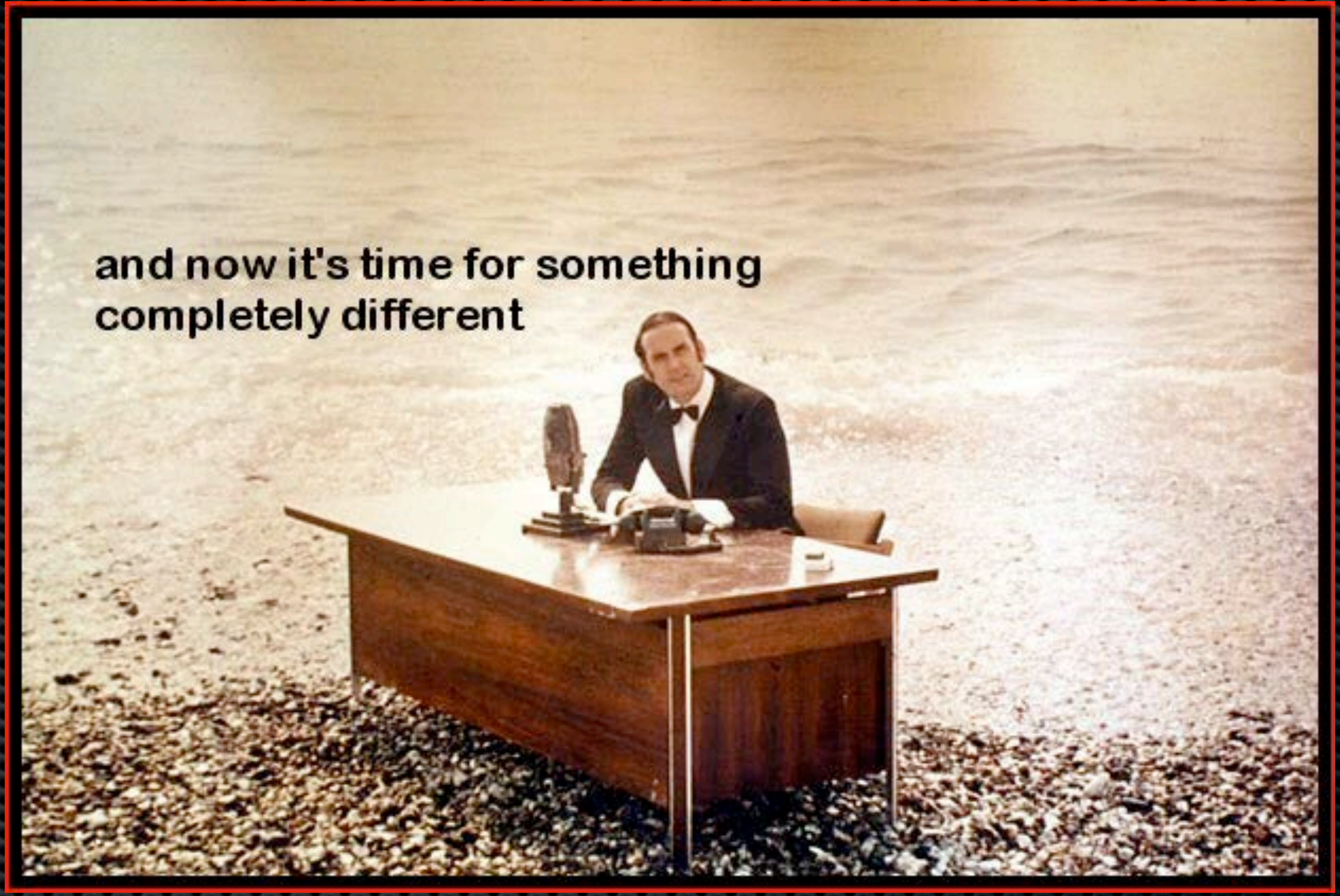

and now it's time for something
completely different

Deriving Appearance Scales

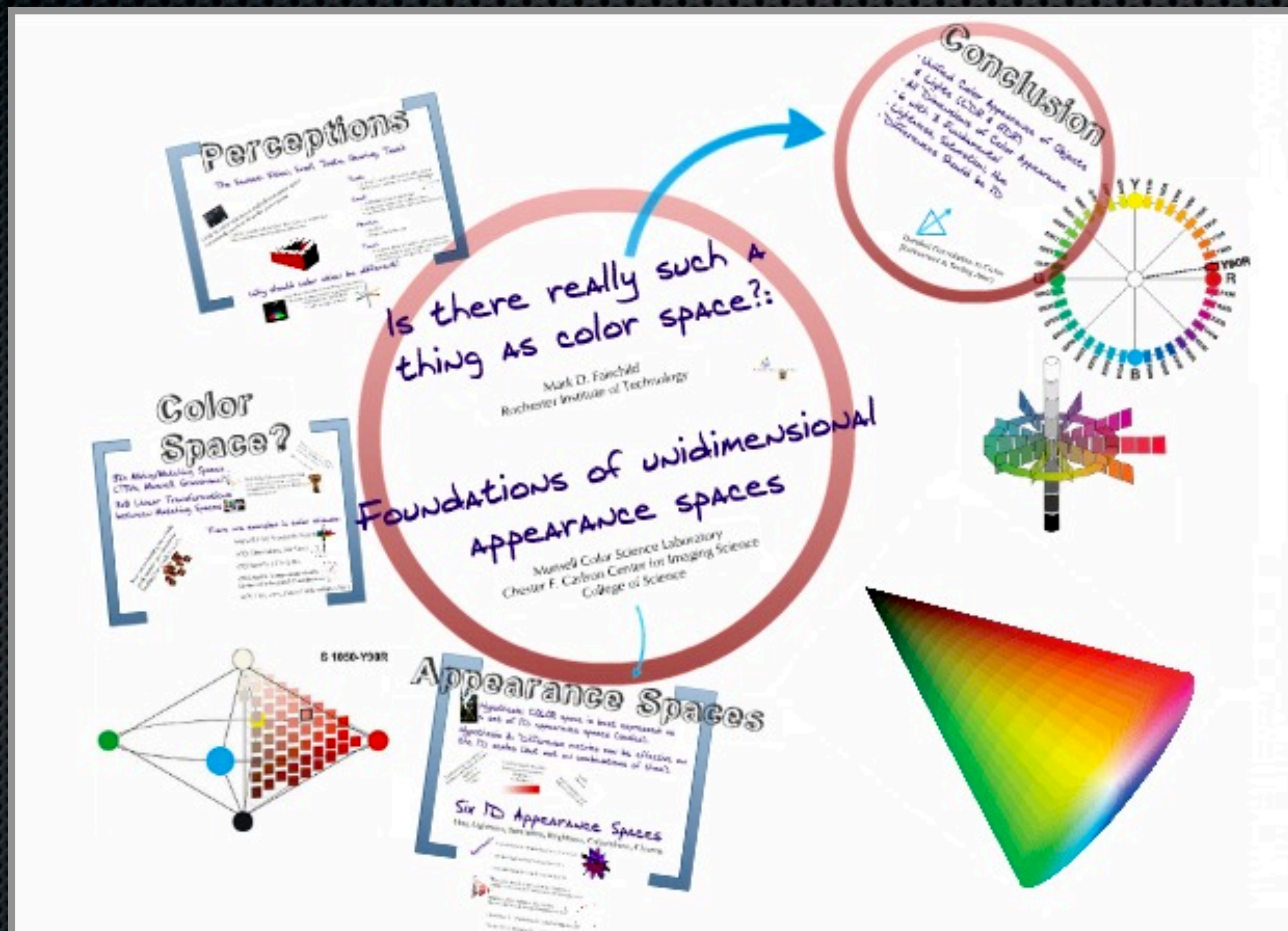
Mark D. Fairchild & Rodney L. Heckaman

Rochester Institute of Technology

Color Spaces & Differences

- Space: CIELAB, L*a*b*, ΔE^*_{ab}
- Scales: Munsell Hue, Value, Chroma
- Where does the 3D Euclidean geometry come from?

