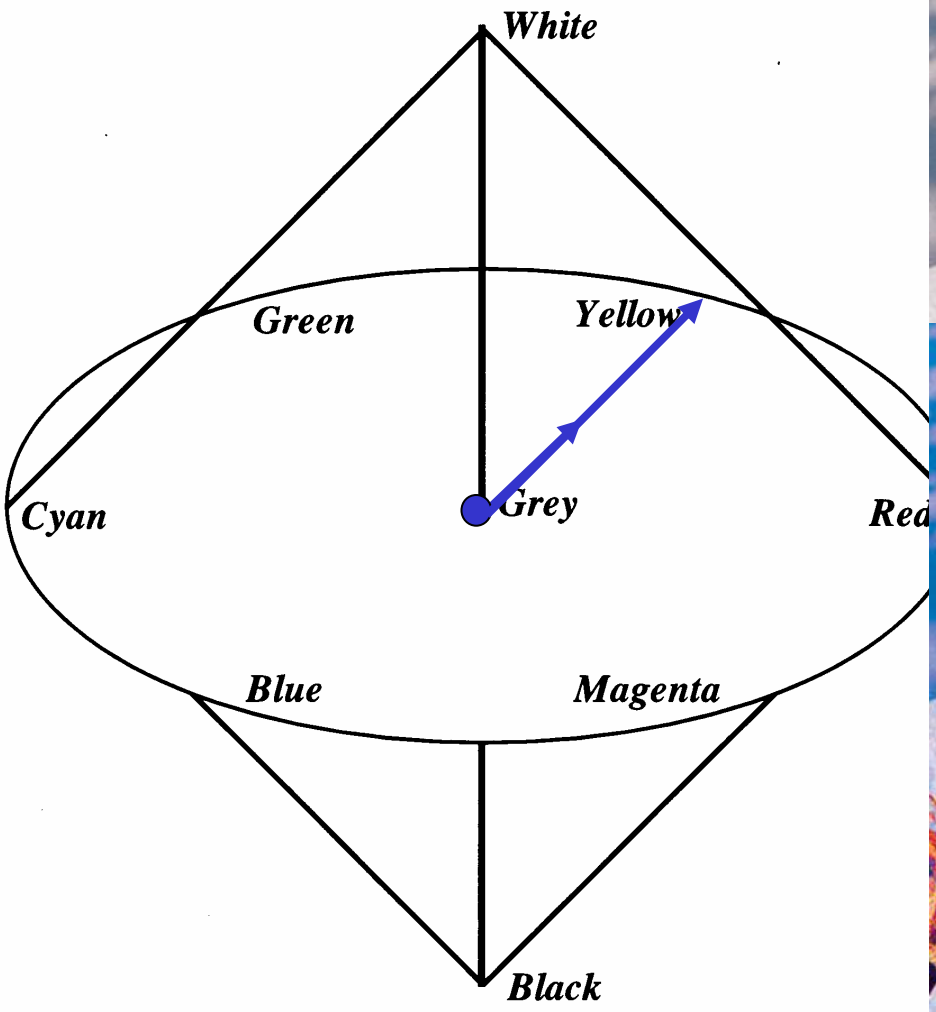
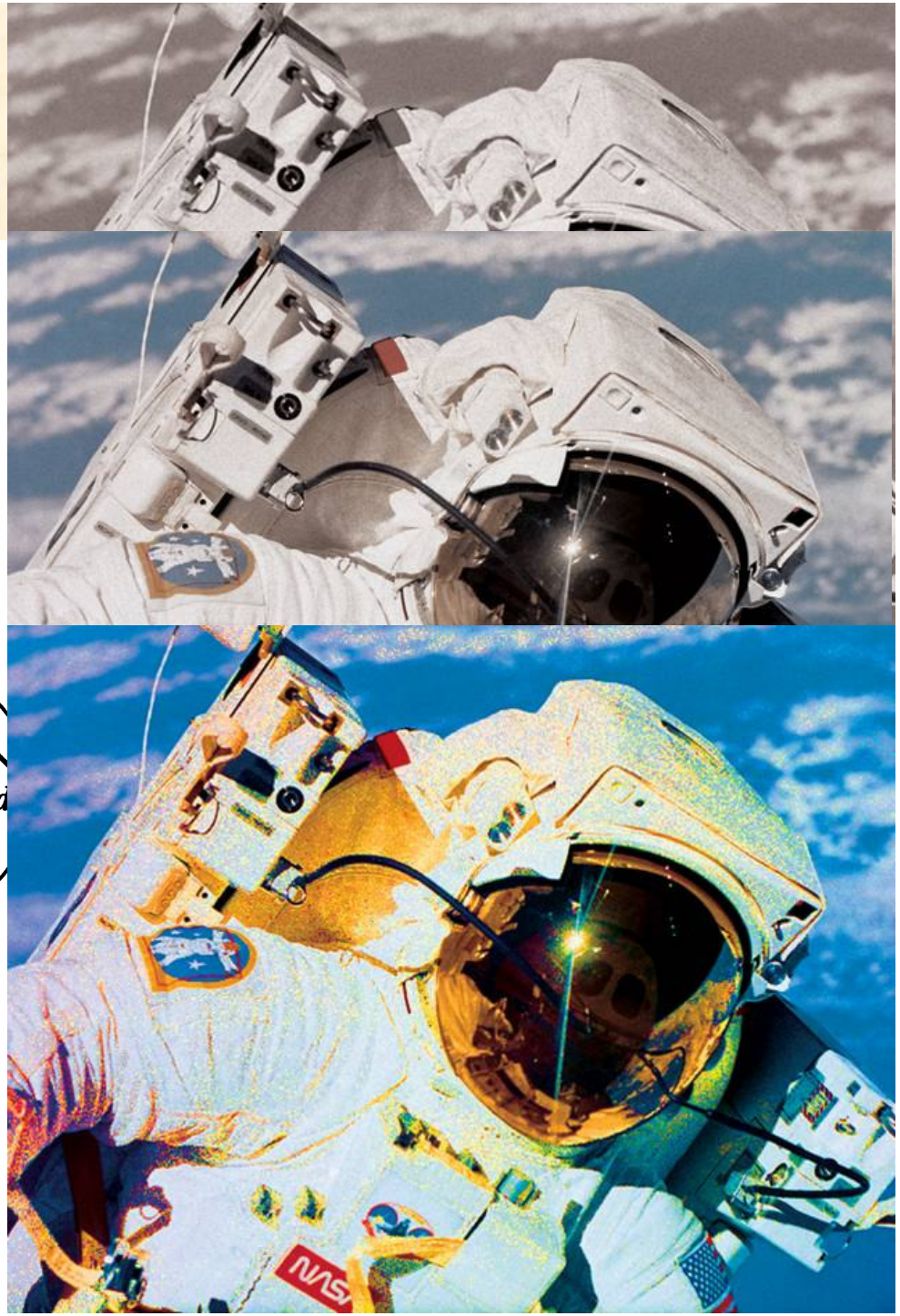
Hue



