line element of light technology (luminance L) and color metrics with „color values” P, D, T

luminance signal function $F(L)$
color signal functions $F(P, D, T)$

Taylor-derivations:

$$\Delta F(L)=\frac{dF}{dL}\Delta L$$

$$\Delta F(P, D, T)=\frac{dF}{dP}\Delta P+\frac{dF}{dD}\Delta D+\frac{dF}{dT}\Delta T$$

JE690−1

line element of *Helmholtz* (1896) with „color values” P, D, T

three separate color signal functions

$$F(P) = i\ln P$$
$$F(D) = j\ln D$$
$$F(T) = k\ln T$$

Taylor-derivations:

$$\Delta F(P, D, T)=\frac{dF}{dP}\Delta P+\frac{dF}{dD}\Delta D+\frac{dF}{dT}\Delta T$$

$$\Delta F(P, D, T)=\frac{i}{P}\Delta P+\frac{j}{D}\Delta D+\frac{k}{T}\Delta T$$

JE690−2

double line element of *Richter* (1987) for the lighting technic with luminance $L=F(P, D, T)$

luminance signal function $F(L)$

$$F(L)=iQ(H)=\begin{cases}\underline{i}\,Q(\underline{H}) & (x<u)\\ \bar{i}\,Q(\bar{H}) & (x\geq u)\end{cases}$$

with: $\underline{k}=1{,}4$ $\bar{k}=1$ $\underline{i}=1$ $\bar{i}=-2$
$x=\log L$ $u=\log L_u$
$H=e^{k(x-u)}$, $\underline{H}=e^{\underline{k}(x-u)}$, $\bar{H}=e^{\bar{k}(x-u)}$

JE691−1

double line element of *Richter* (1987) for the lighting technic with luminance $L=F(P, D, T)$

luminance signal function $F(L)$

$$F(L)=iQ(H)\qquad H=e^{k(x-u)}$$
$$Q[\ln\{1+1/(1+\sqrt{2}H)\}]/\ln\sqrt{2}-1$$

Taylor-derivations:

$$\Delta F(L)=\frac{dF}{dL}\Delta L=i\,\frac{dQ}{dH}\Delta H$$
$$=-i\sqrt{2}\Delta H/[\ln\sqrt{2}(1+\sqrt{2}H)(2+\sqrt{2}H)]$$

JE690−8

line element of *Stiles* (1946) with „color values” P, D, T

three separate color signal functions

$$F(P) = i\ln(1+9P)$$
$$F(D) = j\ln(1+9D)$$
$$F(T) = k\ln(1+9T)$$

Taylor-derivations:

$$\Delta F(P, D, T)=\frac{dF}{dP}\Delta P+\frac{dF}{dD}\Delta D+\frac{dF}{dT}\Delta T$$

$$=\frac{9i}{1+9P}\Delta P+\frac{9j}{1+9D}\Delta D+\frac{9k}{1+9T}\Delta T$$

JE690−1

line element of *Vos&Walraven* (1972) with „color values” P, D, T

three separate color signal functions

$$F(P) = -2i\sqrt{P}$$
$$F(D) = -2j\sqrt{D}$$
$$F(T) = -2k\sqrt{T}$$

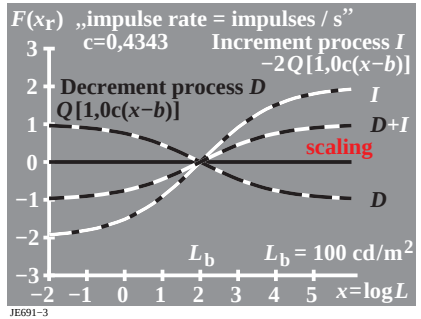
Taylor-derivations:

$$\Delta F(P, D, T)=\frac{dF}{dP}\Delta P+\frac{dF}{dD}\Delta D+\frac{dF}{dT}\Delta T$$

$$\Delta F(P, D, T)=\frac{i}{\sqrt{P}}\Delta P+\frac{j}{\sqrt{D}}\Delta D+\frac{k}{\sqrt{T}}\Delta T$$

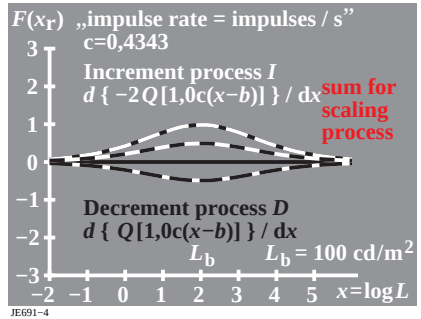
JE690−4

$F(x_r)$ „impulse rate = impulses / s”



JE691−3

$F(x_r)$ „impulse rate = impulses / s”



JE691−4

functions $q[k(x-u)]$
„achromatic signal”-description

with $x=\log L$ (L = luminance)
$u=\log L_u$ (L_u = surround luminan.)

$$q[k(x-u)]=1+1/[1+\sqrt{2}e^{k(x-u)}]$$

function values:

$q[k(x-u) \to +\infty] = 1$
$q[k(x-u) = 0] = \sqrt{2}$
$q[k(x-u) \to -\infty] = 2$

JE690−5

„achromatic signal”-description functions $Q_{lm}[k(x-u)]$

with $x=\log L$ (L = luminance)
$u=\log L_u$ (L_u = surround luminan.)