Last Year @ ISCC



Implementation

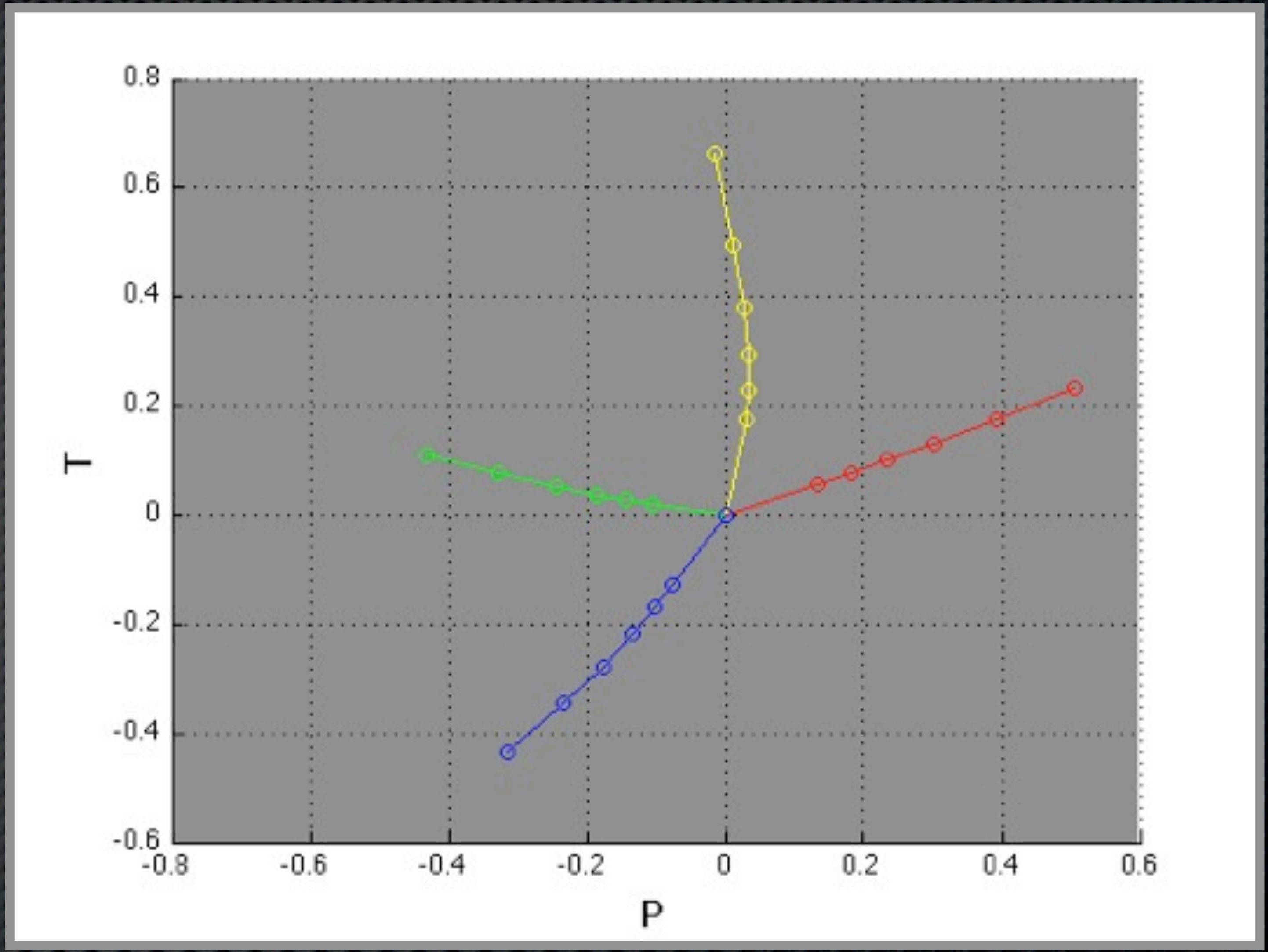
- Chromatic adaptation
- Computation: hue, lightness, saturation
- Derivatives: brightness, colorfulness, chroma

Chromatic Adaptation

- CAT02 to reference viewing conditions
- CIE illuminant D65, 315 cd/m^2
- Corresponding colors in XYZ *(any observer)*

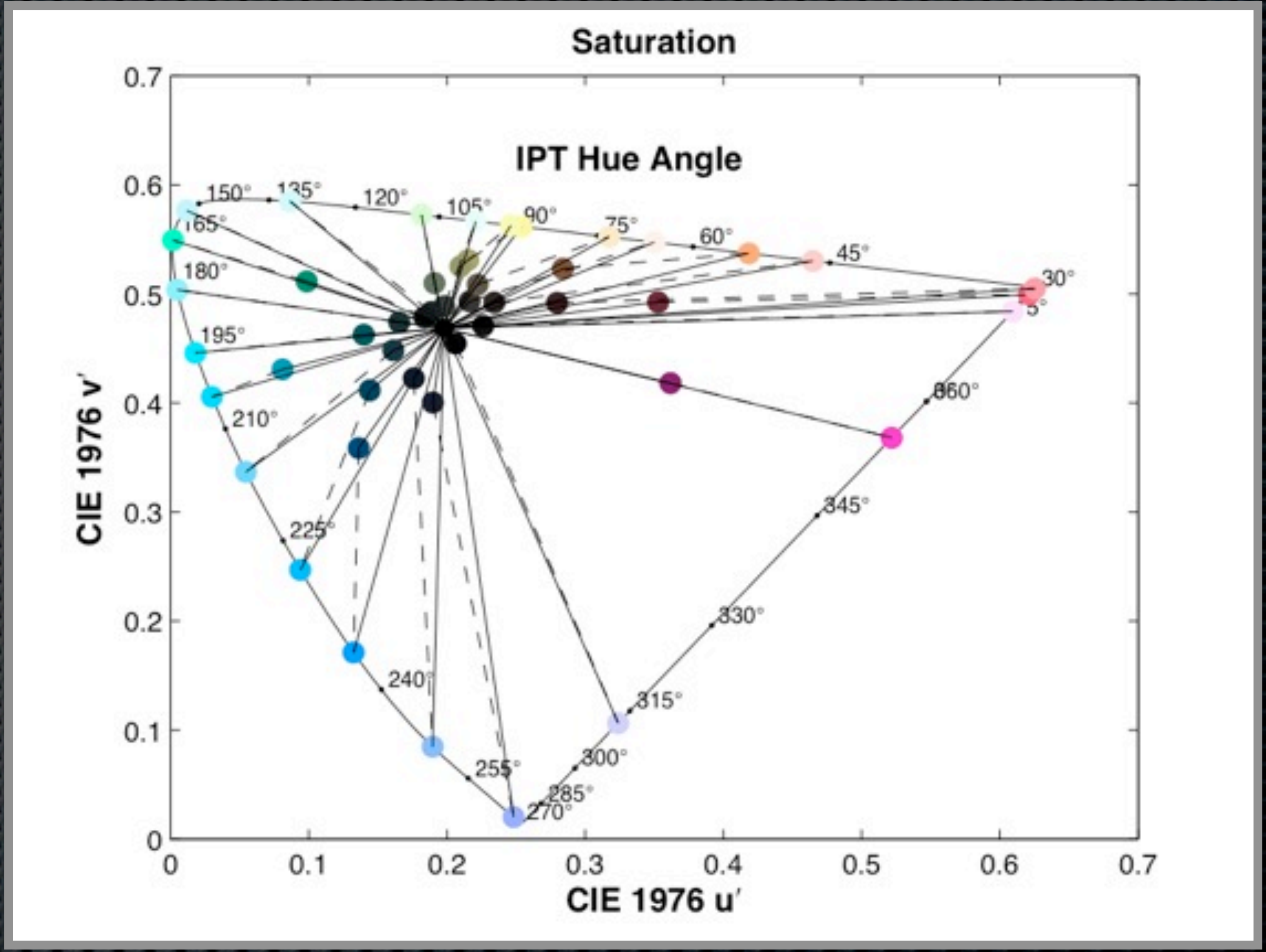
Hue

- IPT hue angle
- NCS unique hues
- 27.4°, 89.8°, 162.2°, 231.3° in IPT
- Simple computation