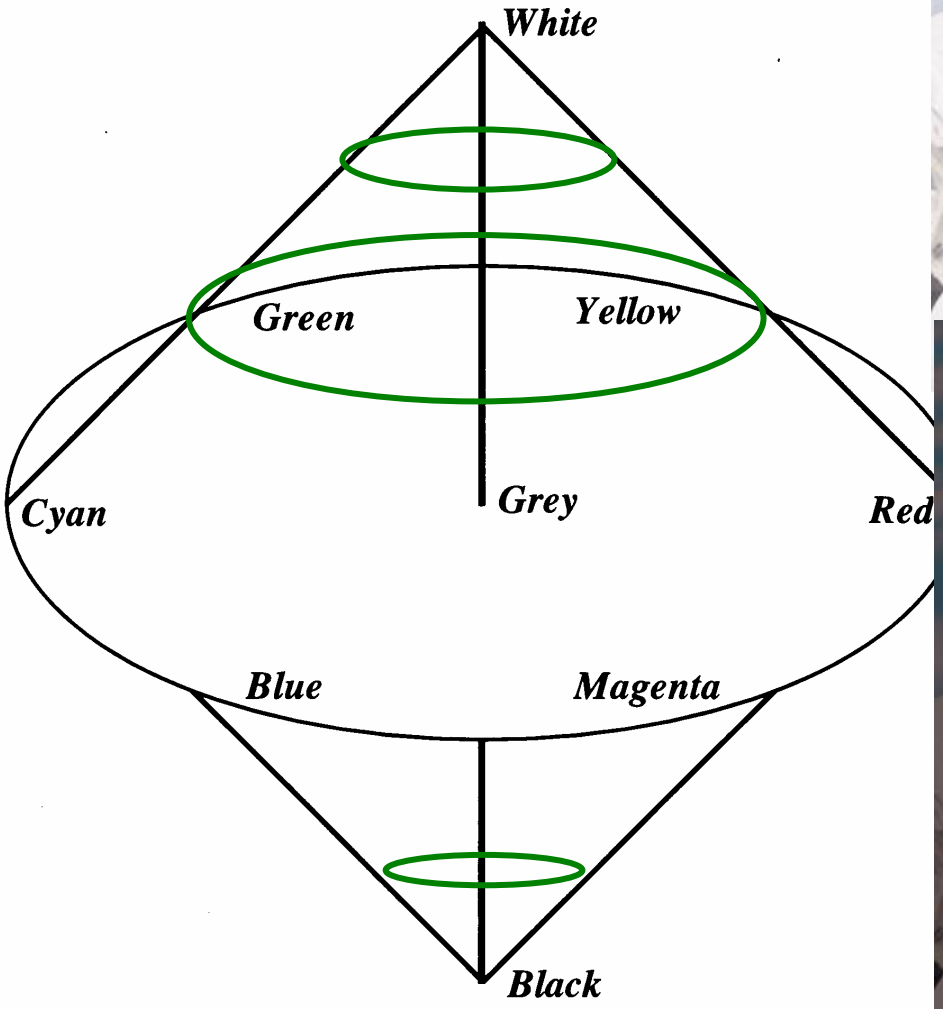


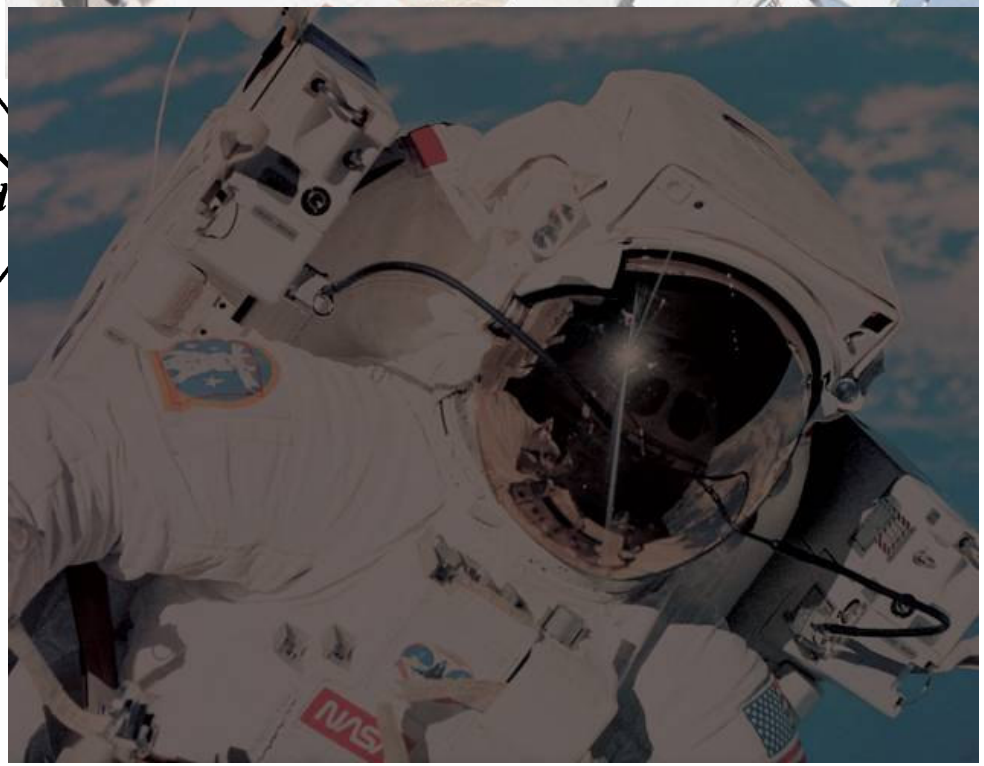
Saturation



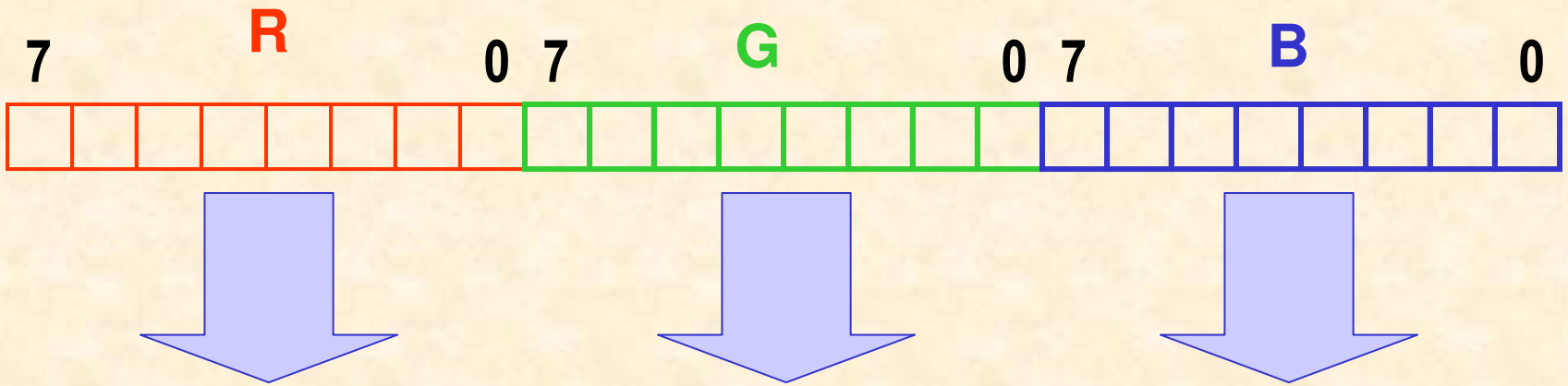


Intensity (Value)

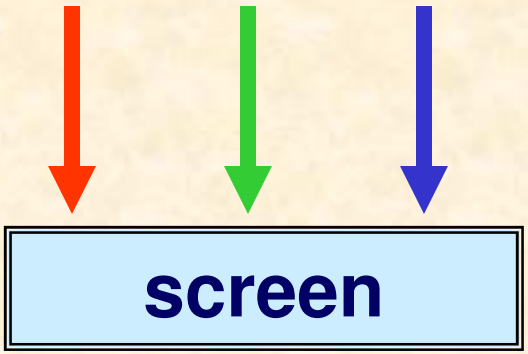




