see similar files: http://farbe.li.tu-berlin.de/DE16/DE16.HTM
technical information: http://farbe.li.tu-berlin.de or http://130.149.60.45/~farbmetrik

Transformation between the *Judd* tristimulus and opponent values

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 81.

For the antagonistic spectral elementary colours
λ_B= 475 nm, λ_G= 502 nm, λ_Y= 574 nm, λ_R= 494c nm
the coordinates $\bar{x}_i$ (i=1 to 3) are used instead of modern coordinates $\bar{l}$, $\bar{a}$, $\bar{b}$.

Linear model equations between spectral colour values in both directions:

$$\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix}=\begin{pmatrix}b_{11}&b_{12}&b_{13}\\ b_{21}&b_{22}&b_{23}\\ b_{31}&b_{32}&b_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}0000&1{,}0000&0{,}0000\\ 2{,}9797&-2{,}6662&-0{,}0960\\ -0{,}4139&1{,}4571&-2{,}4046\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix} \quad (1)$$

$$\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}&a_{13}\\ a_{21}&a_{22}&a_{23}\\ a_{31}&a_{32}&a_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}9093&0{,}3338&-0{,}0133\\ 1{,}0000&0{,}0000&0{,}0000\\ 0{,}4494&-0{,}0574&-0{,}4136\end{pmatrix}\cdot\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix} \quad (2)$$

The tristimulus values X_1, X_2, X_3 and X, Y, Z need the same transformations.

The unnormalized purity data a_u and b_u are defined in LabMUN 1969 as follows:
$a_u=X_2/X_1=x_2/x_1$ (3) $b_u=X_3/X_1=x_3/x_1$ (4) $x_3=1-x_2-x_1$ (5)

The unnormalized purity data a_u and b_u are defined in LabMUN 1969 as follows:
$a_u=[(b_{21}-b_{23})x+(b_{22}-b_{23})y+b_{23}]/y$
$=(3{,}0757x-2{,}5702y-0{,}0960)/y$ (6)
$b_u=[(b_{31}-b_{33})x+(b_{32}-b_{33})y+b_{33}]/y$
$=(1{,}9906x+3{,}8617y-2{,}4046)/y$ (7)

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Transformation between the *Judd* tristimulus and opponent values

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 81.

For the antagonistic spectral elementary colours
λ_B= 475 nm, λ_G= 502 nm, λ_Y= 574 nm, λ_R= 494c nm
the coordinates $\bar{x}_i$ (i=1 to 3) are used instead of modern coordinates $\bar{l}$, $\bar{a}$, $\bar{b}$.

Linear model equations between spectral colour values in both directions:

$$\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix}=\begin{pmatrix}b_{11}&b_{12}&b_{13}\\ b_{21}&b_{22}&b_{23}\\ b_{31}&b_{32}&b_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}0000&1{,}0000&0{,}0000\\ 2{,}9797&-2{,}6662&-0{,}0960\\ -0{,}4139&1{,}4571&-2{,}4046\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix} \quad (1)$$

$$\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}&a_{13}\\ a_{21}&a_{22}&a_{23}\\ a_{31}&a_{32}&a_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}9093&0{,}3338&-0{,}0133\\ 1{,}0000&0{,}0000&0{,}0000\\ 0{,}4494&-0{,}0574&-0{,}4136\end{pmatrix}\cdot\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix} \quad (2)$$

The tristimulus values X_1, X_2, X_3 and X, Y, Z need the same transformations.

The normalized purity data a_n and b_n are defined in LabMUN 1969 as follows:
$a_n=n_a a_u=n_a X_2/X_1=n_a x_2/x_1$; $n_a=2{,}8$ (3) $b_n=b_u=X_3/X_1=x_3/x_1$ (4) $x_3=1-x_2-x_1$ (5)

The normalized purity data a_n and b_n are defined in LabMUN 1969 as follows:
$a_n=n_a[(b_{21}-b_{23})x+(b_{22}-b_{23})y+b_{23}]/y$
$=2{,}8(3{,}0757x-2{,}5702y-0{,}0960)/y$
$=(8{,}6119x-7{,}1965y-0{,}2688)/y$ (6)
$b_n=[(b_{31}-b_{33})x+(b_{32}-b_{33})y+b_{33}]/y$
$=(1{,}9906x+3{,}8617y-2{,}4046)/y$ (7)

DE160−7N

Transformation between the *Judd* purity and chromaticity

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 83.