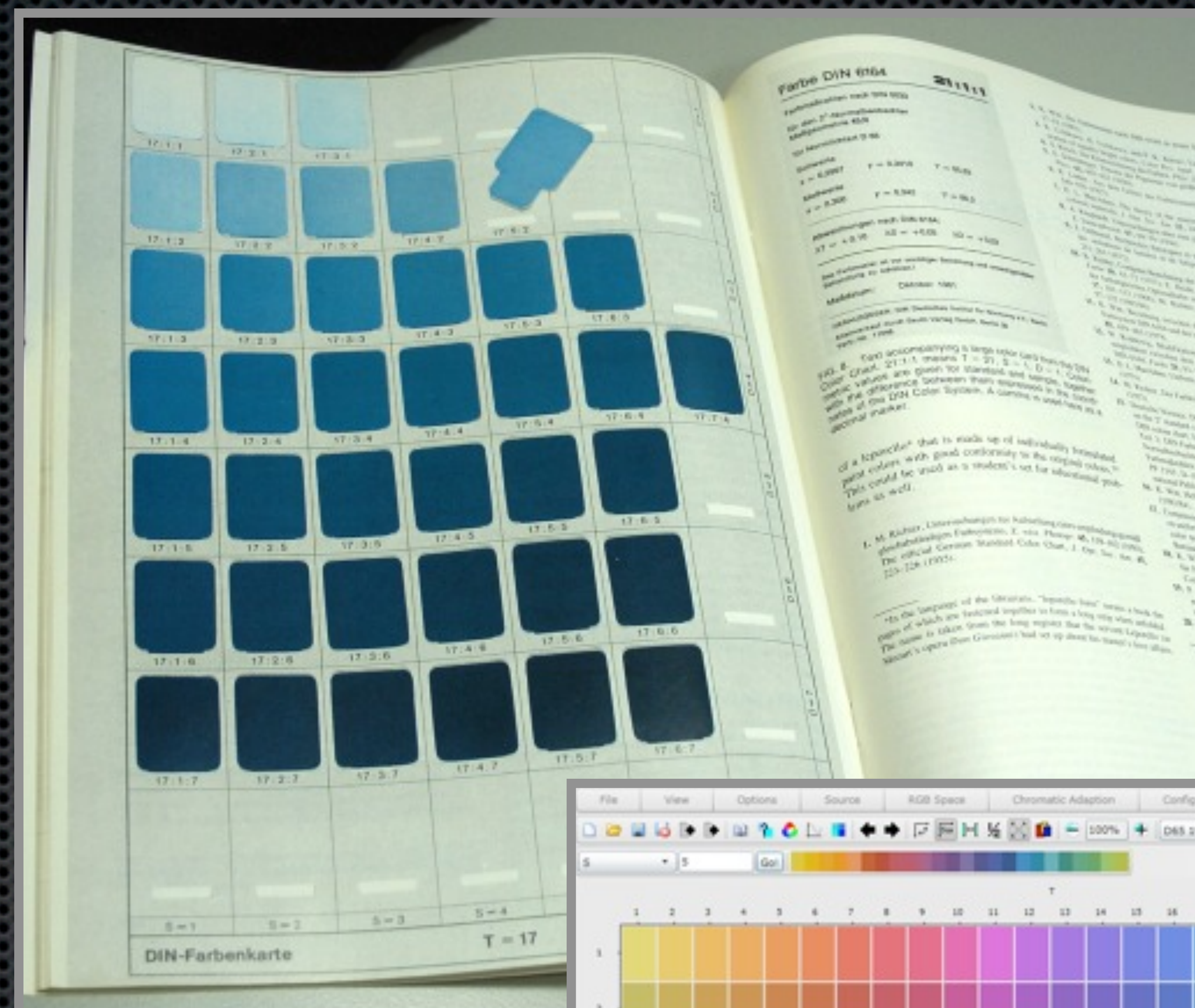
Saturation

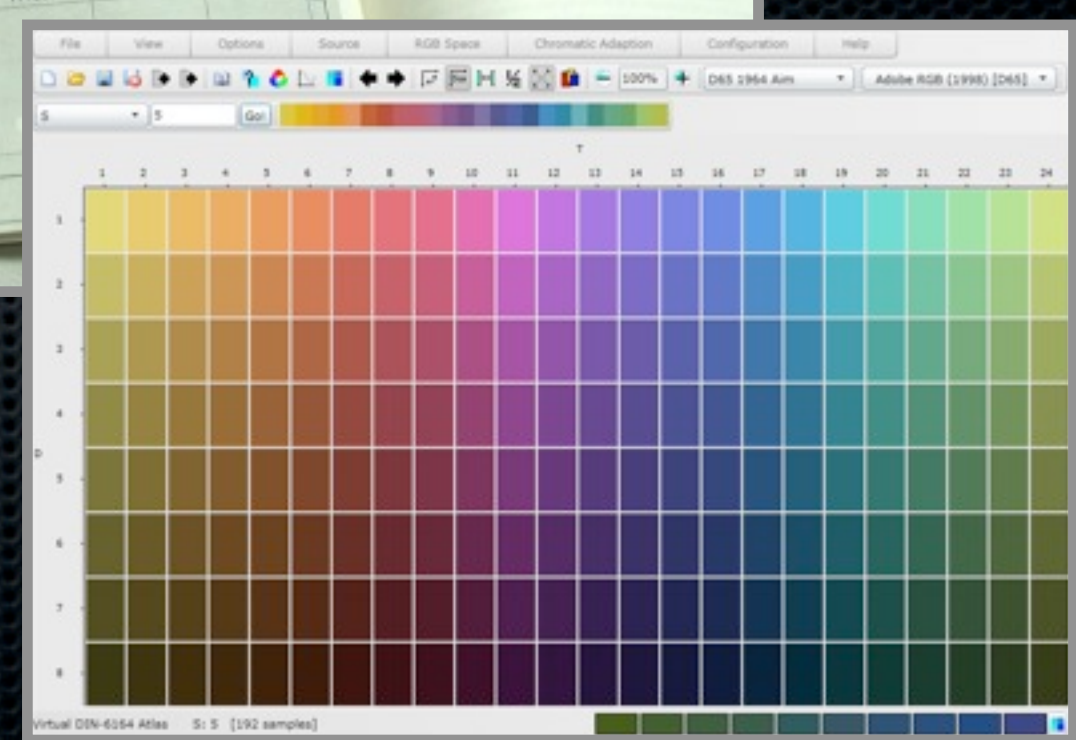
- u'v'
- Excitation purity
- Constant IPT h



Why saturation?

