
CIE supplementary system of photometry

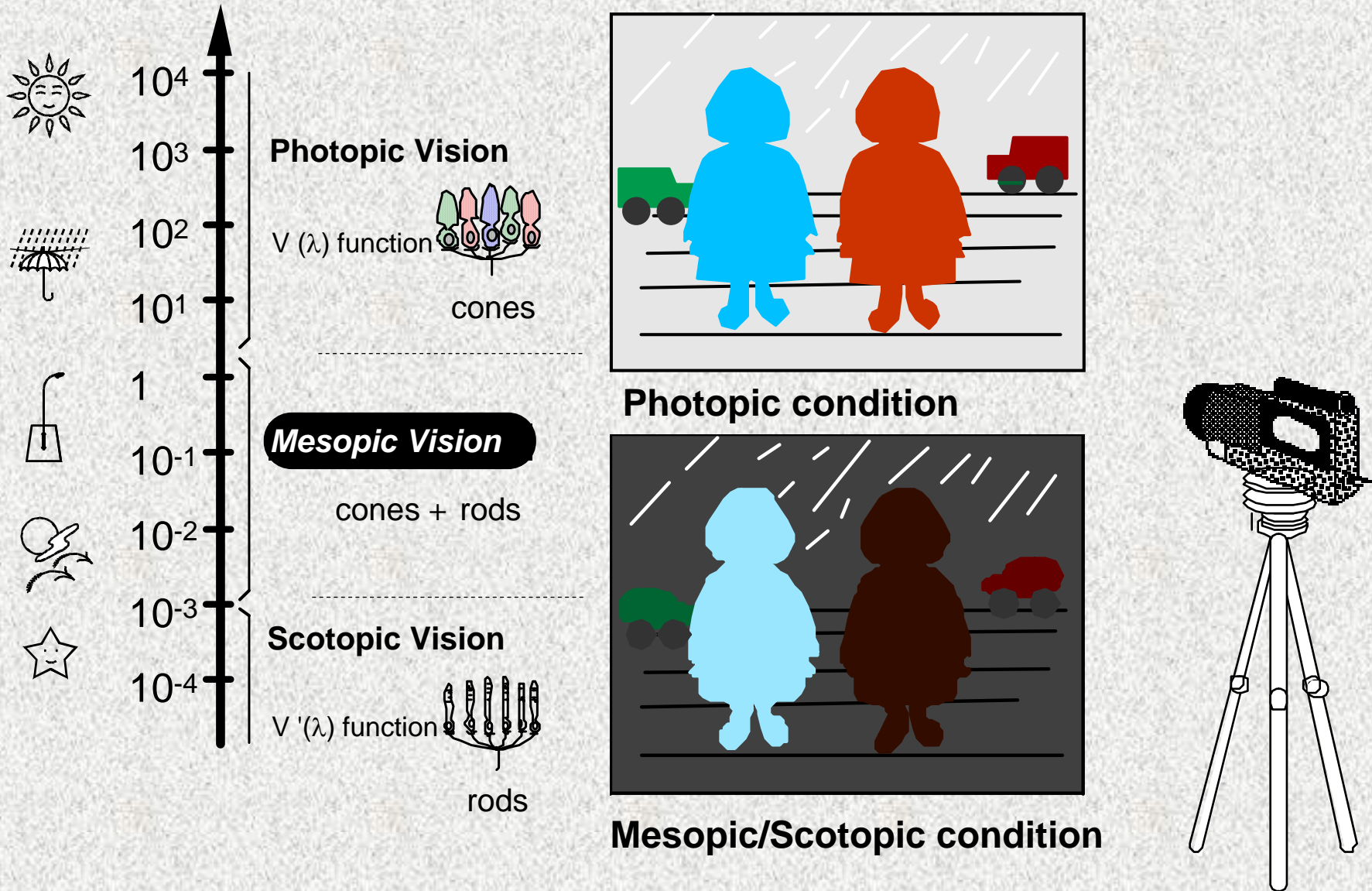
- Photometry for brightness at any level -

CIE TC1-37 “Supplementary system of photometry”

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Evaluation of brightness at any level

