



<http://farbe.li.tu-berlin.de/DE00/DE00L0NP.PDF> / .PS

N: no 3D-linearization (OL) in file (F) or PS-startup (S), page 1/1

-see similar files: <http://farbe.li.tu-berlin.de/DE00/DE00.HTM>
technical information: <http://farbe.li.tu-berlin.de> or <http://130>

The graph plots relative sensitivity (y-axis, 0,0 to 1,0) against wavelength λ in nm (x-axis, 400 to 700). It shows four curves: L (blue), M (red), S (green), and V (black). The experimental-CIE curves (solid lines) peak at approximately 455 nm, 570 nm, 545 nm, and 450 nm respectively. The model curves (dotted lines) peak slightly higher at approximately 455 nm, 570 nm, 545 nm, and 450 nm. The curves for L , M , and S overlap significantly.

graph showing the relationship between logarithmic parameters and wavelength λ . The x-axis is λ/nm (400-700) and the y-axis is u_λ (−1 to 1). Four curves (red, green, blue, yellow) represent different models. A horizontal black line at $u_\lambda = 0$ indicates the maximum absorption threshold $t_a = 0.00$. A vertical dashed red line at $\lambda \approx 550$ nm marks the BoLo \rightarrow MaMo transition. A legend on the right specifies: maximum $\log(g_m) = 0.35$, $g_m = 0.44$, Threshold $t_a = 0.00$.

Cone Excitation Coordinates and the *Munsell* System
K. Richter, Berlin University of Technology, Berlin, Germany

CIE cone sensitivities LMS and CIE tristimulus values XYZ
 LMS and XYZ excitations in luminance units with $Y=0.5(L+M)$

Linear model equations between colour values in both directions

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} 1.32 & -0.66 & 0.34 \\ 0.50 & 0.50 & 0.00 \\ 0.00 & 0.00 & 1.00 \end{pmatrix} \cdot \begin{pmatrix} L \\ M \\ S \end{pmatrix}$$

$$\begin{pmatrix} L \\ M \\ S \end{pmatrix} = \begin{pmatrix} 0.51 & -0.51 & 0.34 \\ 0.67 & 1.33 & 0.00 \\ -0.17 & 0.17 & 1.00 \end{pmatrix} \cdot \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

Linear model equations between colour excitations in both directions

$$\begin{pmatrix} XY \\ YZ \\ ZX \end{pmatrix} = \begin{pmatrix} 1.32 & -0.66 & 0.34 \\ 0.50 & 0.50 & 0.00 \\ 0.00 & 0.00 & 1.00 \end{pmatrix} \cdot \begin{pmatrix} LY \\ MY \\ SY \end{pmatrix}$$

$$\begin{pmatrix} LY \\ MY \\ SY \end{pmatrix} = \begin{pmatrix} 0.51 & -0.51 & 0.34 \\ 0.67 & 1.33 & 0.00 \\ -0.17 & 0.17 & 1.00 \end{pmatrix} \cdot \begin{pmatrix} XY \\ YZ \\ ZX \end{pmatrix}$$

The colour difference formula LABIND 1976 of CIE TC1-81-2018 uses a chromaticity diagram (a, b) , defined by the following equations:
 $a=X'Y-Xy'$ and $b=-0.4ZY=-0.4z'y$

If logarithmic equations are used, it is for example valid $\log S/Y = \log S - \log Y$

Elementary Colours and Colour Image Technology
K. Richter, 2015, Colour, Colour Vision and Elementary Colours in Color Information Technology, 85 pages, in six languages.
<http://farbe.li-berlin.de/color/ES15.PDF>

ISO 9241-306:2018, Ergonomics of human-system interaction Part 306: Field assessment method for electronic visual displays. Test chart in three languages for elementary colour output, see <http://www.standards.iso.org/9241/306/ed-2/index.html>

Reportership Report CIE R1-47-2009, Hue angles of elementary colours, *Thorstein Seim, Norway, see*
<http://files.cie.co.at/526.pdf>

Request for elementary colour research of ISO/TC159/SC4/WG2 *Visual Display Requirements to CIE Division 1 Vision and Colour*
<http://farbe.li-berlin.de/SE38/SE38-1N.PDF>

for further technical information and publications:
go to the homepage *Colorimetry and Colour Image Technology*
<http://farbe.li-berlin.de/index.html>

Elementary Colours and Colour Image Technology
K. Richter, 2016, Output Linearization Method OLM16
for Displays, Offset and Printers, 60 pages, with many figures.
http://farbe.li.tu-berlin.de/OUTLIN16_01.PDF

Richter, K., 1985, Colour appearance elementary hue and chroma differences as function of chromaticity and luminance of center and background field,
BAM research report 115, 1985, 119 pages.

Richter, K., 1980 ,Cube-root color spaces and chromatic adaptation, Color res. and appl. 5, no. 1, 25-43.

Reportership Report CIE R1-57:2013, Border between blackish and luminous colours, *Thorstein Seim, see*
<http://files.cie.co.at/716 CIE R1-57 Report 20Jul-13 10v.2.pdf>

Richter, K., 1970, The appearance of hue as function of saturation and lightness, Farbe 19, no. 1/6, pages 277-282.

Conclusion 31/2007 ISO TC159/SC4/WG2

Ergonomics – Visual Display Requirements

ISO TC159/SC4/WG2 realizes that the colour spaces CIELAB and CIELUV of **CIE Division 1** will soon become ISO/CIE standards. In applications we use these CIE colour spaces and *device-dependent* relative RGB colour spaces. For users of visual display systems a *device-independent* RGB colour space is useful. This produces via software the elementary hues Red, Green and Blue for the RGB data 100, 010 and 001 and equally spaced output in CIE colour spaces for equally spaced RGB input. We recommend that **CIE Division 1** study the colorimetric definition of such a space, which can be used in visual display applications.

Remark: We have realized that an example colour space of this type is published in CIE X030:2006, p. 139–144.

LMS_17 cone sensitivity $Y_{\text{sum}}=100$

$\bar{s}_{\text{R17},s}(\lambda) = B_{3j}\bar{x}_{\text{R17},s}(\lambda) + B_{32}\bar{y}_{\text{R17},s}(\lambda)$
 $+ B_{33}\bar{z}_{\text{R17},s}(\lambda)$

B_{3j}: 0,000 0,000 1,000 λ=440

E00: $\sum \bar{s}_{\text{R17},s}(\lambda) = 99,93$

$x_{\text{R17},s}=0,3333$

$y_{\text{R17},s}=0,3333$

E00

wavelength λ/nm

TUB-test chart DE00; Colorimetric properties of colour vision and colour image technology
LMS receptor sensitivities, XYZ tristimulus values, and references on elementary colours