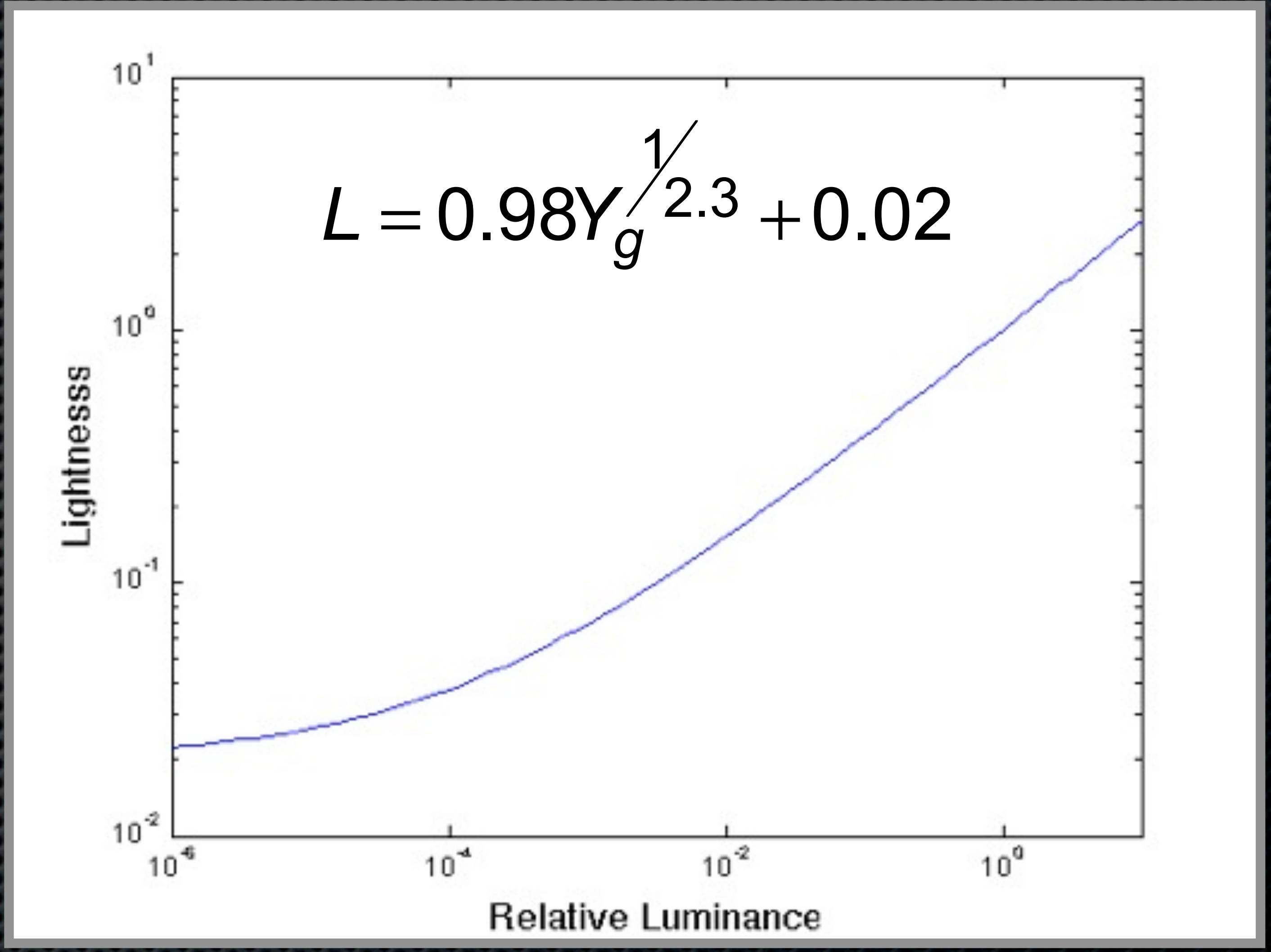
- Fundamental perceptually and physically
- Shadow series
- *e.g.* DIN system





