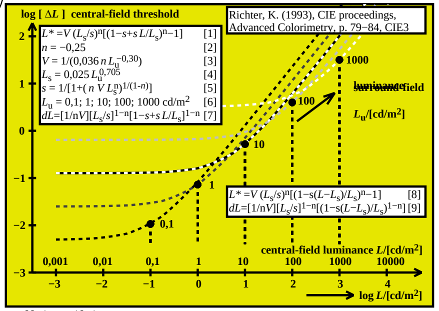
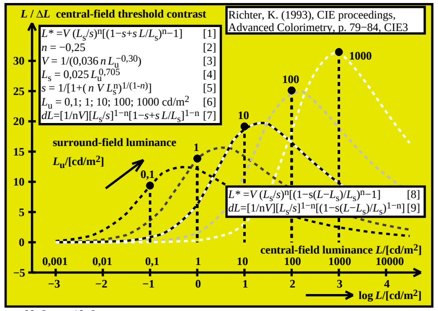
see similar files of the whole serie: http://farbe.li.tu-berlin.de/eess.htm
technical information: http://farbe.li.tu-berlin.de or http://color.li.tu-berlin.de

TUB registration: 20230801-ees0/ees0l0np.pdf /.ps
application for evaluation and measurement of display or print output

TUB material: code=rha4ta



ees00−1n, ees10−1a



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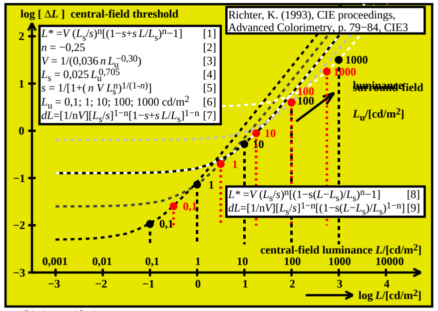

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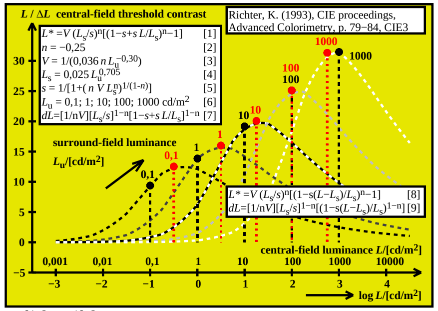

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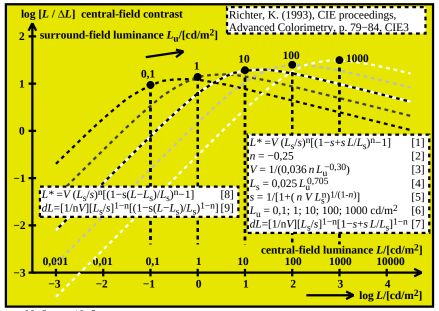

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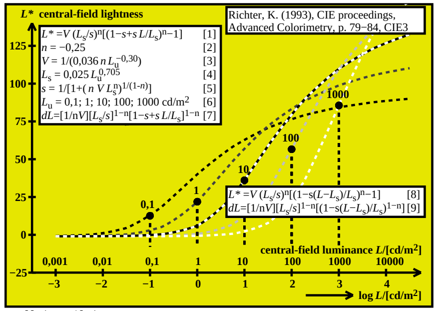

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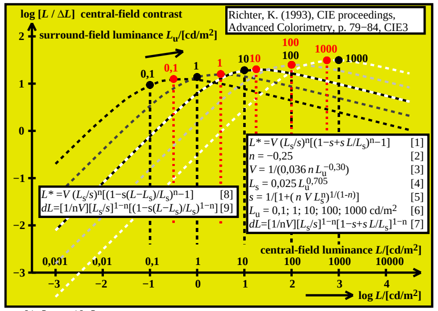

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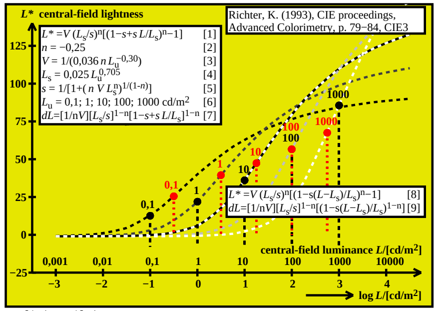


ees01−4n, ees10−4a

Line-element equations according to CIE 230:2019

Colour-threshold (t) function $f_t(x) = \Delta Y_t = \Delta x\, Y_u$ [0]

$\Delta Y_t=(A_1+A_2 Y)/A_0$ $A_0=1{,}5$, $A_1=0{,}0170$, $A_2=0{,}0058$

$$f_{tu}(x) = \frac{\Delta Y_t}{\Delta Y_{tu}} = \frac{1+b\,x}{1+b} \quad b=A_2 Y_u/A_1 \quad x=Y/Y_u \qquad [1]$$

$$F_{tu}(x) = \int \frac{f'_{tu}(x)}{f_{tu}(x)}\,dx = \int \frac{b}{1+b\,x}\,dx \qquad [2]$$

Example for $L^*_{tu}(x)$, ΔY_t with $x=Y/Y_u$, $x_u=1$, b=6,141:

$$L^*_{tu}(x) = \frac{L^*_t(x)}{L^*_{tu}(x)} = \frac{\ln(1+b\,x)}{\ln(1+b)} \qquad [3]$$

$$f_{tu}(x) = \frac{\Delta Y_t}{\Delta Y_{tu}} = \frac{1+b\,x}{1+b} \qquad [4]$$

ees00−5N EEO0−4N

Line-element equations: loudness − sound level [1]

