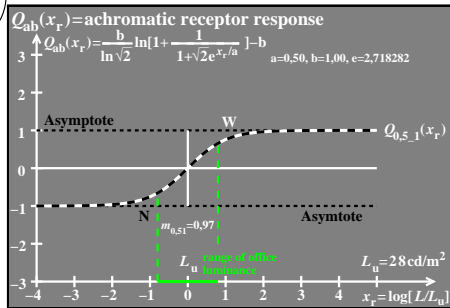


see similar files of the whole serie: <http://farbe.li.tu-berlin.de/hey2.htm> technical information: <http://farbe.li.tu-berlin.de> or <http://color.li.tu-berlin.de>

TUB registration: 20241201-hey2/hey210np.pdf / .ps application for evaluation and measurement of display or print output

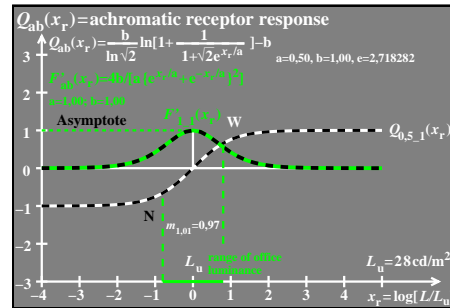
TUB material: code=rh4ta



hey20-1n eer20-1n

Achromatic receptor-response function
 $Q_{ab}[x_r/a]$ for $a=0,5$ and $b=1,0$
 with $x_r = \log [L/L_u]$ (L =test luminance)
 L_u =surround luminance
 $Q_{ab}[x_r/a] = \frac{b}{\ln \sqrt{2}} \ln \left[\frac{1}{1 + \sqrt{2} e^{(x_r/a)}} \right] - b$
function values for $b=1$ and any $a>0$:
 $Q_{a1}[x_r/a \rightarrow -\infty] = -1$ $x = \log L, u = \log L_u$
 $Q_{a1}[x_r/a = 0] = 0$ $x_r = \log [L/L_u]$
 $Q_{a1}[x_r/a \rightarrow +\infty] = +1$ $= x - u$

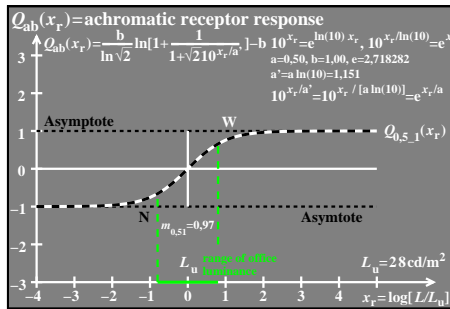
hey20-2n eer20-2n



hey21-1n eer21-1n

Achromatic colour vision with relative luminance
Mathematical equations with hyperbel functions
 $F(x) = \tanh(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}} = \frac{u(x)}{v(x)}$ $u'(x) = v(x)$ $v'(x) = u(x)$ [1]
 $\frac{dF(x)}{dx} = \frac{u'(x)v(x) - u(x)v'(x)}{v^2(x)} = \frac{v^2(x) - u^2(x)}{v^2(x)}$ [2]
 $\frac{dF(x)}{dx} = \frac{[e^x + e^{-x}][e^x + e^{-x}] - [e^x - e^{-x}][e^x - e^{-x}]}{[e^x + e^{-x}]^2}$ [3]
 $\frac{dF(x)}{dx} = \frac{4}{[e^x + e^{-x}]^2} = \frac{1}{\cosh^2(x)}$ [4]