Lightness

- L* “like”
- Power function with offset
- Supported by recent HDR data



Lightness

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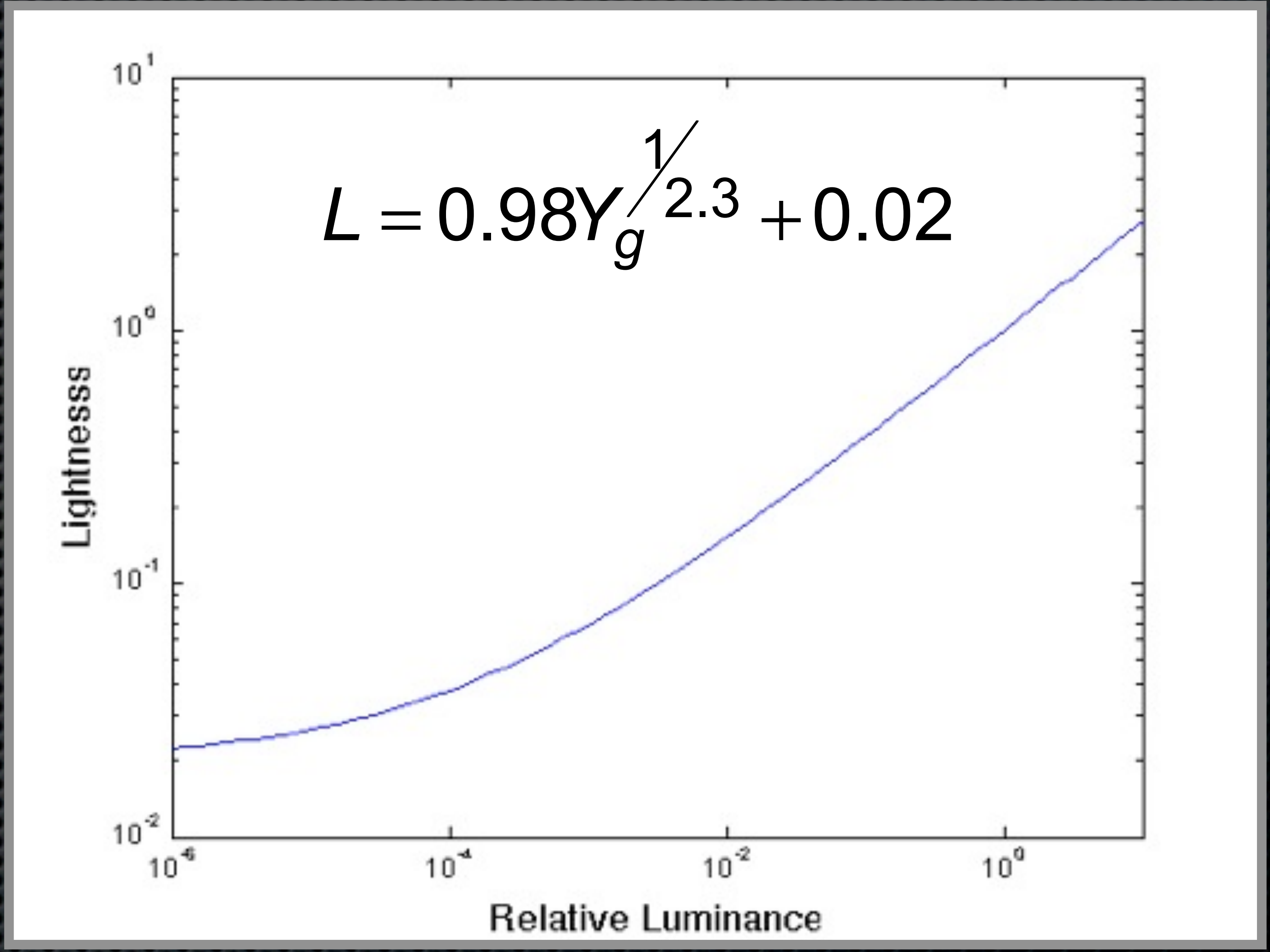
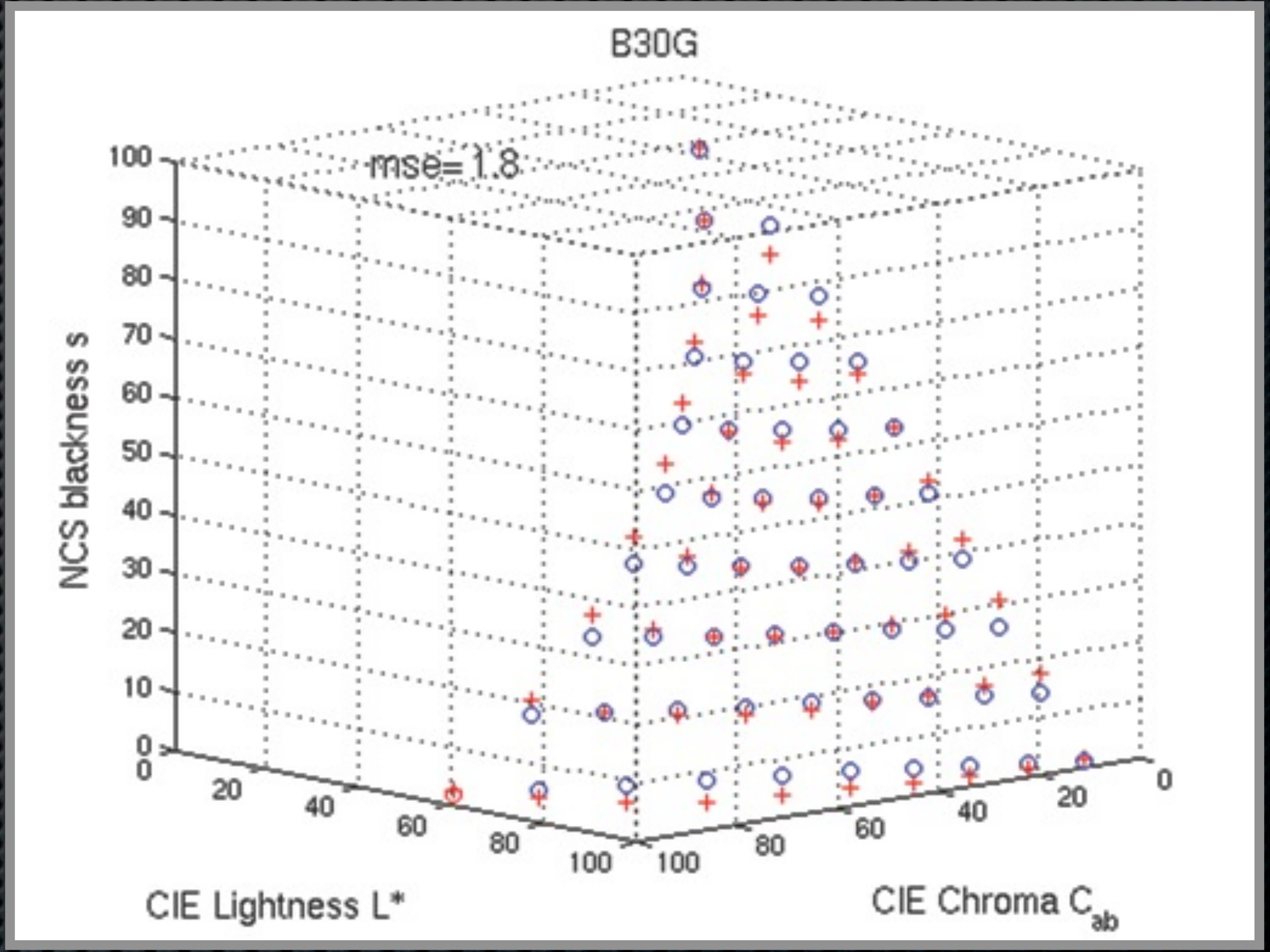


Relative to luminance at G_0 for h and S

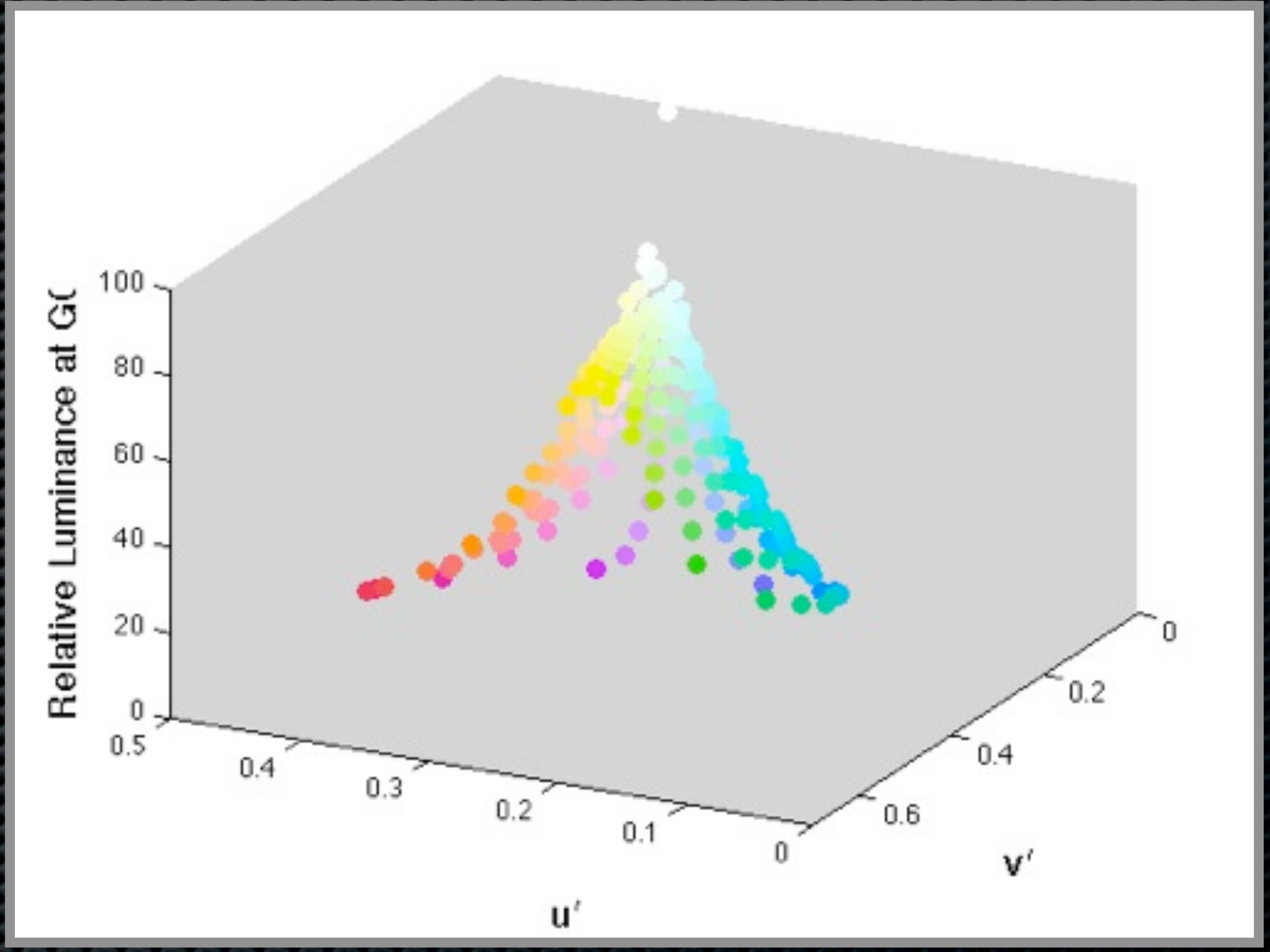
G_0 Computation

- Locus of zero NCS Blackness
- Converted into Y at G_0 as a function u'v'
- Based on earlier gamut mapping work