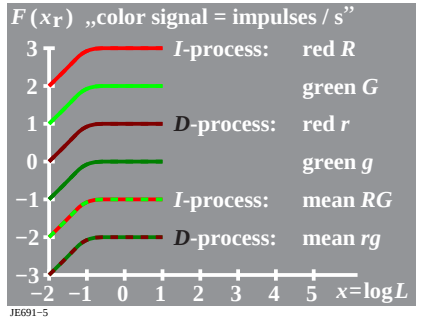
$$Q_{lm}[k(x-u)]=\frac{l}{\ln\sqrt{2}}\ln q[k(x-u)]-m$$

function values with $l = m = 1$:

$Q[k(x-u) \to +\infty] = 1$
$Q[k(x-u) = 0] = 0$
$Q[k(x-u) \to -\infty] = -1$

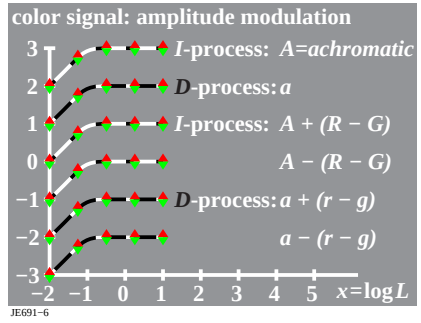
JE690−6

$F(x_r)$ „color signal = impulses / s”



JE691−5

color signal: amplitude modulation



JE691−6

„achromatic signal”discrimination as function of relative light density $h=\ln H= k(x-u)$ ln = natural log.

$$Q'=\frac{d}{dH}[\ln\{1+1/(1+\sqrt{2}H)\}]/\ln\sqrt{2}$$
$$=-\sqrt{2}/[\ln\sqrt{2}(1+\sqrt{2}H)(2+\sqrt{2}H)]$$

function values:

$Q'[k(x-u) \to +\infty] = 0$
$Q'[k(x-u) = 0] = -0{,}5$
$Q'[k(x-u) \to -\infty] = 0$

JE690−7

luminance discrimination possibility $L/\Delta L$ as function of H

with: $L=10^x$ $H=e^h=10^{\log e\,k(x-u)}$
$dL/dx=\ln 10\,L$ $dH/dx=k\,H$

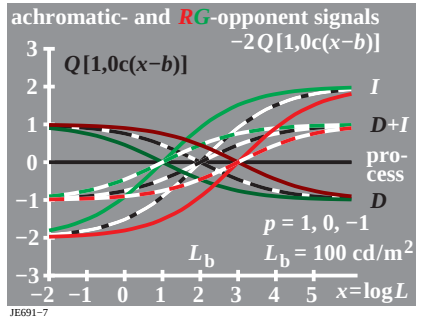
it follows: $L/\Delta L=[k\,H/(dH\ln 10)]$

$$\frac{L}{dL}=\text{const}\;H/[(1+\sqrt{2}H)(2+\sqrt{2}H)]$$

$Q'[k(x-u) \to +\infty] = 0$
$Q'[k(x-u) = 0] =$ maximum
$Q'[k(x-u) \to -\infty] = 0$

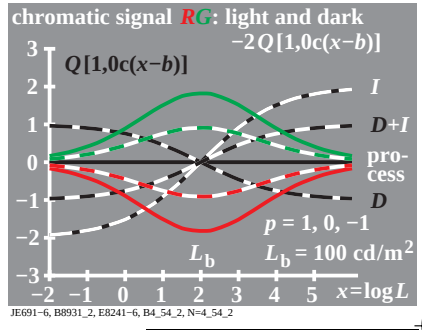
JE690−8

achromatic- and RG-opponent signals



JE691−7

chromatic signal RG: light and dark



JE691−6, B8931_2, E8241−6, B4_54_2, N=4_54_2

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JE690−1

line element of *Helmholtz* (1896) with „color values” P, D, T

three separate color signal functions

$$F(P) = i \ln P$$
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Taylor-derivations:

$$\Delta F(P, D, T)=\frac{dF}{dP}\Delta P+\frac{dF}{dD}\Delta D+\frac{dF}{dT}\Delta T$$

$$\Delta F(P, D, T)=\frac{i}{P}\Delta P+\frac{j}{D}\Delta D+\frac{k}{T}\Delta T$$