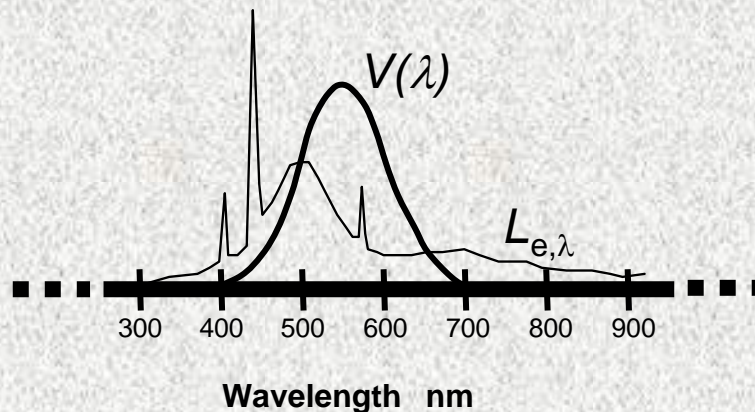


Need for a new system of photometry for brightness

CIE1924 Photometric System

CIE luminance

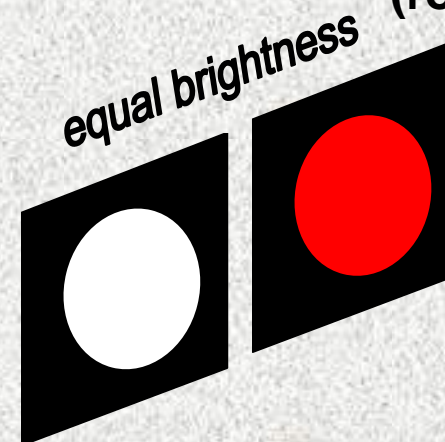
$$L = K_m \int L_{e,\lambda} V(\lambda) d\lambda$$



Supplementary System of Photometry

New photometric quantity
(Equivalent luminance, L_{eq})

- Chromatic effect
(Helmholtz-Kohlrausch)
- Purkinje effect
(rod contribution)



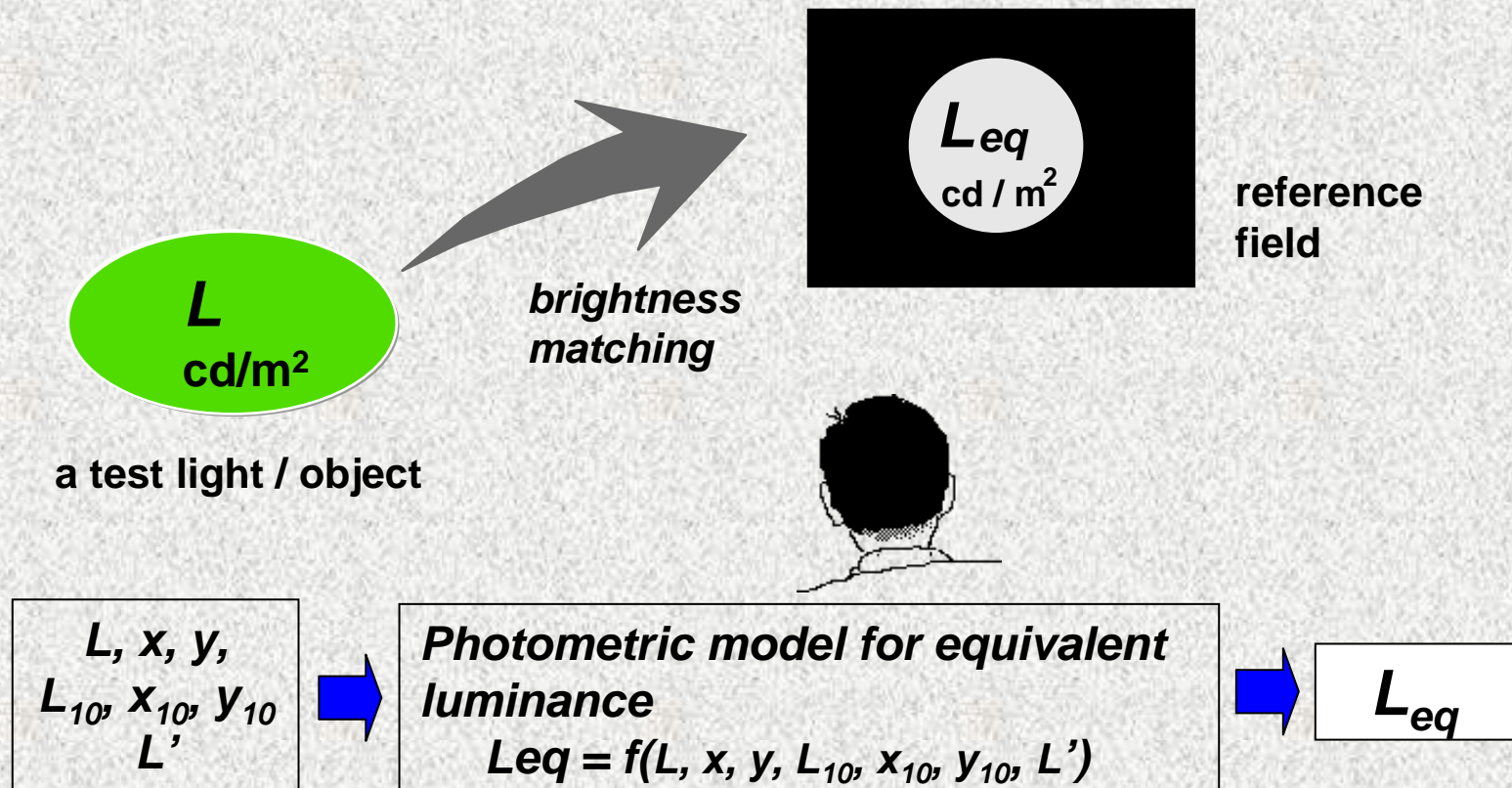
$$L_{eq}(\text{white}) = L_{eq}(\text{red})$$