Y of G_0 "Tent"

- Y of G0
- Several h and S
- Define L reference
- Automatic Helmholtz-Kohlrausch effect



Evans Terminal Brightness

- Evans 1948
- From Marshall and Talbot 1942

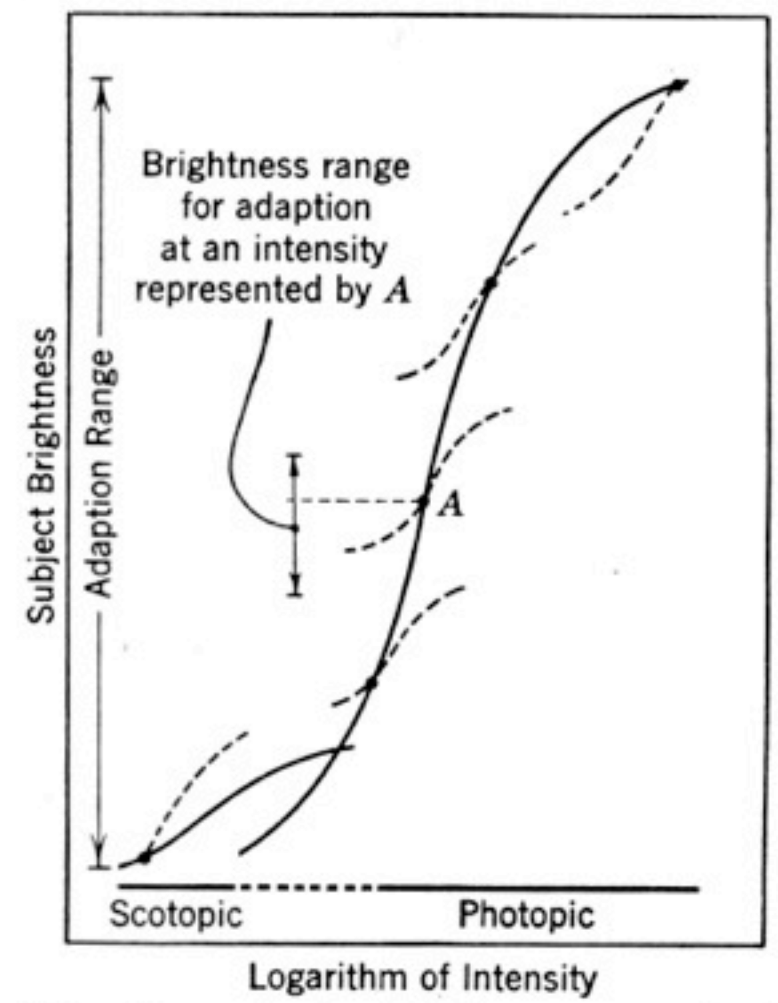


FIG. 7·9 Curve showing brightness range for different levels of adaptation. Above the brightness range for a given level of adaptation added intensity merely tends to cause pain without increasing subjective brightness; below this brightness range, visibility is zero. (W. H. Marshall and S. A. Talbot, *Biological Symposia*, Vol. 7, p. 130, The Jaques Cattell Press.)

Stevens’ Terminal Brightness

- Stevens & Stevens 1963
- Stevens’ Effect
- Brightness with adaptation
- Also terminal brightness

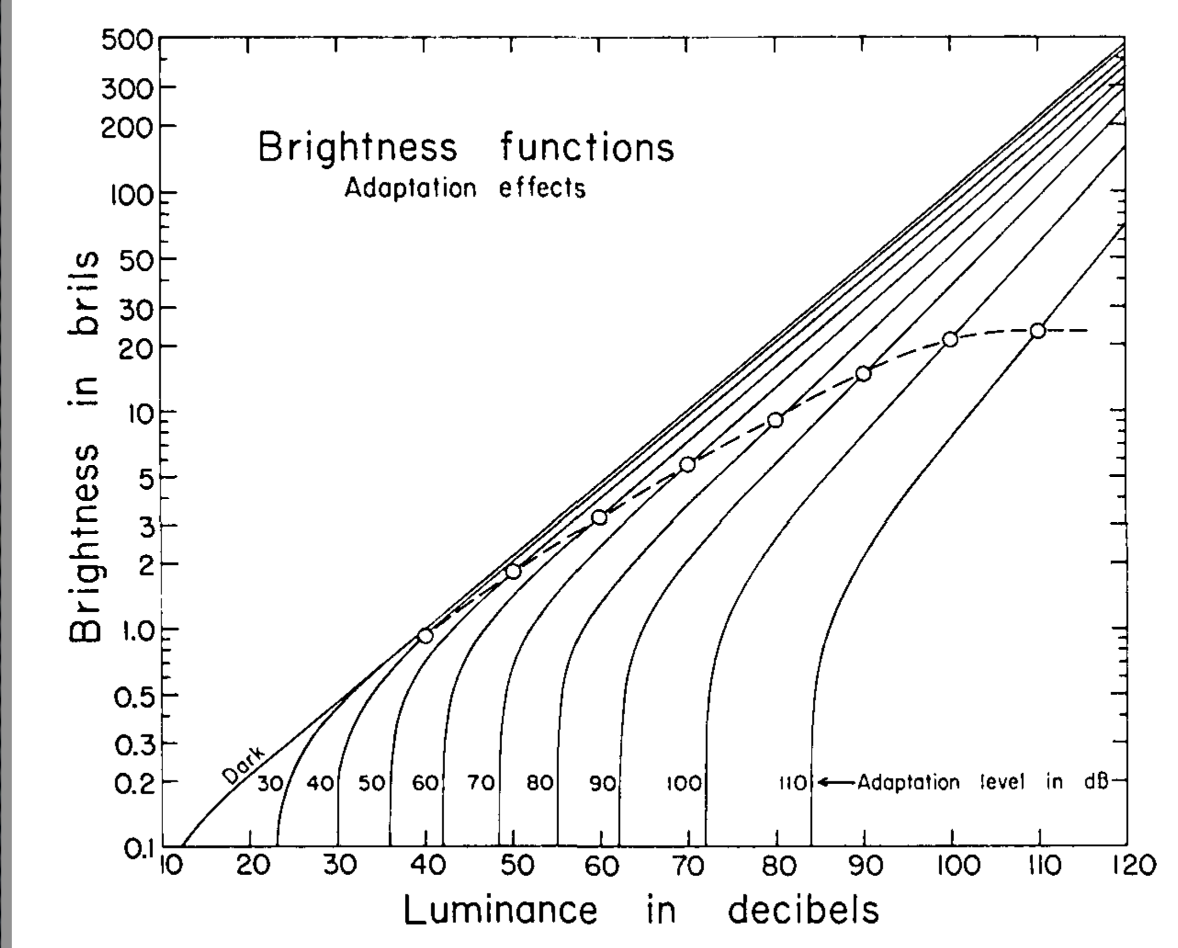
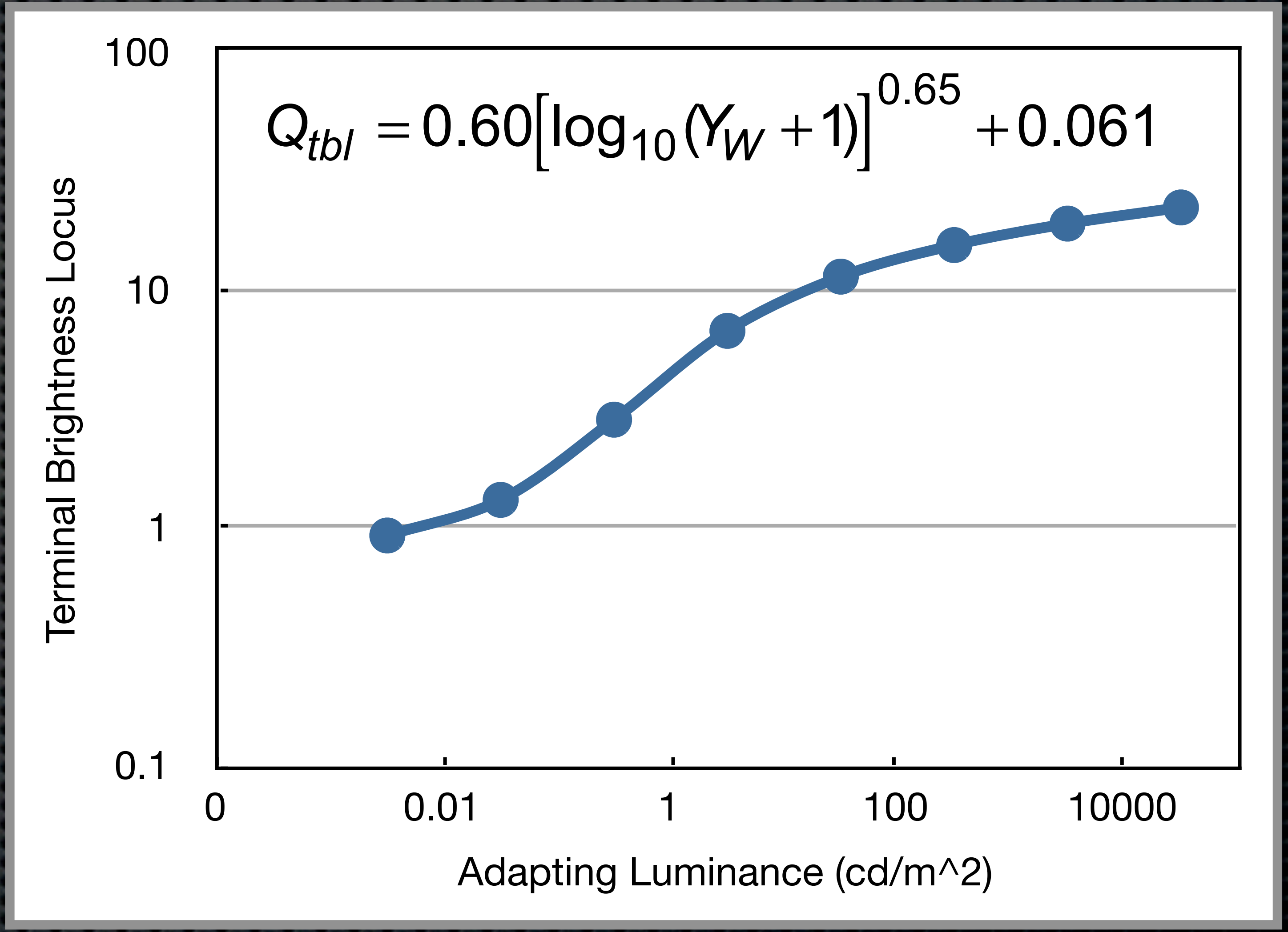