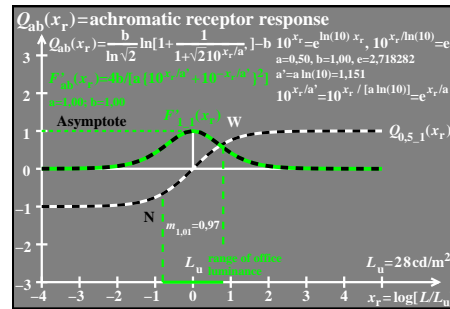
hey21-2n eer21-2n



hey20-3n eer20-3n

Achromatic receptor-response function
 $Q_{ab}[x_r/a]$ for $a=0,5$ and $b=1,0$
 with $x_r = \log [L/L_u]$ (L =test luminance)
 L_u =surround luminance
 $Q_{ab}[x_r/a] = \frac{b}{\ln \sqrt{2}} \ln \left[\frac{1}{1 + \sqrt{2} e^{(x_r/a)}} \right] - b$
function values for $b=1$ and any $a>0$:
 $Q_{a1}[x_r/a \rightarrow -\infty] = -1$ $x = \log L, u = \log L_u$
 $Q_{a1}[x_r/a = 0] = 0$ $x_r = \log [L/L_u]$
 $Q_{a1}[x_r/a \rightarrow +\infty] = +1$ $= x - u$

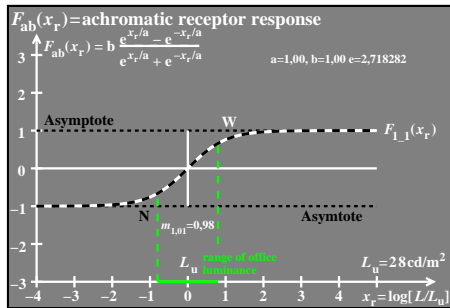
hey20-4n eer20-4n



hey21-3n eer21-3n

Achromatic colour vision with relative luminance
Mathematical equations with hyperbel functions
 $F(x, a) = \tanh(x/a) = \frac{e^{x/a} - e^{-x/a}}{e^{x/a} + e^{-x/a}} = \frac{u(x/a)}{v(x/a)}$ [1]
 $\frac{dF(x, a)}{dx} = \frac{u'(x/a)v(x/a) - u(x/a)v'(x/a)}{v^2(x/a)}$ [2]
 $\frac{dF(x, a)}{dx} = \frac{v^2(x/a) - u^2(x/a)}{av^2(x/a)}$ [3]
 $\frac{dF(x, a)}{dx} = \frac{4}{a[e^{x/a} + e^{-x/a}]^2} = \frac{1}{a \cosh^2(x/a)}$ [4]

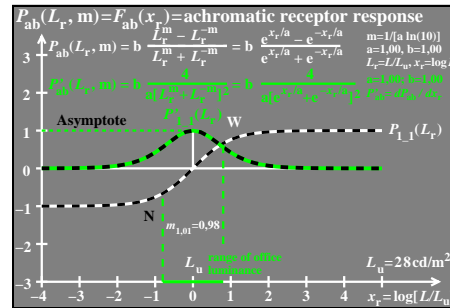
hey21-4n eer21-4n



hey20-5n eer20-5n

Mathematical equations of hyperbel functions
 See: *Handbook of mathematical functions, NBS, USA, Sec. 4.5*
 $\sinh(x) = \frac{e^x - e^{-x}}{2}$ [1], $\cosh(x) = \frac{e^x + e^{-x}}{2}$ [2]
 $\tanh(x) = \frac{\sinh(x)}{\cosh(x)} = \frac{e^x - e^{-x}}{e^x + e^{-x}}$ [3]
 $\tanh(x/2) = \frac{\sinh(x)}{\cosh(x) + 1} = \frac{\cosh(x) + 1}{\sinh(x)} = \frac{e^{x/2} - e^{-x/2}}{e^{x/2} + e^{-x/2}}$ [4]
 $\sinh^2(x) + \cosh^2(x) = 1$ [5]