Simple equation by the ***Weber-Fechner* law** between the loudness N^* and the sound level E

$$\frac{\Delta N^*}{N^*} = n\,\frac{\Delta E}{E} \qquad [1]$$

It is assumed at the hearing threshold E_s

$$\frac{\Delta N^*}{N^*+N^*_s} = n\,\frac{\Delta E}{E+E_s} \qquad [2]$$

Integration on both sides and requirement $N^*=0$ for $E=0$

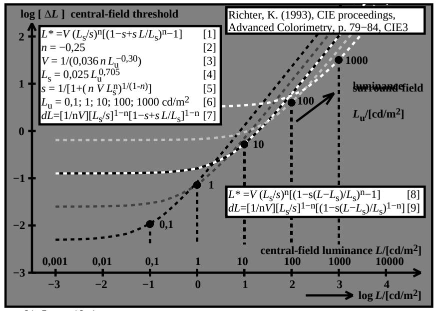
$$N^* = N^*_s\,[\,(1+\frac{E}{E_s})^n - 1\,] \qquad [3]$$

Small change with threshold factor s and $N^*=0$ for $E=E_s$

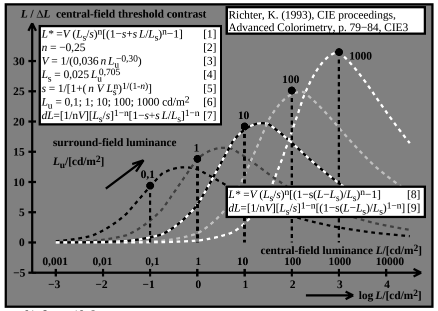
$$N^* = N^*_s\,[\,(1+s\,\frac{E-E_s}{E_s})^n - 1\,] \qquad [4]$$

1) *Zwicker E., Feldkeller R., (1967),* Das Ohr als Nachrichtenempfänger (the ear as information receiver), Hirzel-Verlag, 232 pages, see 133−139

ees00−6N



ees01−5n, ees10−1a



ees01−6n, ees10−2a

Line-element equations: lightness − luminance [1]

Simple equation by the ***Weber-Fechner* law** between the lightness L^* and the luminance L

$$\frac{\Delta L^*}{L^*} = n\,\frac{\Delta L}{L} \qquad [1]$$

It is assumed at the luminance threshold L_s

$$\frac{\Delta L^*}{L^*+L^*_s} = n\,\frac{\Delta L}{L+L_s} \qquad [2]$$

Integration on both sides and requirement $L^*=0$ for $L=0$

$$L^* = L^*_s\,[\,(1+\frac{L}{L_s})^n - 1\,] \qquad [3]$$

Small change with threshold factor s and $L^*=0$ for $L=L_s$

$$L^* = L^*_s\,[\,(1+s\,\frac{L-L_s}{L_s})^n - 1\,] \qquad [4]$$

1) *Richter, Klaus.*, (1969), Antagonistic signals in colour vision and relation with the perceived colour order (in German), Dis. Universität Basel, 150 pages, see 115-123

ees00−7N

Line-element equations: lightness − tristimulus value

Richter [1] has used the following equation to approximate between the lightness L^* and the tristimulus value Y

$$L^* = L^*_s\,[\,(1+s\,\frac{Y-Y_s}{L_s})^n - 1\,] \qquad [1]$$

The parameters are for the *Munsell Value* function [2]

$L^*_s=2{,}5125$ $s=0{,}4250$ $Y_s=0{,}1551$ $n=0{,}3333$ [2]

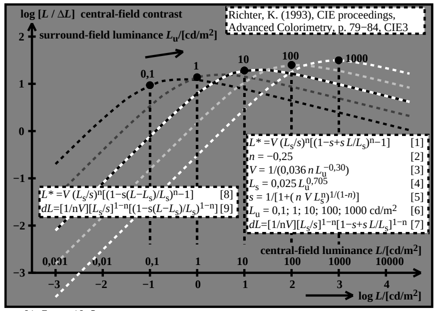
The parameters are for the *CIELAB-lightness* function [3]

$$L^* = 116\,(Y/Y_n)^{1/3} - 16 \quad (0{,}8<Y<100,\ Y_n=100) \qquad [3]$$

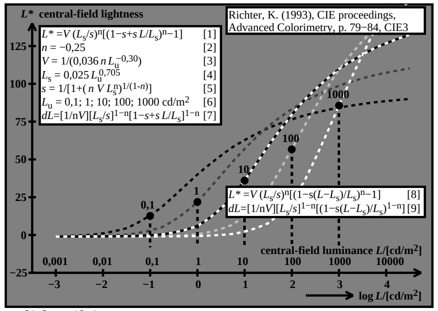
$L^*_s=2{,}5125$ $s=0{,}4250$ $Y_s=0{,}1551$ $n=0{,}3333$ [4]

1) *Richter, Klaus.*, (1969), Antagonistic signals in colour vision and relation with the perceived colour order (in German), Dis. Universität Basel, 150 pages, see 115-123, 74 MB, see for free download https://edoc/unibas.ch/72306/
2) *Newhall, S.M., Nickerson, D., Judd, D.B. (1943), Final report of the O.S.A. subcommittee on the spacing of Munsell Colors, OSA 33, 385-418, see p. 417*
3) ISO/CIE 11664−4:2019 Colorimetry, CIE 1976 L*a*b* colour space

ees00−8N



ees01−7n, ees10−3a



ees01−8n, ees10−4a

TUB-test chart ees0; Achromatic thresholds; 5 luminances L_u=0,1, 1, 10, 100, 1000 cd/m²
ΔL (0,4s), contrast, and lightness; experimental data of *Lingelbach* and equations of *Richter*