How to scale brightness

Equivalent Luminance, L_{eq}

- CIE photopic luminance of a specified (540 Thz) reference field
- Same brightness as the test light or object



Two visual effects to be taken into account

Chromatic effect on brightness:

(Luminance) + (Chromatic signals)

Purkinje effect (rod contribution):

(Photopic Luminance) + (Scotopic Luminance)

Chromatic effect on brightness

Vector luminance model

Guth(1973) : $[L^2 + (R/G)^2 + (Y/B)^2]^{1/2}$

Yaguchi (1983) : $[L^2 + (R/G)^{2p} + (Y/B)^{2q}]^{1/2}$

Empirical formula using chromaticity

Ware-Cowan(1983): $\log (L_{eq}/L) = 0.256 - 0.184y - 2.527xy + 4.656x^3y + 4.657xy^4$

■ Nakano et al (1999): $\log (L_{eq}/L) = (1/2) \log (-0.0054 - 0.21x + 0.77y + 1.44x^2 - 2.97xy + 1.59y^2 - 2.11zy^2 - \log y)$

Purkinje effect (rod contribution)

For a case of no chromatic contribution

Palmer: $aL + (1-a)L'$

For a case of chromatic contribution

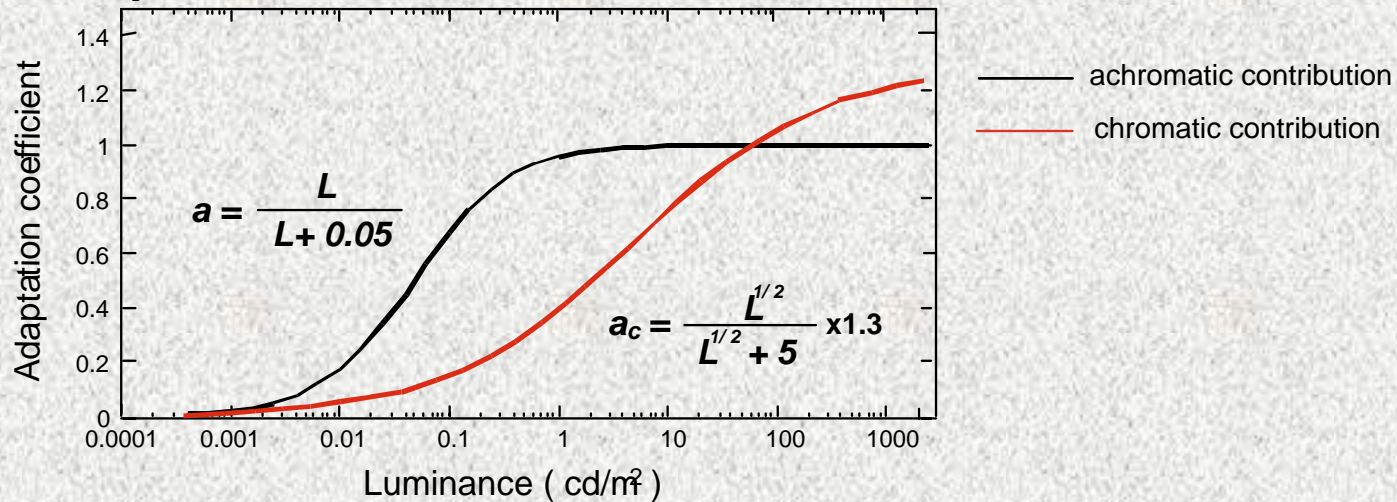
Kokoschka, Sagawa; $a(L+C) + (1-a)L'$

■ Nakano, Ikeda; $aL + (1-a)L' + a_c C$

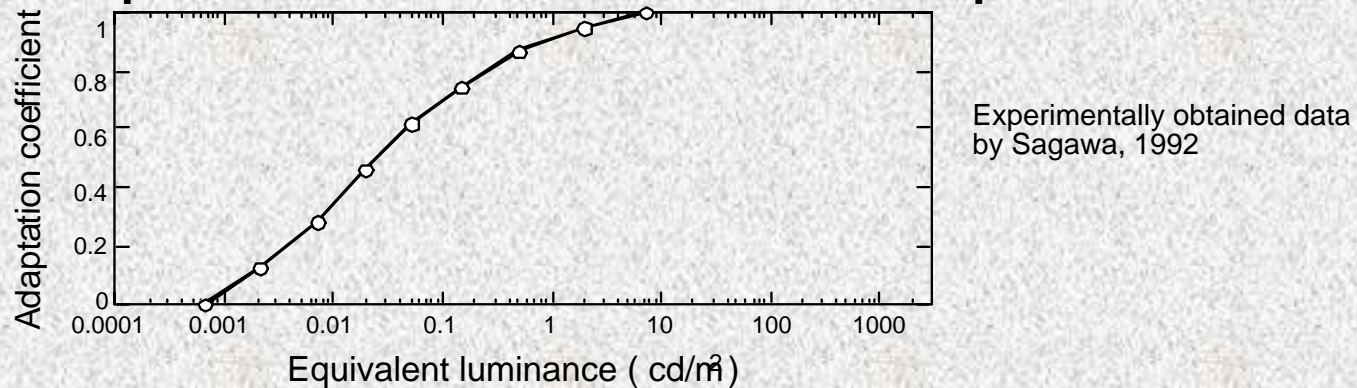
a, a_c ; adaptation coefficient

How the adaptation coefficient is determined

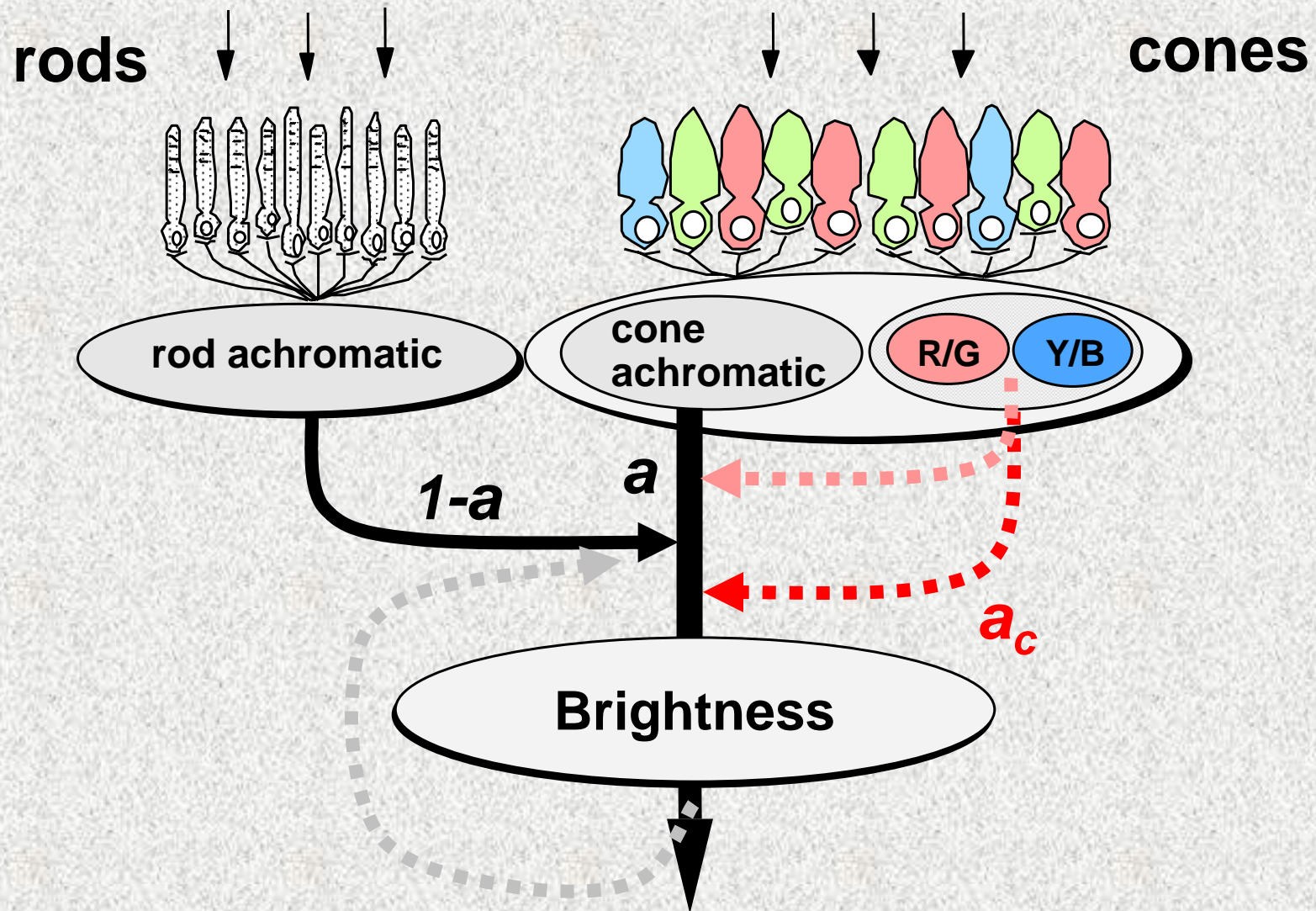
adaptation coefficient as a function of luminance