For the antagonistic spectral elementary colours
λ_B= 475 nm, λ_G= 502 nm, λ_Y= 574 nm, λ_R= 494c nm
the coordinates $\bar{x}_i$ (i=1 to 3) are used instead of modern coordinates $\bar{l}$, $\bar{a}$, $\bar{b}$.

Relation between opponent and spectral colour values:

$$\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}&a_{13}\\ a_{21}&a_{22}&a_{23}\\ a_{31}&a_{32}&a_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}9093&0{,}3338&-0{,}0133\\ 1{,}0000&0{,}0000&0{,}0000\\ 0{,}4494&-0{,}0574&-0{,}4136\end{pmatrix}\cdot\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix} \quad (2)$$

The tristimulus values X_1, X_2, X_3 and X, Y, Z need the same transformations.
The unnormalized purity data a_u and b_u are defined in LabMUN 1969 as follows:
$a_u=X_2/X_1=x_2/x_1$ (3) $b_u=X_3/X_1=x_3/x_1$ (4) $x_3=1-x_2-x_1$ (5)
Use of equations (2) to (5) leads to:

$$\begin{pmatrix}X\\ Y\\ Z\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}a_u&a_{13}b_u\\ a_{21}&a_{22}a_u&a_{23}b_u\\ a_{31}&a_{32}a_u&a_{33}b_u\end{pmatrix}\cdot\begin{pmatrix}X_1\\ X_1\\ X_1\end{pmatrix} \quad (6)$$

and with $x=X/(X+Y+Z)$ and $y=Y/(X+Y+Z)$ (7)

$x=[a_{11}+a_{12}a_u+a_{13}b_u]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})a_u+(a_{13}+a_{23}+a_{33})b_u]$
$y=[a_{21}+a_{22}a_u+a_{23}b_u]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})a_u+(a_{13}+a_{23}+a_{33})b_u]$ (8)
$x=(\alpha_{11}+\alpha_{12}a_u+\alpha_{13}b_u)/(\alpha_{31}+\alpha_{32}a_u+\alpha_{33}b_u)$
$=(0{,}9093+0{,}3338a_u-0{,}0133b_u)/(2{,}3587+0{,}2764a_u-0{,}4269b_u)$ (9)
$y=(\alpha_{21}+\alpha_{22}a_u+\alpha_{23}b_u)/(\alpha_{31}+\alpha_{32}a_u+\alpha_{33}b_u)$
$=(1{,}000+0{,}000a_u+0{,}000b_u)/(2{,}3587+0{,}2764a_u-0{,}4269b_u)$ (10)

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Transformation between the *Judd* purity and chromaticity

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 83.

For the antagonistic spectral elementary colours
λ_B= 475 nm, λ_G= 502 nm, λ_Y= 574 nm, λ_R= 494c nm
the coordinates $\bar{x}_i$ (i=1 to 3) are used instead of modern coordinates $\bar{l}$, $\bar{a}$, $\bar{b}$.

Relation between opponent and spectral colour values:

$$\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}&a_{13}\\ a_{21}&a_{22}&a_{23}\\ a_{31}&a_{32}&a_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}9093&0{,}3338&-0{,}0133\\ 1{,}0000&0{,}0000&0{,}0000\\ 0{,}4494&-0{,}0574&-0{,}4136\end{pmatrix}\cdot\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix} \quad (2)$$

The tristimulus values X_1, X_2, X_3 and X, Y, Z need the same transformations.
The normalized purity data a_n and b_n are defined in LabMUN 1969 as follows:
$a_n=n_a a_u=n_a X_2/X_1=n_a x_2/x_1$; $n_a=2{,}8$ (3) $b_n=b_u=X_3/X_1=x_3/x_1$ (4) $x_3=1-x_2-x_1$ (5)
Use of equations (2) to (5) leads to:

$$\begin{pmatrix}X\\ Y\\ Z\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}a_n/\mathrm{n_a}&a_{13}b_n\\ a_{21}&a_{22}a_n/\mathrm{n_a}&a_{23}b_n\\ a_{31}&a_{32}a_n/\mathrm{n_a}&a_{33}b_n\end{pmatrix}\cdot\begin{pmatrix}X_1\\ X_1\\ X_1\end{pmatrix} \quad (6)$$

with $x=X/(X+Y+Z)$ and $y=Y/(X+Y+Z)$ (7)

