

DIGITAL CINEMATOGRAPHY COLOR SCIENCE BASICS

KEY NOTES

- luminance information vs. chrominance information
- bit depth
- sampling
- rec.709
- correct / grade / time

LUMINANCE

LUMA: brightness information

- abundant; no distinguishable detail, over exposed (**WHITE**)
- deficient; no distinguishable detail, under exposed (**BLACK**)
- component; **Y** is used for mathematical variable



Digital Y'CbCr (8 bits per sample) is derived from analog R'G'B' as follows:

$$Y' = 16 + (65.481 \cdot R' + 128.553 \cdot G' + 24.966 \cdot B')$$

$$C_B = 128 + (-37.797 \cdot R' - 74.203 \cdot G' + 112.0 \cdot B')$$

$$C_R = 128 + (112.0 \cdot R' - 93.786 \cdot G' - 18.214 \cdot B')$$

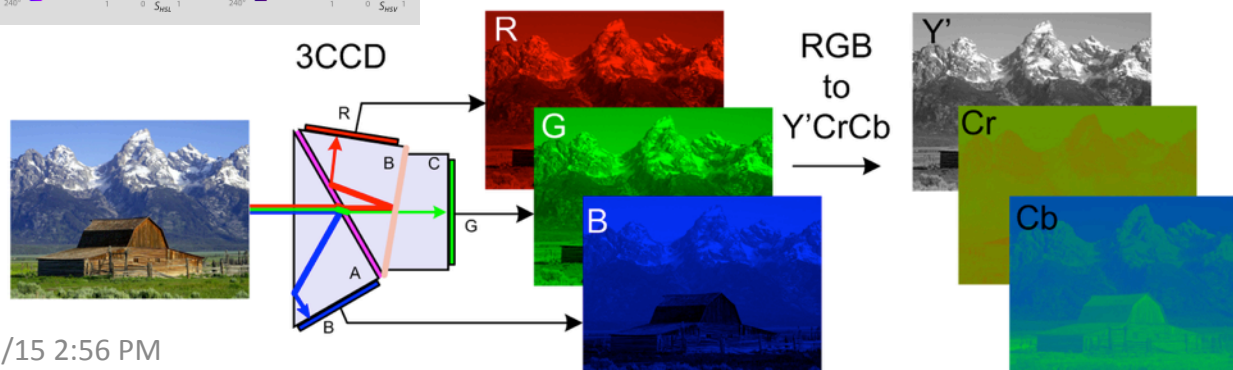
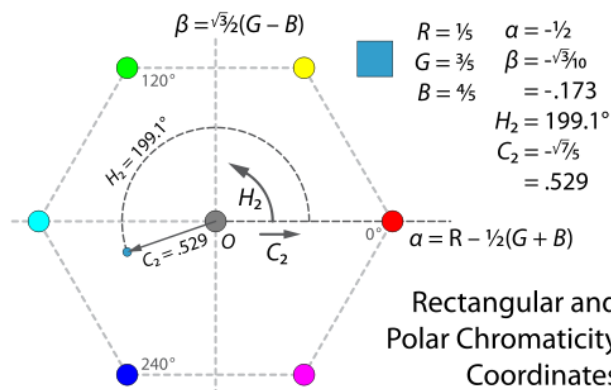
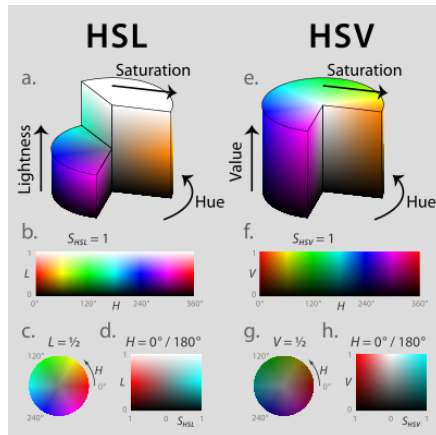
or simply componentwise

$$(Y', C_B, C_R) = (16, 128, 128) + (219 \cdot Y, 224 \cdot P_B, 224 \cdot P_R)$$