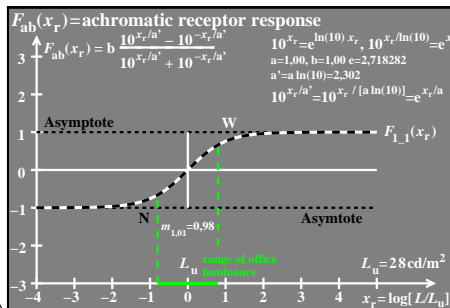
hey20-6n eer20-6n



hey21-5n eer21-5n

Achromatic colour vision with relative luminance
Mathematical equations with potential functions
 $F(L) = \frac{L^m - L^{-m}}{L^m + L^{-m}} = \frac{u(L)}{v(L)}$ $u'(L) = m[L^{m-1} + L^{-m-1}]$ $v'(L) = m[L^{m-1} - L^{-m-1}]$ [1]
 $\frac{dF(L)}{dL} = \frac{u'(L)v(L) - u(L)v'(L)}{v^2(L)}$ [2]
 $u'(L)v(L) - v'(L)u(L) = m \{ [L^{m-1} + L^{-m-1}][L^m + L^{-m}] - [L^{m-1} - L^{-m-1}][L^m - L^{-m}] \}$ [3]
 $= m \{ L^{2m-1} + L^{-1} + L^{-2m-1} - L^{2m-1} + L^{-1} + L^{-2m-1} \} = 4m/L^{-1}$
 $\frac{dF(L)}{dL} = \frac{4m}{L[L^m + L^{-m}]^2}$ [4]

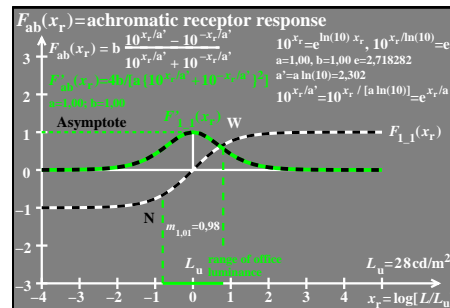
hey21-6n eer21-6n



hey20-7n eer20-7n

Mathematical equations of hyperbel functions
 See: *Handbook of mathematical functions, NBS, USA, Sec. 4.5*
 $\sinh(x) = \frac{10^{x/2a'} - 10^{-x/2a'}}{2}$ [1], $\cosh(x) = \frac{10^{x/2a'} + 10^{-x/2a'}}{2}$ [2]
 $\tanh(x) = \frac{\sinh(x)}{\cosh(x)} = \frac{10^{x/2a'} - 10^{-x/2a'}}{10^{x/2a'} + 10^{-x/2a'}}$ [3]
 $\tanh(x/2) = \frac{\sinh(x)}{\cosh(x) + 1} = \frac{\cosh(x) + 1}{\sinh(x)} = \frac{10^{x/2a'} - 10^{-x/2a'}}{10^{x/2a'} + 10^{-x/2a'}} \cdot \frac{10^{x/2a'}}{10^{x/2a'}} = \frac{10^{x/a'} - 10^{-x/a'}}{10^{x/a'} + 10^{-x/a'}}$ [4]
 $\sinh^2(x) + \cosh^2(x) = 1$ [5]

hey20-8n eer20-8n



hey21-7n eer21-7n

Achromatic colour vision with relative luminance
Equations with hyperbel and potential functions
 $F_{ab}(x_r, a) = b \tanh(x_r/a) = b \frac{e^{x_r/a} - e^{-x_r/a}}{e^{x_r/a} + e^{-x_r/a}}$ $x_r = \log(L_r)$ $L_r = L/L_u$ [1a]
 $\frac{dF_{ab}(x_r, a)}{dx_r} = \frac{4b}{a[e^{x_r/a} + e^{-x_r/a}]^2} = \frac{4b}{a} \frac{x_r = \ln L_r / \ln(10)}{dx_r / dL_r = 1 / (\ln(10) L_r)}$ $m = 1 / (a \ln(10))$ [5a]
 $F_{ab}(L_r, m) = b \tanh(x_r/a) = b \frac{L_r^m - L_r^{-m}}{L_r^m + L_r^{-m}}$ $x_r = \log(L_r)$ $L_r = L/L_u$ [1b]
 $\frac{dF_{ab}(L_r, m)}{dL_r} = \frac{4bm}{L_r[L_r^m + L_r^{-m}]^2} = \frac{4bm}{L_r} \frac{x_r = \ln L_r / \ln(10)}{dx_r / dL_r = 1 / (\ln(10) L_r)}$ $dx_r = (a m / L_r) dL_r$ [5b]

hey21-8n eer21-8n

TUB-test chart hey2; Model of normalized response functions $F_{ab}(x_r)$, $Q_{ab}(x_r)$ & $P_{ab}(L_r)$, and derivation, Tangens hyperbolicus $\tanh(x_r)$ and modified functions with e^{x_r} , 10^{x_r} , and L_r