Colour coding in SVGA graphics cards



Digital to Analog Converter (DAC) 3 x 8 bits



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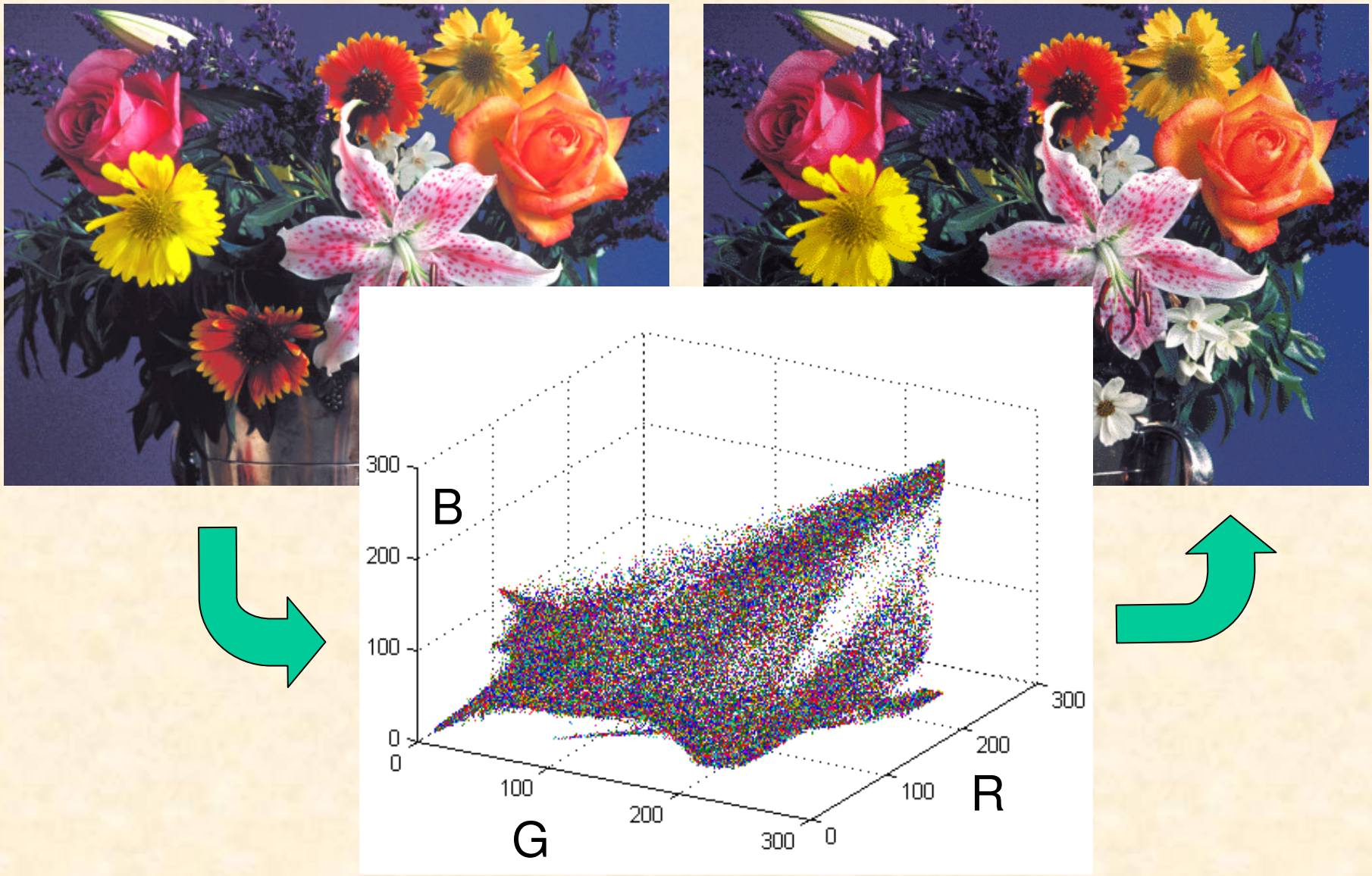
Colour resolutions in PC computers