CHROMINANCE

CHROMA: color information

- prime colors; red, green, blue (**RGB**)
- effective relationship with luma (**HUE, SATURATION**)
- components; **C_B**, **C_R** are used for mathematical variables



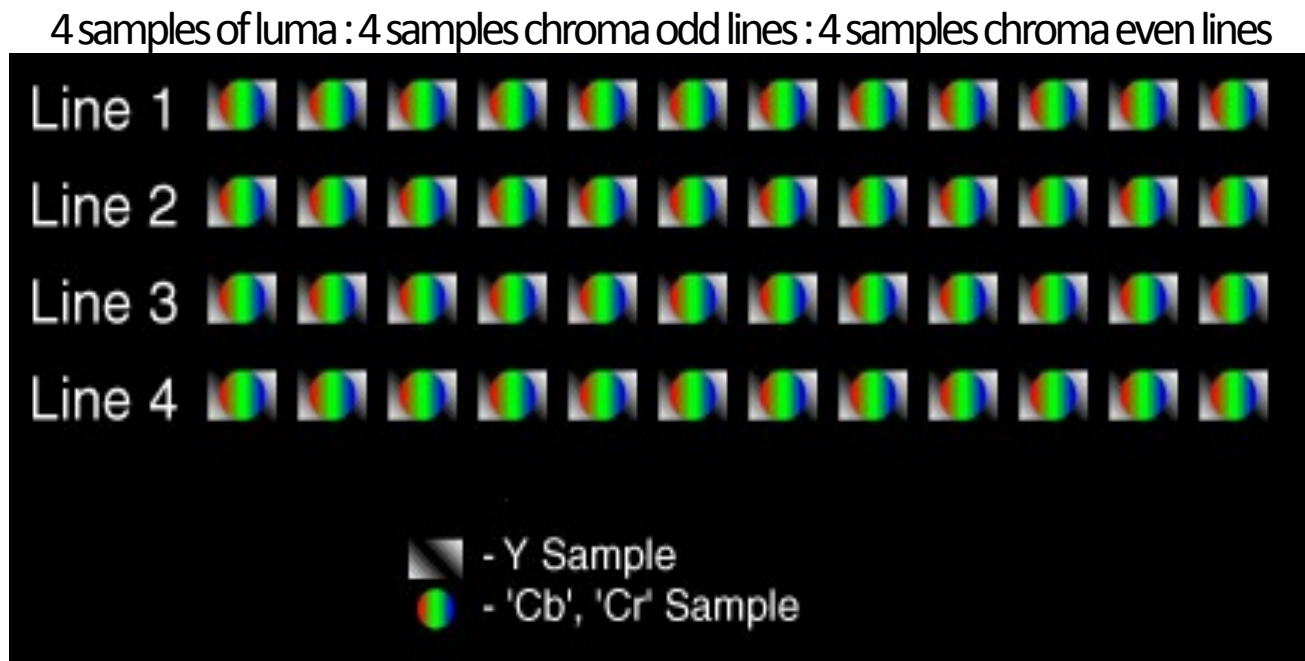
PIXEL SAMPLING

bit depth: 2 bits per pixel of information (**LUMA, CHROMA**)

raster: 1920 pixels x 1080 pixels (**1080 lines**)

luma sample: for all resolution lines

chroma sample: differentiated odd and even lines



SMPTE REC.709

8 bit: 8 bit value; $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 256$ (2^8)