adaptation coefficient as a function of equivalent luminance



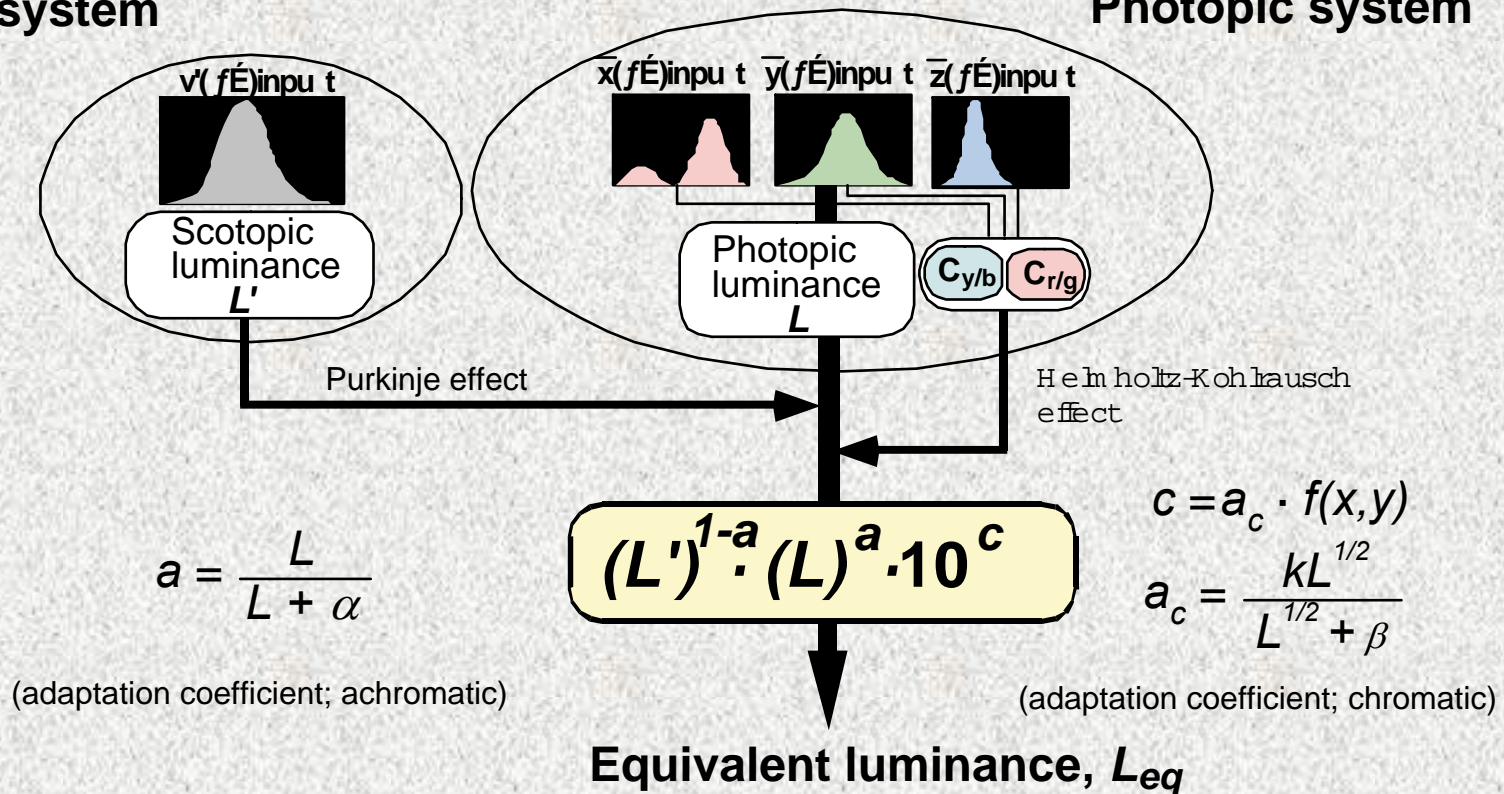
A vision model for brightness



A System to be Proposed by TC1-37

Scotopic system

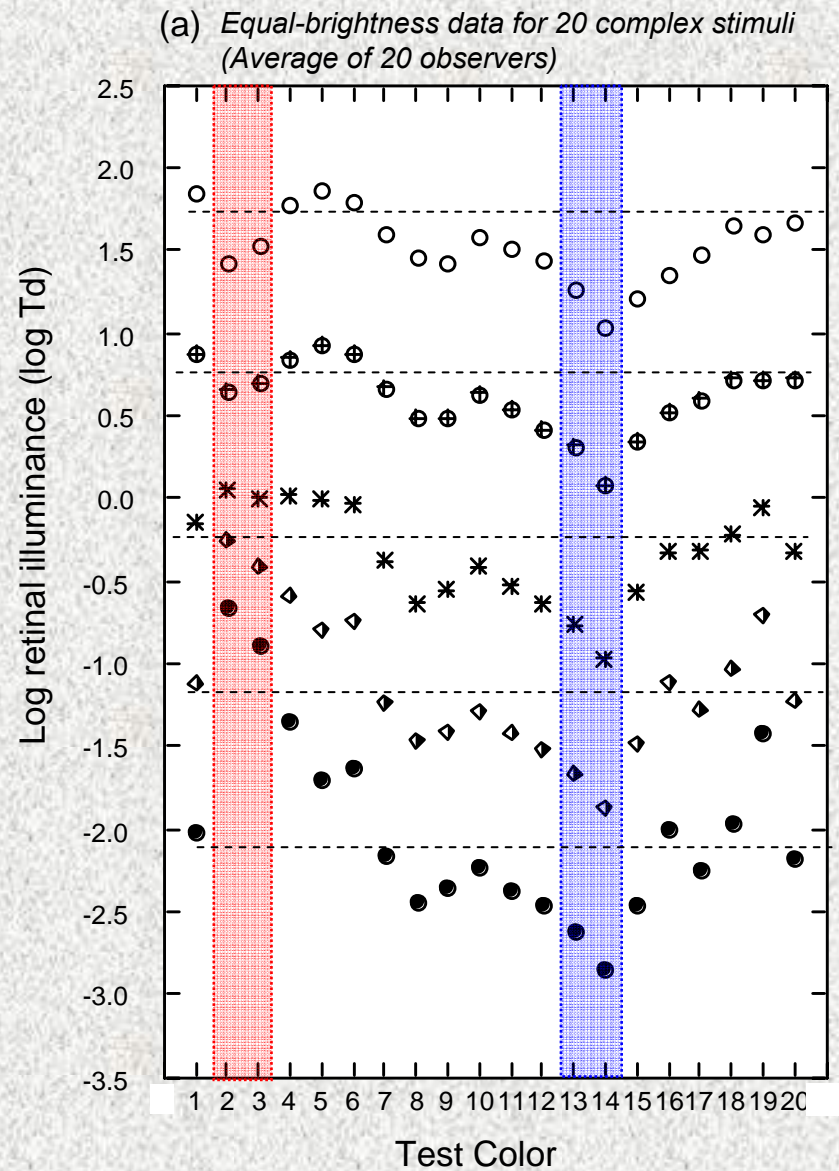
Photopic system