- True-colour: 2^{24} colours -> 16777216
- High-colour: 2^{16} colours -> 65536 (R5, G6, B5)
- 256 colours (indexed colours from look-up-table)

RGB to indexed image



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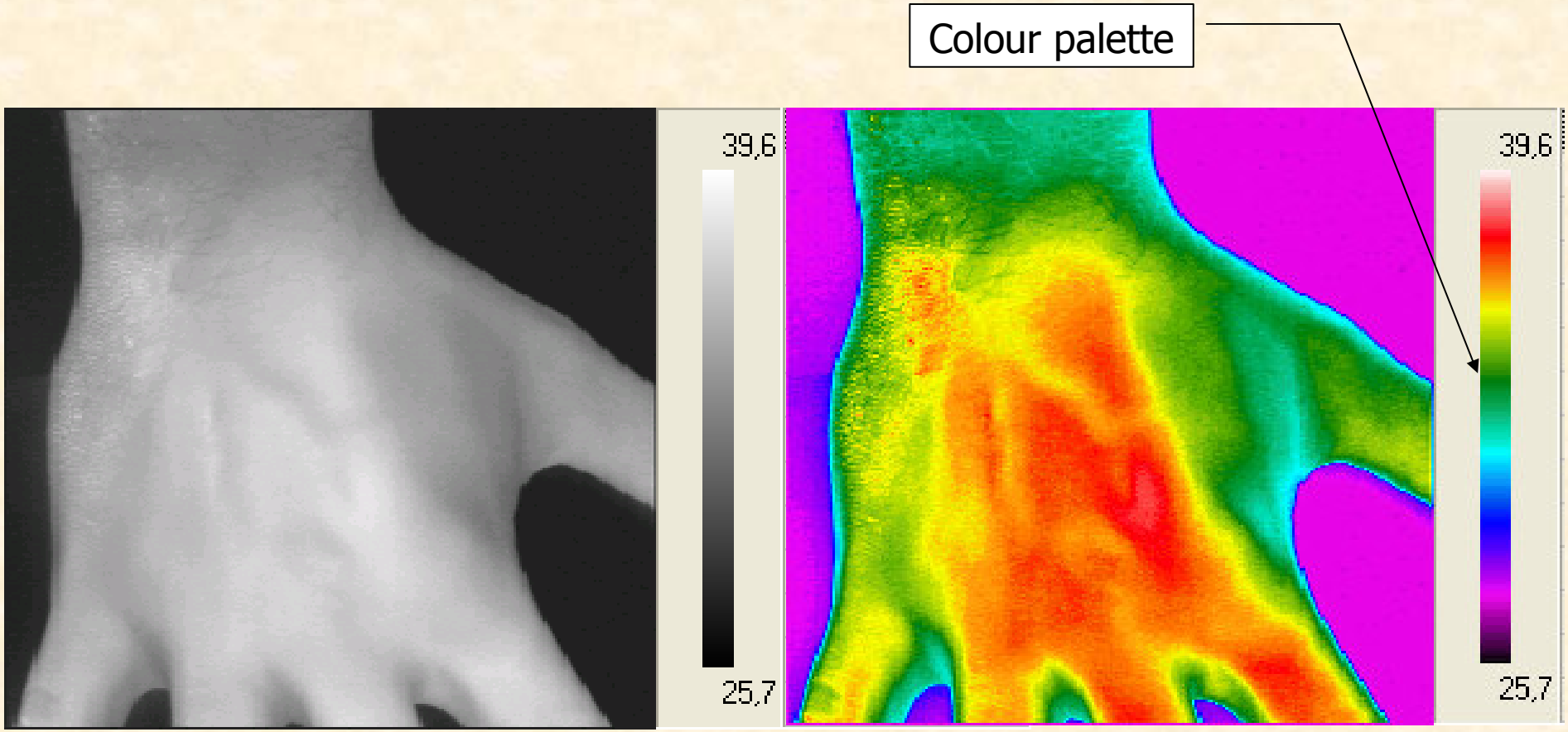
Indexed images in thermography