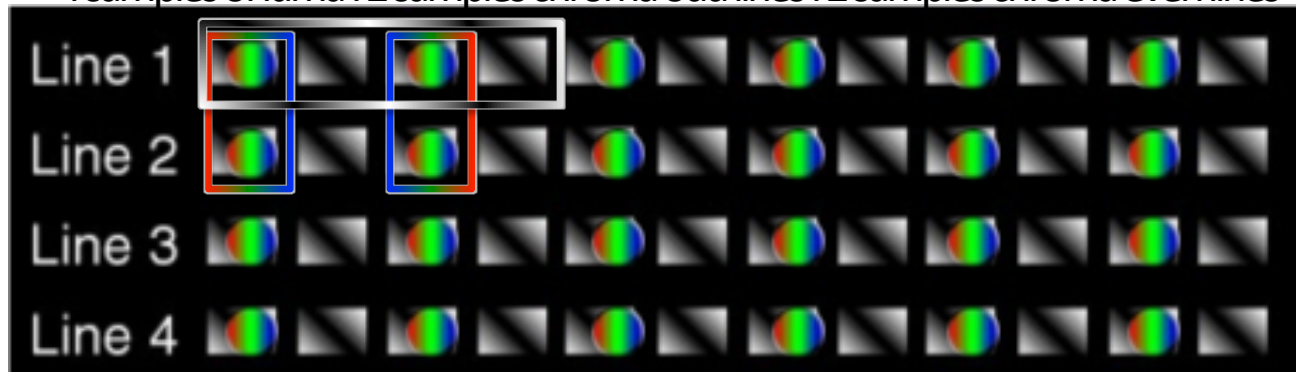
- legal values range; **16** (black) to **235** (white)

1080: 1080 rows of pixels, HD resolution (**lines**)

4:2:2: all lines **luma** - odd lines **chroma** - even lines **chroma**

- 4 pixels luma sampled with all lines
- 2 pixels chroma sampled with odd lines
- 2 pixels chroma sampled with even line

4 samples of luma : 2 samples chroma odd lines : 2 samples chroma even lines



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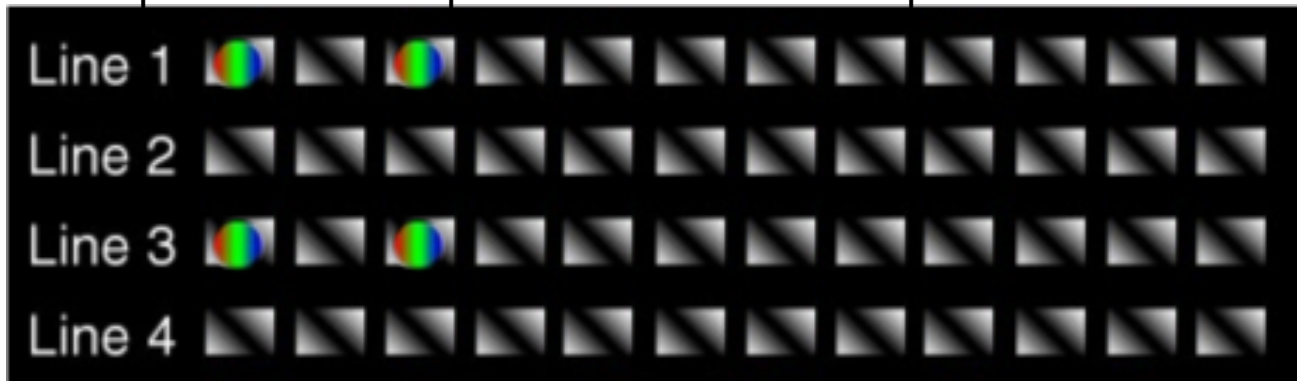
8 bit

1080p

4:2:0 (record to SDHC card)

- 4 pixels luma sampled with all lines
- 2 pixels chroma sampled with odd lines
- 0 pixels chroma sampled with even lines

4 samples of luma : 2 samples chroma odd lines : 2 samples chroma even lines



CONSIDERATIONS

human physiology: perception of brightness greater than color

delivery venue: theatrical, television, broadcast, web

technical limits: file size; storage space, transport speeds

encoding: codecs, processing (picture styles), bit depth (banding)

colorist: post color workflow

- correct; “*NORMALIZE*” contrast exposure
- grade; “*STYLIZE*” color hue saturation aesthetics
- time; “*EQUALIZE*” luma/chroma match

(shot-shot · scene-scene)