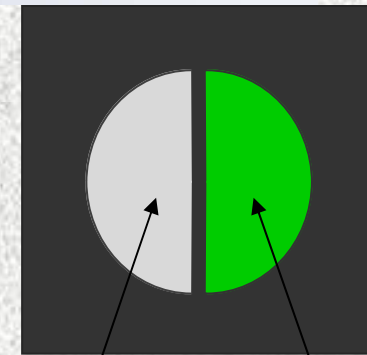
Parameters:

$$\alpha = 0.05 \text{ cd/m}^2, \beta = 2.24 \text{ cd/m}^2, k = 1.3, f(x,y) = \text{Nakano (1999)}$$

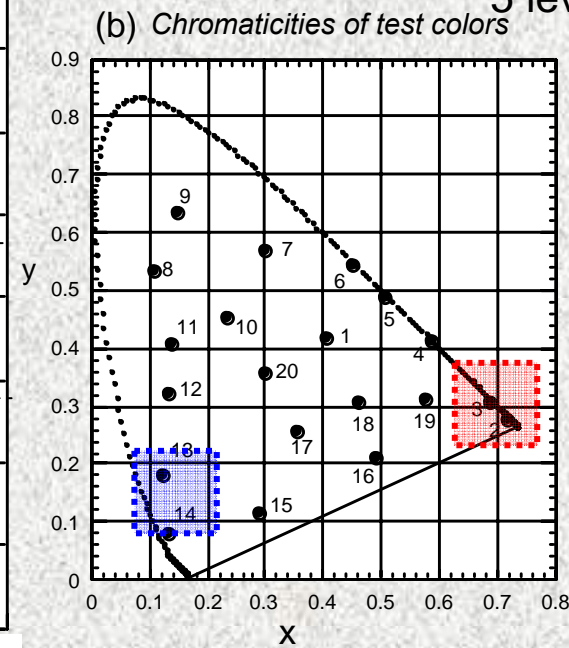
Brightness Matching Data in the Mesopic Range