$x=[a_{11}+a_{12}a_n/n_a+a_{13}b_n]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})/n_a+(a_{13}+a_{23}+a_{33})b_n]$
$y=[a_{21}+a_{22}a_n/n_a+a_{23}b_n]/[a_{11}+a_{21}+a_{31}(a_{12}+a_{22}+a_{32})/n_a+(a_{13}+a_{23}+a_{33})b_n]$ (8)
$x=(\alpha_{11}+\alpha_{12}a_n+\alpha_{13}b_n)/(\alpha_{31}+\alpha_{32}a_n+\alpha_{33}b_n)$
$=(0{,}9093+0{,}1192a_n-0{,}0133b_n)/(2{,}3587+0{,}0987a_n-0{,}4269b_n)$ (9)
$y=(\alpha_{21}+\alpha_{22}a_n+\alpha_{23}b_n)/(\alpha_{31}+\alpha_{32}a_n+\alpha_{33}b_n)$
$=(1{,}000+0{,}000a_n+0{,}000b_n)/(2{,}3587+0{,}0987a_n-0{,}4269b_n)$ (10)

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Transformation between the *Judd* tristimulus and opponent values

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 81.

For the antagonistic spectral elementary colours
λ_B= 475 nm, λ_G= 502 nm, λ_Y= 574 nm, λ_R= 494c nm
modern coordinates $\bar{l}$, $\bar{a}$, $\bar{b}$ are used instead of $\bar{x}_i$ (i=1 to 3).

Linear model equations between spectral colour values in both directions:

$$\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix}=\begin{pmatrix}b_{11}&b_{12}&b_{13}\\ b_{21}&b_{22}&b_{23}\\ b_{31}&b_{32}&b_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}0000&1{,}0000&0{,}0000\\ 2{,}9797&-2{,}6662&-0{,}0960\\ -0{,}4139&1{,}4571&-2{,}4046\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix} \quad (1)$$

$$\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}&a_{13}\\ a_{21}&a_{22}&a_{23}\\ a_{31}&a_{32}&a_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}9093&0{,}3338&-0{,}0133\\ 1{,}0000&0{,}0000&0{,}0000\\ 0{,}4494&-0{,}0574&-0{,}4136\end{pmatrix}\cdot\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix} \quad (2)$$

The tristimulus values L, A, B and X, Y, Z need the same transformations.

The unnormalized purity data a_u and b_u are defined in LabMUN 1969 as follows:
$a_u=X/Y=x/y$ (3) $b_u=-Z/Y=-z/y$ (4) $z=1-x-y$ (5)

The unnormalized purity data a_u and b_u are defined in LabMUN 1969 as follows:
$a_u=[(b_{21}-b_{23})x+(b_{22}-b_{23})y+b_{23}]/y$
$=(3{,}0757x-2{,}5702y-0{,}0960)/y$ (6)
$b_u=[(b_{31}-b_{33})x+(b_{32}-b_{33})y+b_{33}]/y$
$=(1{,}9906x+3{,}8617y-2{,}4046)/y$ (7)

DE160−7N

Transformation between the *Judd* tristimulus and opponent values

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 81.

For the antagonistic spectral elementary colours
λ_B= 475 nm, λ_G= 502 nm, λ_Y= 574 nm, λ_R= 494c nm
modern coordinates $\bar{l}$, $\bar{a}$, $\bar{b}$ are used instead of $\bar{x}_i$ (i=1 to 3).

Linear model equations between spectral colour values in both directions:

$$\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix}=\begin{pmatrix}b_{11}&b_{12}&b_{13}\\ b_{21}&b_{22}&b_{23}\\ b_{31}&b_{32}&b_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}0000&1{,}0000&0{,}0000\\ 2{,}9797&-2{,}6662&-0{,}0960\\ -0{,}4139&1{,}4571&-2{,}4046\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix} \quad (1)$$

$$\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}&a_{13}\\ a_{21}&a_{22}&a_{23}\\ a_{31}&a_{32}&a_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}9093&0{,}3338&-0{,}0133\\ 1{,}0000&0{,}0000&0{,}0000\\ 0{,}4494&-0{,}0574&-0{,}4136\end{pmatrix}\cdot\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix} \quad (2)$$

The tristimulus values L, A, B and X, Y, Z need the same transformations.