JE690−2

double line element of *Richter* (1987) for the lighting technic with luminance $L=F(P, D, T)$

luminance signal function $F(L)$

$$F(L)=iQ(H)=\begin{cases}\underline{i}\,Q(\underline{H}) & (x<u)\\ \bar{i}\,Q(\bar{H}) & (x\geq u)\end{cases}$$

with: $\underline{k}=1{,}4$ $\bar{k}=1$ $\underline{i}=1$ $\bar{i}=-2$
$x=\log L$ $u=\log L_u$
$H=e^{k(x-u)}$, $\underline{H}=e^{\underline{k}(x-u)}$, $\bar{H}=e^{\bar{k}(x-u)}$

JE691−1

double line element of *Richter* (1987) for the lighting technic with luminance $L=F(P, D, T)$

luminance signal function $F(L)$

$$F(L)=iQ(H) \qquad H=e^{k(x-u)}$$
$$Q[\ln\{1+1/(1+\sqrt{2}H)\}]/\ln\sqrt{2}-1$$

Taylor-derivations:

$$\Delta F(L)=\frac{dF}{dL}\Delta L=i\,\frac{dQ}{dH}\Delta H$$
$$=-i\sqrt{2}\Delta H/[\ln\sqrt{2}(1+\sqrt{2}H)(2+\sqrt{2}H)]$$

JE690−8

line element of *Stiles* (1946) with „color values” P, D, T

three separate color signal functions

$$F(P) = i \ln(1+9P)$$
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$$F(T) = k \ln(1+9T)$$

Taylor-derivations:

$$\Delta F(P, D, T)=\frac{dF}{dP}\Delta P+\frac{dF}{dD}\Delta D+\frac{dF}{dT}\Delta T$$
$$=\frac{9i}{1+9P}\Delta P+\frac{9j}{1+9D}\Delta D+\frac{9k}{1+9T}\Delta T$$

JE690−1

line element of *Vos&Walraven* (1972) with „color values” P, D, T

three separate color signal functions

$$F(P) = -2i\sqrt{P}$$
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Taylor-derivations:

$$\Delta F(P, D, T)=\frac{dF}{dP}\Delta P+\frac{dF}{dD}\Delta D+\frac{dF}{dT}\Delta T$$

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JE690−4

$F(x_r)$ „impulse rate = impulses / s”
c=0,4343 Increment process I $-2Q[1,0c(x-b)]$
Decrement process D $Q[1,0c(x-b)]$
I
$D+I$
scaling
D
L_b L_b = 100 cd/m²
$x=\log L$

JE691−3

$F(x_r)$ „impulse rate = impulses / s”
c=0,4343
Increment process I $d\{-2Q[1,0c(x-b)]\}/dx$
sum for scaling process
Decrement process D $d\{Q[1,0c(x-b)]\}/dx$
L_b L_b = 100 cd/m²
$x=\log L$

JE691−4

functions $q[k(x-u)]$ „achromatic signal”-description

with $x=\log L$ (L = luminance)
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JE690−5

„achromatic signal”-description functions $Q_{lm}[k(x-u)]$

with $x=\log L$ (L = luminance)
$u=\log L_u$ (L_u = surround luminan.)

$$Q_{lm}[k(x-u)]=-\frac{l}{\ln\sqrt{2}}\ln q[k(x-u)]-m$$

function values with $l = m = 1$:

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$Q[k(x-u) = 0] = 0$
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JE690−6

$F(x_r)$ „color signal = impulses / s”
I-process: red R
green G
D-process: red r
green g
I-process: mean RG
D-process: mean rg
$x=\log L$

JE691−5

color signal: amplitude modulation
I-process: A=achromatic
D-process: a
I-process: $A+(R-G)$
$A-(R-G)$
D-process: $a+(r-g)$
$a-(r-g)$
$x=\log L$

JE691−6

„achromatic signal”discrimination as function of relative light density $h=\ln H=k(x-u)$ ln = natural log.

$$Q'=\frac{d}{dH}[\ln\{1+1/(1+\sqrt{2}H)\}]/\ln\sqrt{2}$$
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JE690−7

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it follows: $L/\Delta L=[kH/(dH\ln 10)]$

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JE690−8

achromatic- and RG-opponent signals
$-2Q[1,0c(x-b)]$
$Q[1,0c(x-b)]$
I
$D+I$
pro-cess
D
p = 1, 0, −1
L_b L_b = 100 cd/m²
$x=\log L$

JE691−7

chromatic signal RG: light and dark
$-2Q[1,0c(x-b)]$
$Q[1,0c(x-b)]$
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$D+I$
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$x=\log L$

JE691−6, B8931_2, E8241−6, B4_54_2, N=4_54_2