- 100Td
- ⊙ 10Td
- * 1Td
- ◇ 0.1Td
- 0.01Td

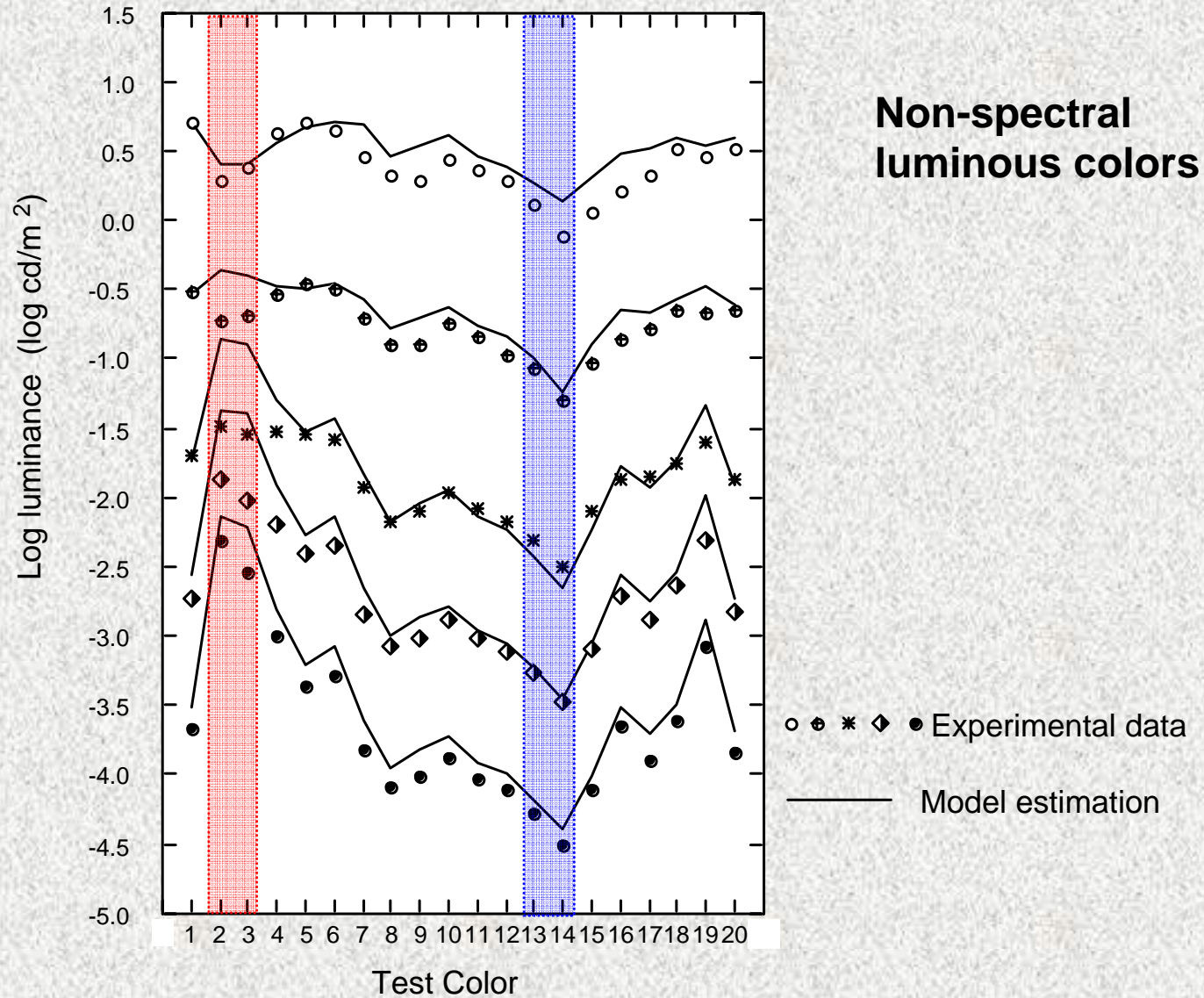


Reference 5 levels
Test 20 colors

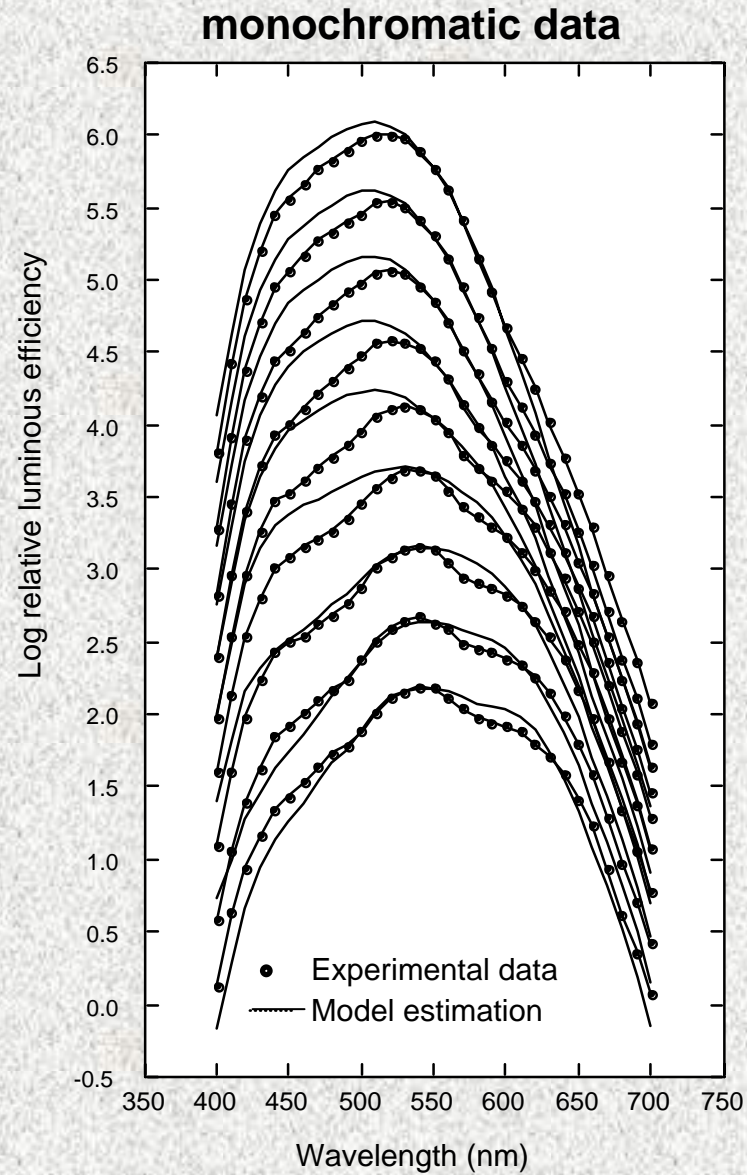


(Sagawa et al; 1992)