FIG. 7. Brightness functions for various levels of adaptation. The dashed line shows the terminal brightness locus—the level of sensation reached when the eye comes into full equilibrium with the luminance it is viewing.

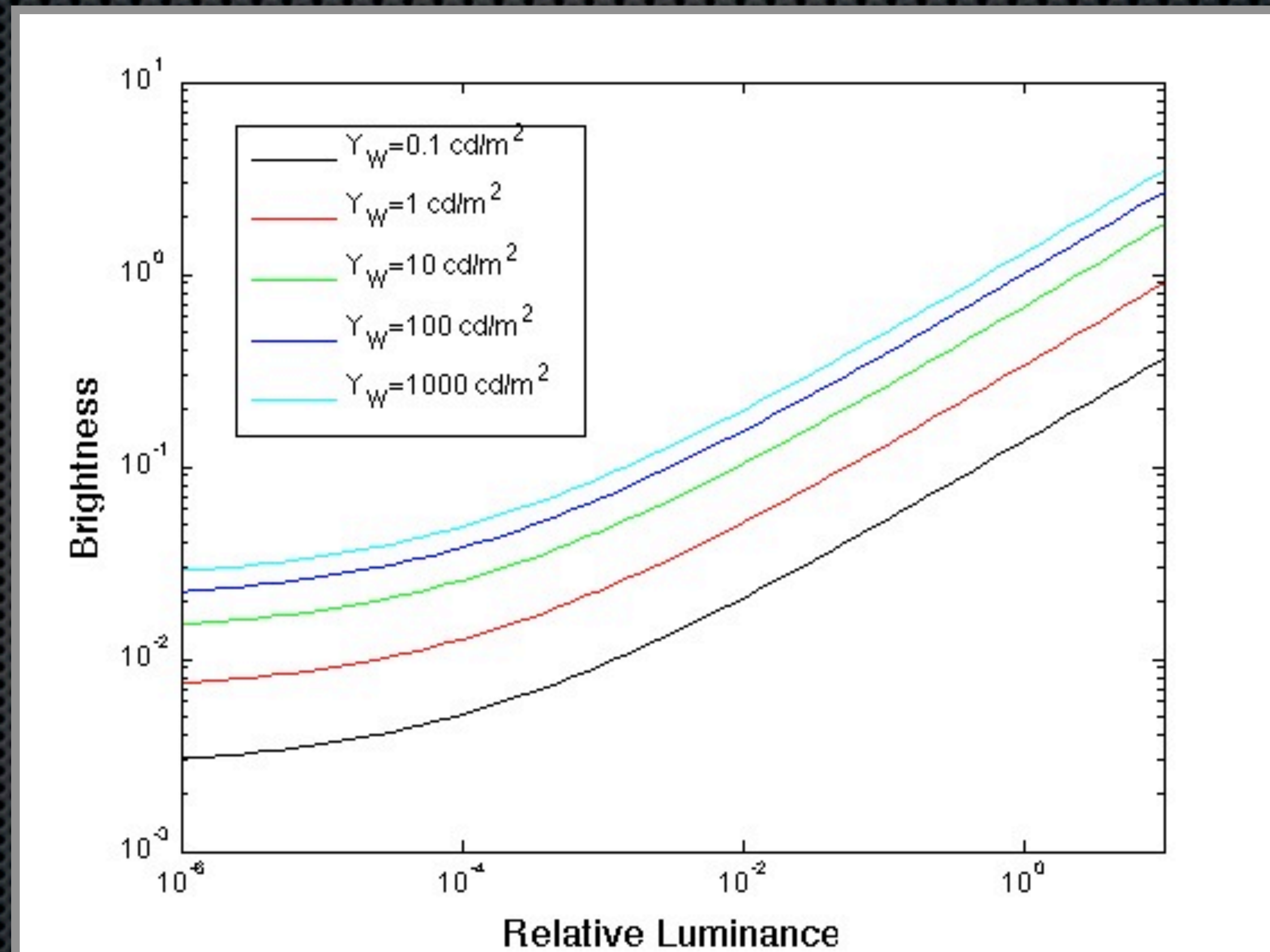
Terminal Brightness Locus

- Fitted to Stevens' data
- Defines maximum brightness for each adaptation level



Brightness

- $Q = Q_{tbl}L$

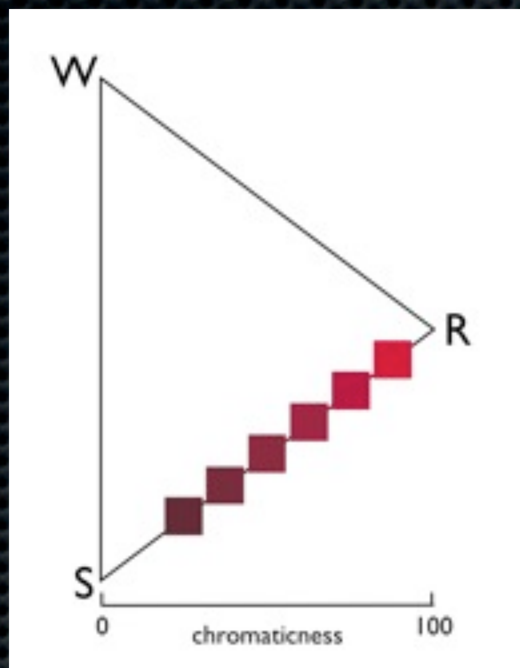


Colorfulness & Chroma

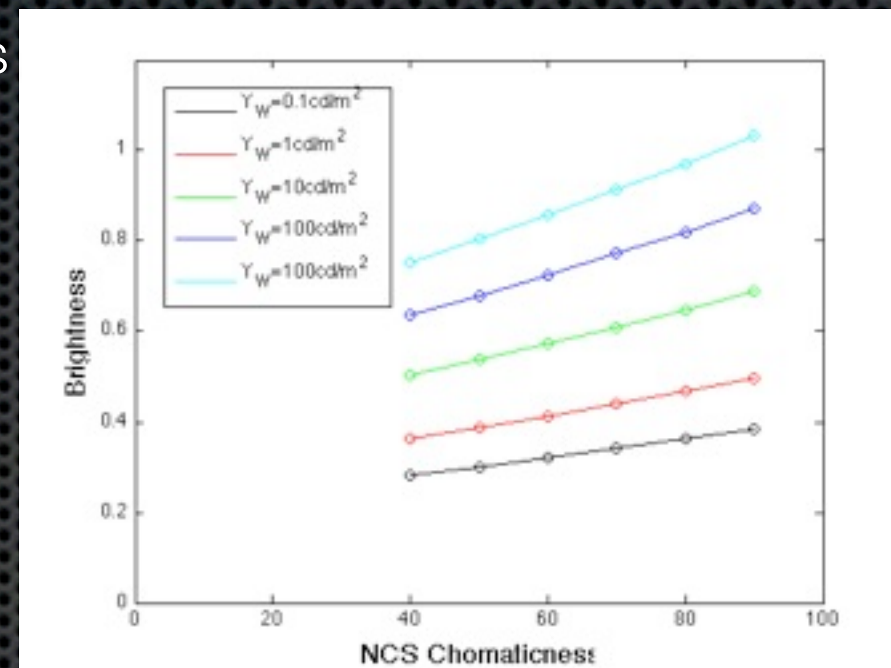
- $C = LS$
- $M = QS$

Examples

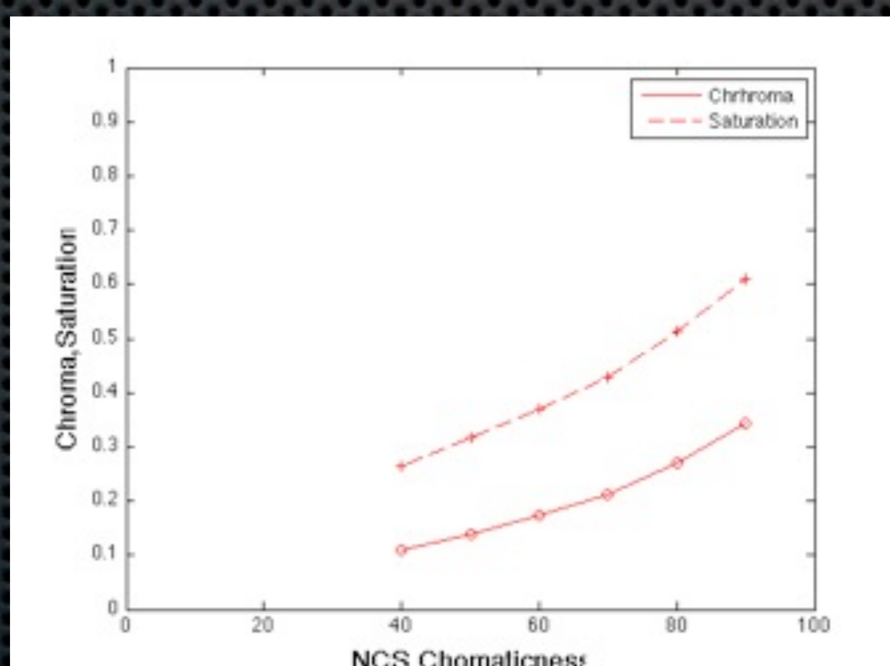
Some NCS Samples