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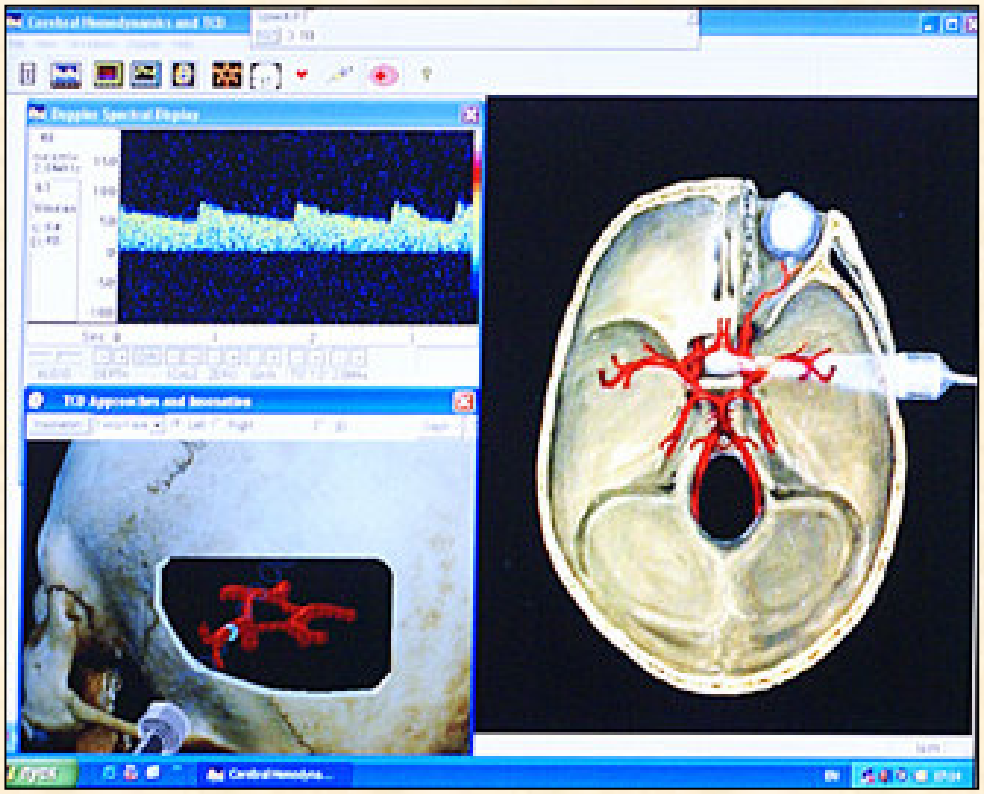
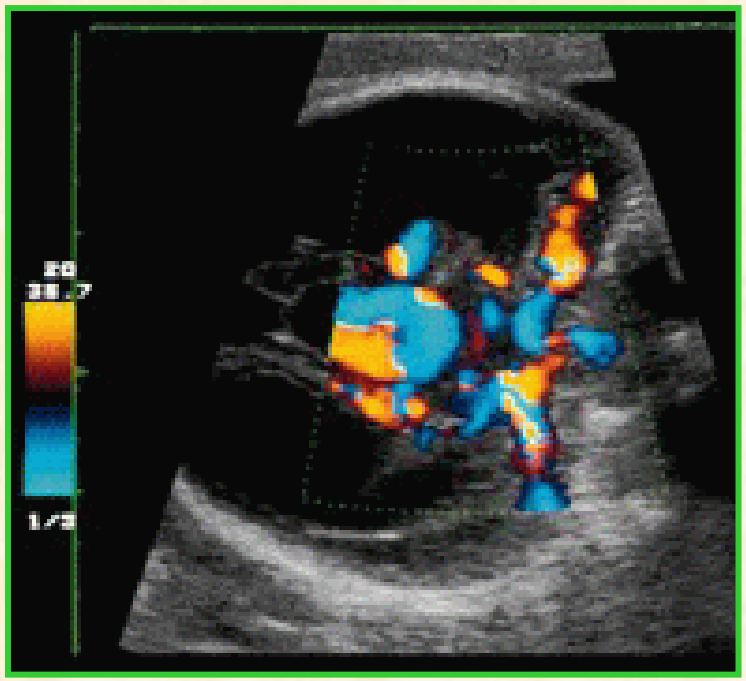
Indexed images in medicine





Psudo-colours represent blood flow velocity

Images recorded in the Moscow Institute of Electronic Technologies

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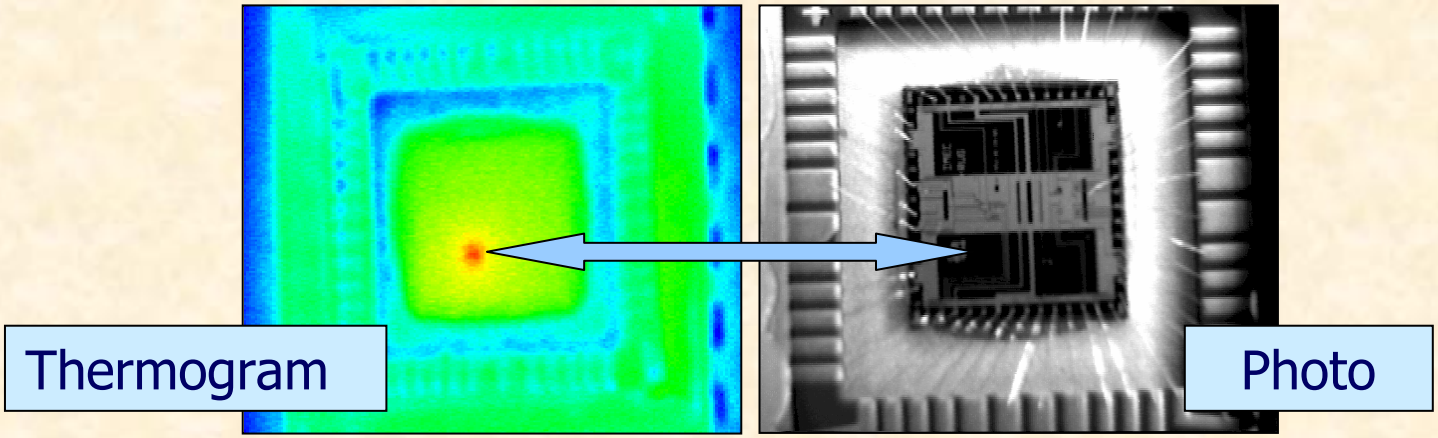
Multimodal images