Testing of the model by BM data (1)

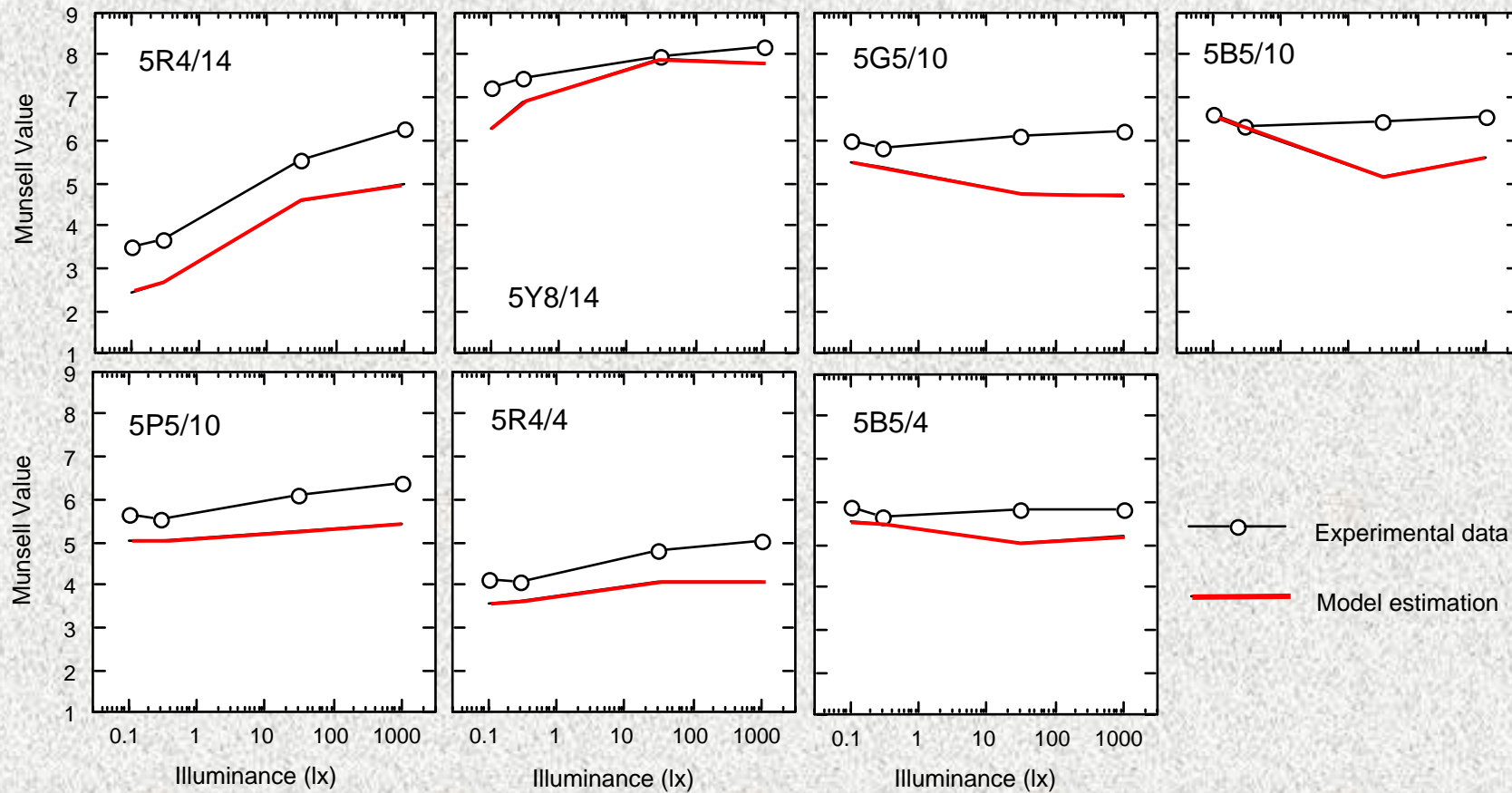


Testing of the model by BM data (2)



Testing of the model by BM data (3)

Reflected sampled collected by TC1-21 at Workshop 91



Summary

1. The photometric model for brightness at any level investigated in TC1-37 can be proposed as CIE Supplementary System of Photometry.
2. Draft technical report will be prepared by the end of 2007 and final version will be submitted to Division 1 at the next Division meeting.

Thank you !

Chromatic effect at high luminance level