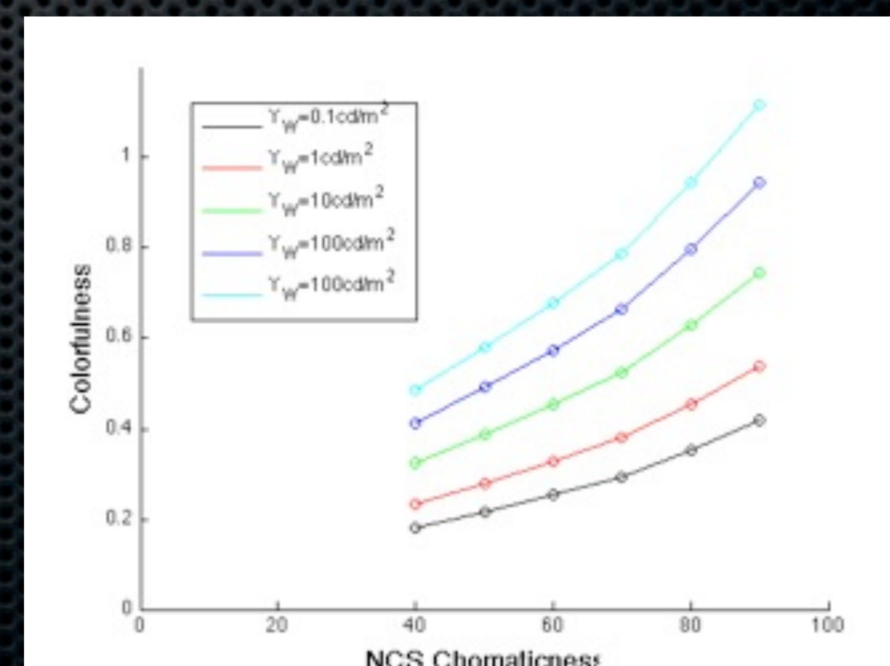
Brightness



Chroma Saturation



Colorfulness



Color Differences

- $\Delta h = h_2 - h_1$
- $\Delta L = L_2 - L_1$
- $\Delta S = S_2 - S_1$
- *etc.*

Color Differences

- $\Delta h = h_2 - h_1$
- $\Delta L = L_2 - L_1$
- $\Delta S = S_2 - S_1$
- *etc.*

ΔE

Color Differences

- $\Delta h = h_2 - h_1$
- $\Delta L = L_2 - L_1$
- $\Delta S = S_2 - S_1$
- *etc.*

$\cancel{\Delta E}$

Conclusions

- Scales ... not spaces
- Lightness, saturation, hue ...
- ... Brightness, colorfulness, chroma
- Differences on scales only

MATLAB online

Thank You

Questions ...