The normalized purity data a_n and b_n are defined in LabMUN 1969 as follows:
$a_n=n_a a_u=n_a X/Y=n_a x/y$; $n_a=2{,}8$ (3) $b_n=b_u=X/Y=x/y$ (4) $z=1-x-y$ (5)

The normalized purity data a_n and b_n are defined in LabMUN 1969 as follows:
$a_n=n_a[(b_{21}-b_{23})x+(b_{22}-b_{23})y+b_{23}]/y$
$=2{,}8(3{,}0757x-2{,}5702y-0{,}0960)/y$
$=(8{,}6119x-7{,}1965y-0{,}2688)/y$ (6)
$b_n=[(b_{31}-b_{33})x+(b_{32}-b_{33})y+b_{33}]/y$
$=(1{,}9906x+3{,}8617y-2{,}4046)/y$ (7)

DE160−7N

Transformation between the *Judd* purity and chromaticity

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 83.

For the antagonistic spectral elementary colours
λ_B= 475 nm, λ_G= 502 nm, λ_Y= 574 nm, λ_R= 494c nm
modern coordinates $\bar{l}$, $\bar{a}$, $\bar{b}$ are used instead of $\bar{x}_i$ (i=1 to 3).

Relation between opponent and spectral colour values:

$$\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}&a_{13}\\ a_{21}&a_{22}&a_{23}\\ a_{31}&a_{32}&a_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}9093&0{,}3338&-0{,}0133\\ 1{,}0000&0{,}0000&0{,}0000\\ 0{,}4494&-0{,}0574&-0{,}4136\end{pmatrix}\cdot\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix} \quad (2)$$

The tristimulus values L, A, B and X, Y, Z need the same transformations.
The unnormalized purity data a_u and b_u are defined in LabMUN 1969 as follows:
$a_u=X/Y=x/y$ (3) $b_u=-Z/Y=-z/y$ (4) $z=1-x-y$ (5)
Use of equations (2) to (5) leads to:

$$\begin{pmatrix}X\\ Y\\ Z\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}a_u&a_{13}b_u\\ a_{21}&a_{22}a_u&a_{23}b_u\\ a_{31}&a_{32}a_u&a_{33}b_u\end{pmatrix}\cdot\begin{pmatrix}L\\ a\\ b\end{pmatrix} \quad (6)$$

and with $x=X/(X+Y+Z)$ and $y=Y/(X+Y+Z)$ (7)

$x=[a_{11}+a_{12}a_u+a_{13}b_u]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})a_u+(a_{13}+a_{23}+a_{33})b_u]$
$y=[a_{21}+a_{22}a_u+a_{23}b_u]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})a_u+(a_{13}+a_{23}+a_{33})b_u]$ (8)
$x=(\alpha_{11}+\alpha_{12}a_u+\alpha_{13}b_u)/(\alpha_{31}+\alpha_{32}a_u+\alpha_{33}b_u)$
$=(0{,}9093+0{,}3338a_u-0{,}0133b_u)/(2{,}3587+0{,}2764a_u-0{,}4269b_u)$ (9)
$y=(\alpha_{21}+\alpha_{22}a_u+\alpha_{23}b_u)/(\alpha_{31}+\alpha_{32}a_u+\alpha_{33}b_u)$
$=(1{,}000+0{,}000a_u+0{,}000b_u)/(2{,}3587+0{,}2764a_u-0{,}4269b_u)$ (10)

DE160−7N

Transformation between the *Judd* purity and chromaticity

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 83.

For the antagonistic spectral elementary colours
λ_B= 475 nm, λ_G= 502 nm, λ_Y= 574 nm, λ_R= 494c nm
modern coordinates $\bar{l}$, $\bar{a}$, $\bar{b}$ are used instead of $\bar{x}_i$ (i=1 to 3).