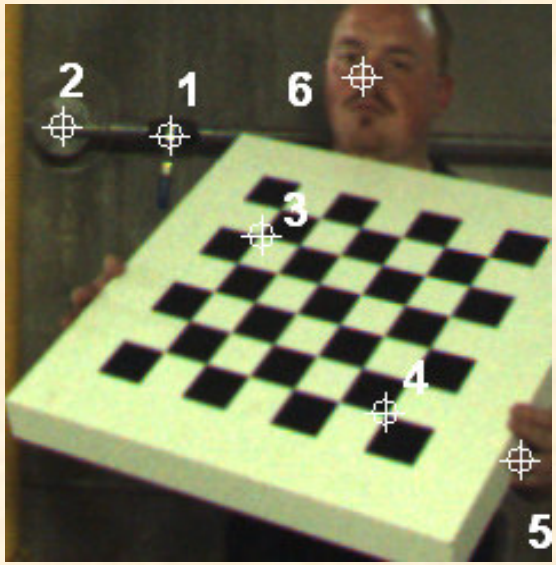
Multimodal images come from different imaging techniques of the same objects, these images are called **modalities**

Different modalities of an integrated circuit

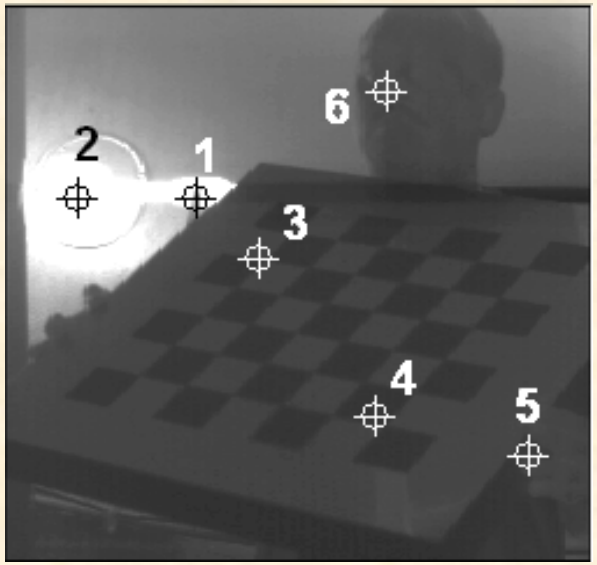


~2μm 380-700 *nm*

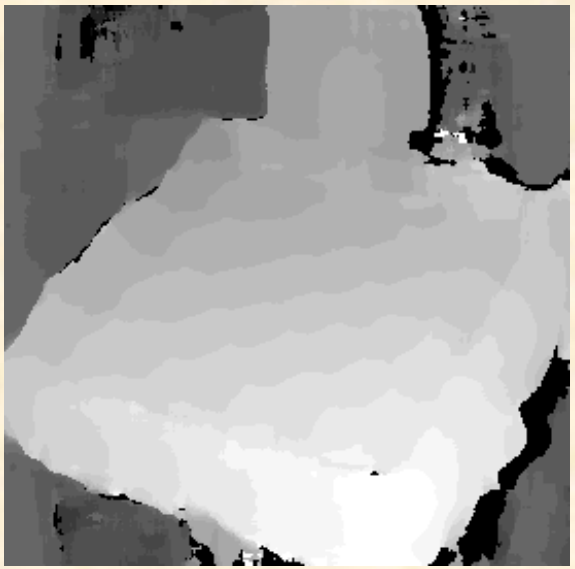
Multimodal images



RGB image



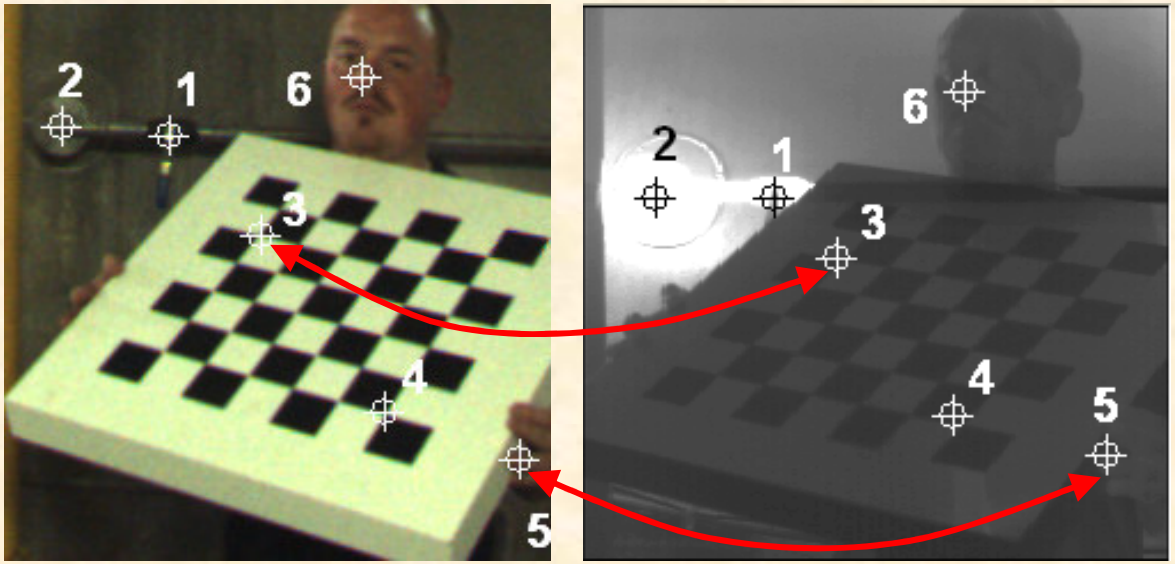
Thermographic image



Stereovision image
(depth map)

Multimodal images

Matching (***Registration***) – geometric transformation of different modalities into one coordinate system