Relation between opponent and spectral colour values:

$$\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}&a_{13}\\ a_{21}&a_{22}&a_{23}\\ a_{31}&a_{32}&a_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}9093&0{,}3338&-0{,}0133\\ 1{,}0000&0{,}0000&0{,}0000\\ 0{,}4494&-0{,}0574&-0{,}4136\end{pmatrix}\cdot\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix} \quad (2)$$

The tristimulus values L, A, B and X, Y, Z need the same transformations.
The normalized purity data a_n and b_n are defined in LabMUN 1969 as follows:
$a_n=n_a a_u=n_a X/Y=n_a x/y$; $n_a=2{,}8$ (3) $b_n=b_u=-Z/Y=z/y$ (4) $z=1-x-y$ (5)
Use of equations (2) to (5) leads to:

$$\begin{pmatrix}X\\ Y\\ Z\end{pmatrix}=\begin{pmatrix}a_{11}&a_{12}a_n/\mathrm{n_a}&a_{13}b_n\\ a_{21}&a_{22}a_n/\mathrm{n_a}&a_{23}b_n\\ a_{31}&a_{32}a_n/\mathrm{n_a}&a_{33}b_n\end{pmatrix}\cdot\begin{pmatrix}L\\ L\\ L\end{pmatrix} \quad (6)$$

with $x=X/(X+Y+Z)$ and $y=Y/(X+Y+Z)$ (7)

$x=[a_{11}+a_{12}a_n/n_a+a_{13}b_n]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})/n_a+(a_{13}+a_{23}+a_{33})b_n]$
$y=[a_{21}+a_{22}a_n/n_a+a_{23}b_n]/[a_{11}+a_{21}+a_{31}(a_{12}+a_{22}+a_{32})/n_a+(a_{13}+a_{23}+a_{33})b_n]$ (8)
$x=(\alpha_{11}+\alpha_{12}a_n+\alpha_{13}b_n)/(\alpha_{31}+\alpha_{32}a_n+\alpha_{33}b_n)$
$=(0{,}9093+0{,}1192a_n-0{,}0133b_n)/(2{,}3587+0{,}0987a_n-0{,}4269b_n)$ (9)
$y=(\alpha_{21}+\alpha_{22}a_n+\alpha_{23}b_n)/(\alpha_{31}+\alpha_{32}a_n+\alpha_{33}b_n)$
$=(1{,}000+0{,}000a_n+0{,}000b_n)/(2{,}3587+0{,}0987a_n-0{,}4269b_n)$ (10)

DE160−7N

1

Transformation between the *Judd* tristimulus and opponent values

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 58.

elementary colour	dominant wavelength	*Judd* spectral tristimulus values $\bar{x}(\lambda)$	$\bar{y}(\lambda)$	$\bar{z}(\lambda)$	chromatic values *RG* $\bar{x}_2(\lambda)$	*YB* $\bar{x}_3(\lambda)$
blue	λ_B=475 nm	0,8267	0,9339	0,0017	0,0000	−
green	λ_G=502 nm	0,0107	0,0038	0,0005	−1,0000	0,0000
yellow	λ_Y=574 nm	0,1304	0,1124	0,9281	0,0000	1,0000
red	λ_R=494c,E nm	0,0028	0,3701	0,2238	−	0,0000

There are six equations to calculate the six constants: b_{21} to b_{33}
$\bar{x}_2(\lambda_B)=b_{21}\bar{x}(\lambda_B)+b_{22}\bar{y}(\lambda_B)+b_{23}\bar{z}(\lambda_B)=0$ $\bar{x}_3(\lambda_G)=b_{31}\bar{x}(\lambda_G)+b_{32}\bar{y}(\lambda_G)+b_{33}\bar{z}(\lambda_G)=0$
$\bar{x}_2(\lambda_G)=b_{21}\bar{x}(\lambda_G)+b_{22}\bar{y}(\lambda_G)+b_{23}\bar{z}(\lambda_G)=-1$ $\bar{x}_3(\lambda_Y)=b_{31}\bar{x}(\lambda_Y)+b_{32}\bar{y}(\lambda_Y)+b_{33}\bar{z}(\lambda_Y)=1$
$\bar{x}_2(\lambda_Y)=b_{21}\bar{x}(\lambda_Y)+b_{22}\bar{y}(\lambda_Y)+b_{23}\bar{z}(\lambda_Y)=0$ $\bar{x}_3(\lambda_R)=b_{31}\bar{x}(\lambda_R)+b_{32}\bar{y}(\lambda_R)+b_{33}\bar{z}(\lambda_R)=0$
Together with the use of the standard equation: $\bar{x}_1(\lambda)=\bar{y}(\lambda)$ (1)
the equations between spectral oponent and tristimulus colour values are:

$$\begin{pmatrix}\bar{x}_1(\lambda)\\ \bar{x}_2(\lambda)\\ \bar{x}_3(\lambda)\end{pmatrix}=\begin{pmatrix}b_{11}&b_{12}&b_{13}\\ b_{21}&b_{22}&b_{23}\\ b_{31}&b_{32}&b_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}0000&1{,}0000&0{,}0000\\ 2{,}9797&-2{,}6662&-0{,}0960\\ -0{,}4139&1{,}4571&-2{,}4046\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix} \quad (2)$$

Remark: The weighting ratio in the *RG* and *YB* direction is 2,8:1 or 1:0,3571.