1. Detection of the same characteristic points
2. Matching

Reference points method

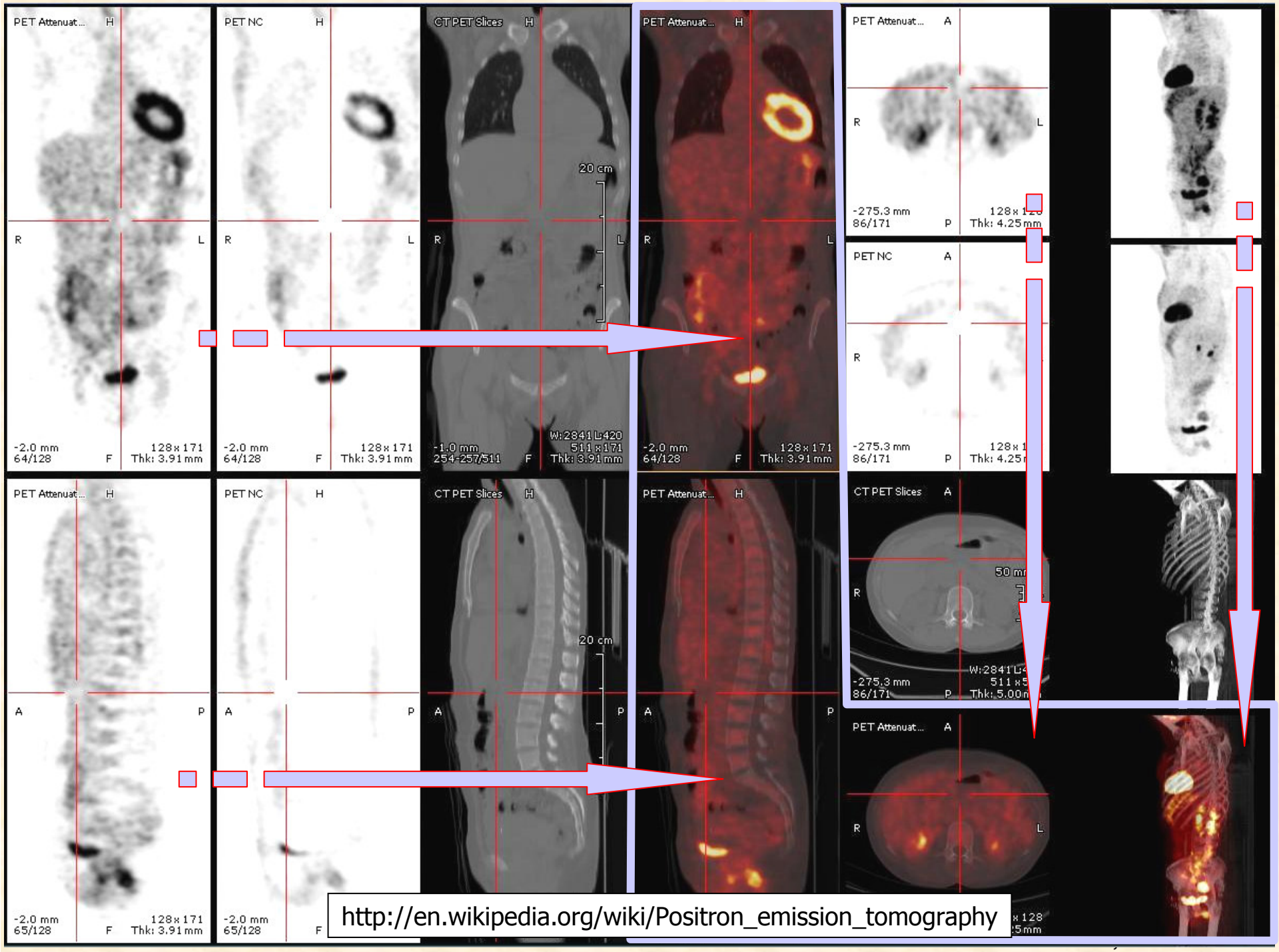
Multimodal images

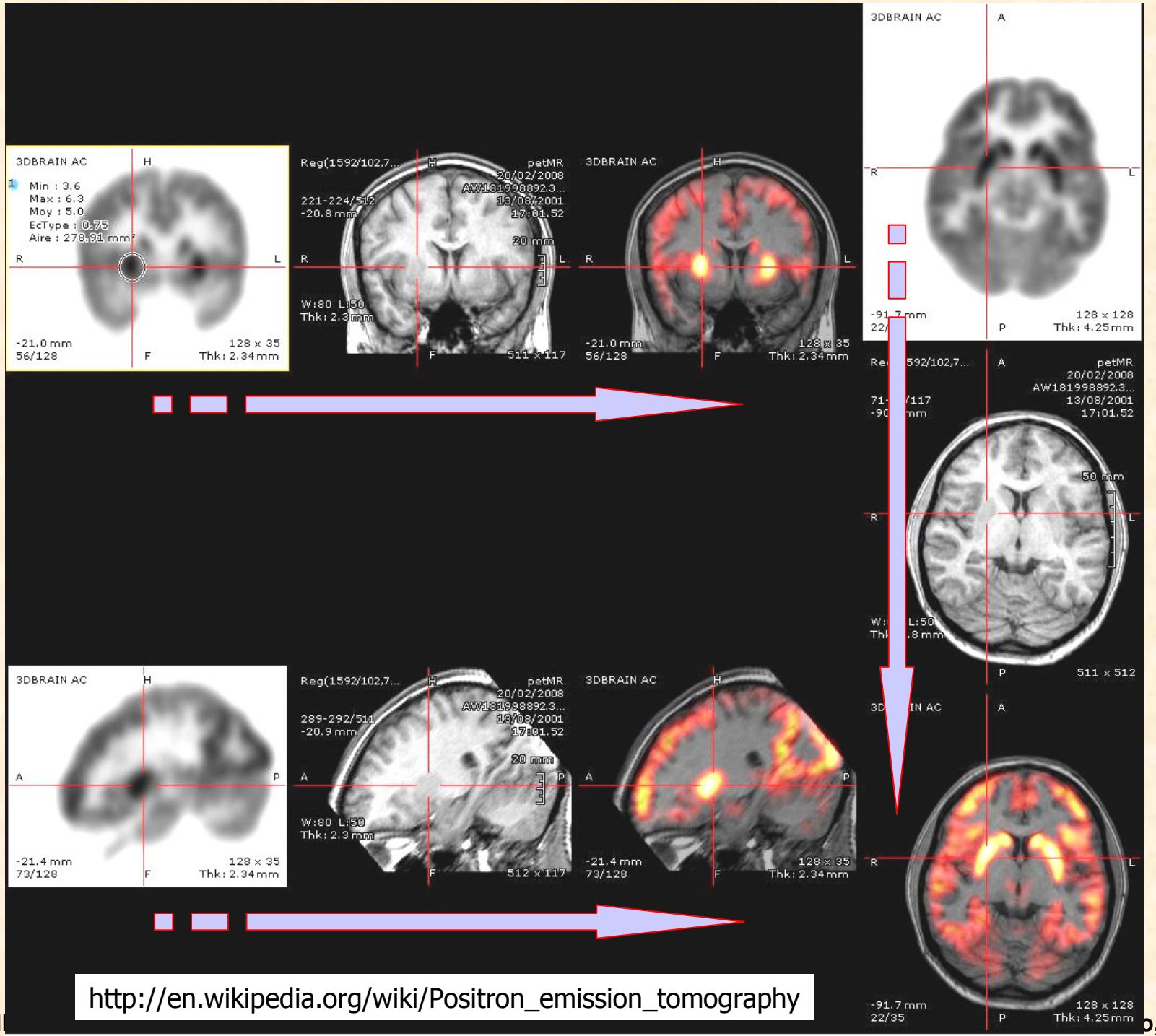
Image fusion is combining of modalities for display into a single image.

Next slades show PET and CT modalities and their fusion techniques.

[The images are dowloaded from public domain repository:

http://en.wikipedia.org/wiki/Positron_emission_tomography]

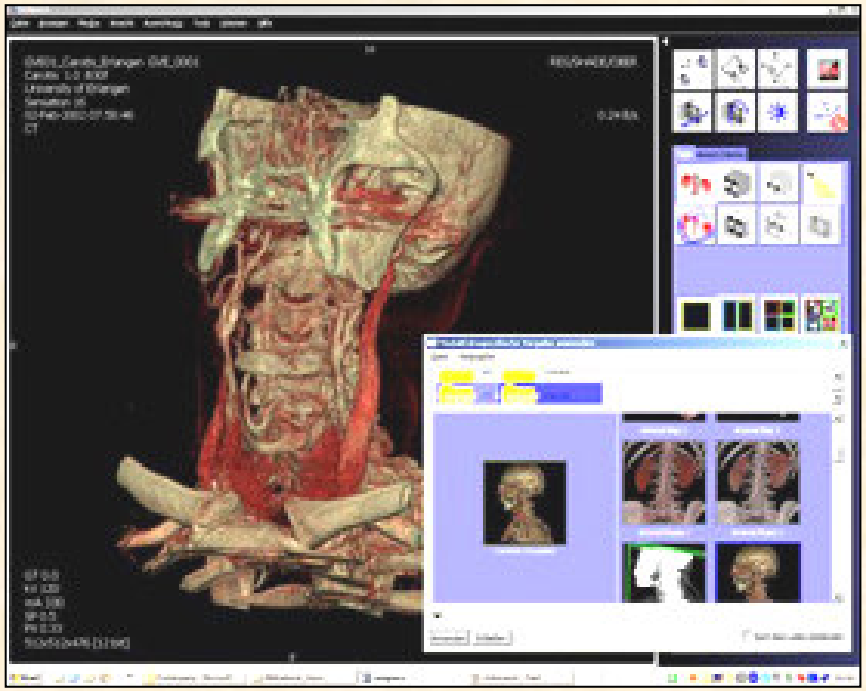

PET Attenuat... H
PET NC H
CT PET Slices H
PET Attenuat... H
PET Attenuat... A
PET NC A
CT PET Slices A
PET Attenuat... A
20 cm
50 mm
R
L
A
P
-2.0 mm
64/128
F
128 x 171
Thk: 3.91 mm
-1.0 mm
254-257/511
W:2841 L:420
511 x 171
-275.3 mm
86/171
P
Thk: 4.25 mm
Thk: 5.00 mm
65/128
http://en.wikipedia.org/wiki/Positron_emission_tomography

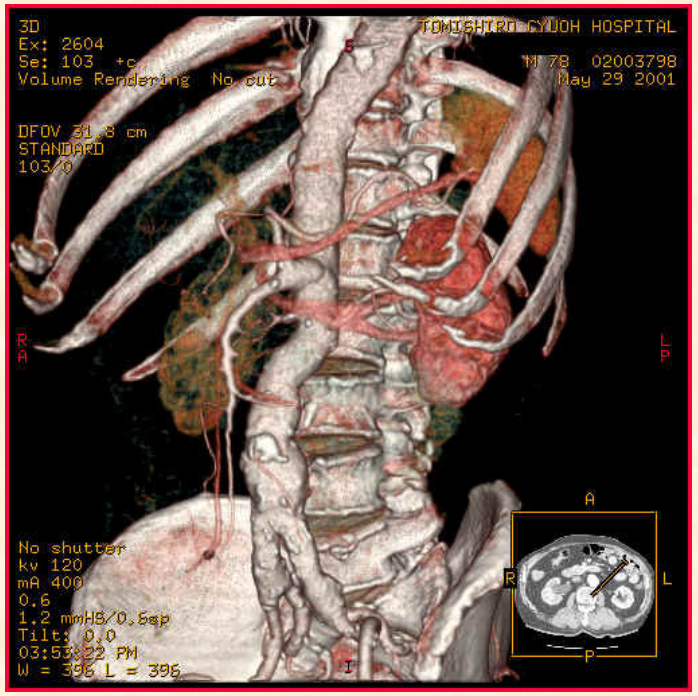


PET + CT

http://en.wikipedia.org/wiki/Positron_emission_tomography

3D image fusion





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