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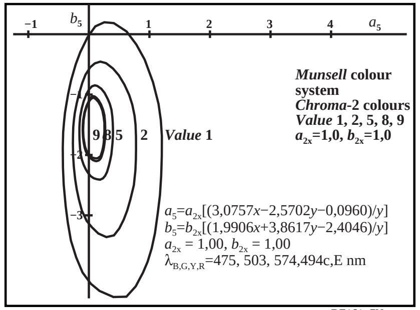

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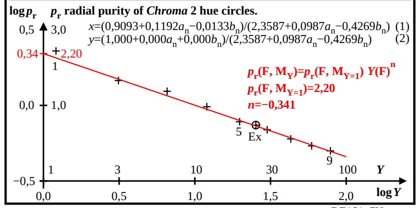
Relation between the radial purity p_r of *Chroma* 2 and tristimulus value *Y*

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 101.

V	Y	x_M	y_M	$a_{n,M}$	$b_{n,M}$	x_U	y_U	$a_{n,U}$	$b_{n,U}$	$p_{r,MU}$
1,000	1,210	0,315	0,296	1,060	−2,130	0,314	0,324	0,310	−1,623	2,290
5,000	19,770	0,314	0,323	0,340	−1,640	0,314	0,324	0,310	−1,623	0,780
9,000	78,660	0,314	0,328	0,230	−1,550	0,314	0,324	0,310	−1,623	0,500



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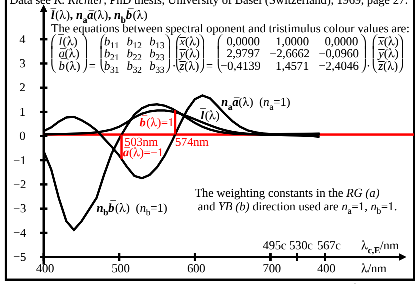
***Judd* spectral tristimulus and chromatic values $\bar{l}(\lambda)$, $\bar{a}(\lambda)$, $\bar{b}(\lambda)$**

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 27.



DE161−7N

Transformation between the *Judd* tristimulus and opponent values

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 58.

elementary colour	dominant wavelength	*Judd* spectral tristimulus values $\bar{x}(\lambda)$	$\bar{y}(\lambda)$	$\bar{z}(\lambda)$	chromatic values *RG* $\bar{a}(\lambda)$	*YB* $\bar{b}(\lambda)$
blue	λ_B=475 nm	0,8267	0,9339	0,0017	0,0000	−
green	λ_G=502 nm	0,0107	0,0038	0,0005	−1,0000	0,0000
yellow	λ_Y=574 nm	0,1304	0,1124	0,9281	0,0000	1,0000
red	λ_R=494c,E nm	0,0028	0,3701	0,2238	−	0,0000

There are six equations to calculate the six constants: b_{21} to b_{33}
$\bar{a}(\lambda_B)=b_{21}\bar{x}(\lambda_B)+b_{22}\bar{y}(\lambda_B)+b_{23}\bar{z}(\lambda_B)=0$ $\bar{b}(\lambda_G)=b_{31}\bar{x}(\lambda_G)+b_{32}\bar{y}(\lambda_G)+b_{33}\bar{z}(\lambda_G)=0$
$\bar{a}(\lambda_G)=b_{21}\bar{x}(\lambda_G)+b_{22}\bar{y}(\lambda_G)+b_{23}\bar{z}(\lambda_G)=-1$ $\bar{b}(\lambda_Y)=b_{31}\bar{x}(\lambda_Y)+b_{32}\bar{y}(\lambda_Y)+b_{33}\bar{z}(\lambda_Y)=1$
$\bar{a}(\lambda_Y)=b_{21}\bar{x}(\lambda_Y)+b_{22}\bar{y}(\lambda_Y)+b_{23}\bar{z}(\lambda_Y)=0$ $\bar{b}(\lambda_R)=b_{31}\bar{x}(\lambda_R)+b_{32}\bar{y}(\lambda_R)+b_{33}\bar{z}(\lambda_R)=0$
Together with the use of the standard equation: $\bar{l}(\lambda)=\bar{y}(\lambda)$ (1)
the equations between spectral oponent and tristimulus colour values are:

$$\begin{pmatrix}\bar{l}(\lambda)\\ \bar{a}(\lambda)\\ \bar{b}(\lambda)\end{pmatrix}=\begin{pmatrix}b_{11}&b_{12}&b_{13}\\ b_{21}&b_{22}&b_{23}\\ b_{31}&b_{32}&b_{33}\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix}=\begin{pmatrix}0{,}0000&1{,}0000&0{,}0000\\ 2{,}9797&-2{,}6662&-0{,}0960\\ -0{,}4139&1{,}4571&-2{,}4046\end{pmatrix}\cdot\begin{pmatrix}\bar{x}(\lambda)\\ \bar{y}(\lambda)\\ \bar{z}(\lambda)\end{pmatrix} \quad (2)$$

Remark: The weighting ratio in the *RG* and *YB* direction is 2,8:1 or 1:0,3571.

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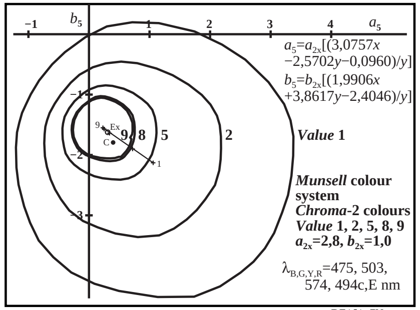

DE161−7N

Relation between the radial purity p_r of *Chroma* 2 and tristimulus value *Y*

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 101.

Value V	sample data Y	x_M	y_M	$a_{n,M}$	$b_{n,M}$	surround data x_U	y_U	$a_{n,U}$	$b_{n,U}$	purity $p_{r,MU}$
1,000	1,210	0,315	0,296	1,060	−2,130	0,314	0,324	0,310	−1,623	2,290
2,000	3,130	0,314	0,308	0,720	−1,900	0,314	0,324	0,310	−1,623	1,460
3,000	6,560	0,314	0,315	0,560	−1,780	0,314	0,324	0,310	−1,623	1,240
4,000	12,000	0,314	0,320	0,430	−1,690	0,314	0,324	0,310	−1,623	0,980
5,000	19,770	0,314	0,323	0,340	−1,640	0,314	0,324	0,310	−1,623	0,780
5,570	**25,300**	**0,314**	**0,324**	**0,310**	**−1,623**	**0,314**	**0,324**	**0,310**	**−1,623**	**0,740**
6,000	30,050	0,314	0,325	0,300	−1,610	0,314	0,324	0,310	−1,623	0,690
7,000	43,060	0,314	0,326	0,270	−1,590	0,314	0,324	0,310	−1,623	0,600
8,000	59,100	0,314	0,327	0,250	−1,570	0,314	0,324	0,310	−1,623	0,540
9,000	78,660	0,314	0,328	0,230	−1,550	0,314	0,324	0,310	−1,623	0,500

For experimental (Ex) surround (bold data), see*Newhall*, JOSA 30 (1940) p. 622
$x=(\alpha_{11}+\alpha_{12}a_n+\alpha_{13}b_n)/(\alpha_{31}+\alpha_{32}a_n+\alpha_{33}b_n)$
$=(0{,}9093+0{,}1192a_n-0{,}0133b_n)/(2{,}3587+0{,}0987a_n-0{,}4269b_n)$ (9)
$y=(\alpha_{21}+\alpha_{22}a_n+\alpha_{23}b_n)/(\alpha_{31}+\alpha_{32}a_n+\alpha_{33}b_n)$
$=(1{,}000+0{,}000a_n+0{,}000b_n)/(2{,}3587+0{,}0987a_n-0{,}4269b_n)$ (10)

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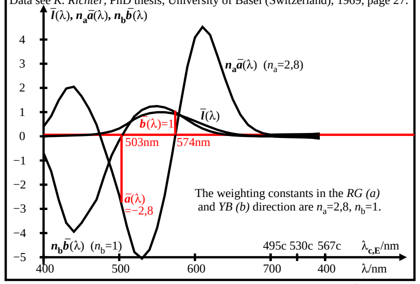
***Judd* spectral tristimulus and chromatic values $\bar{l}(\lambda)$, $\bar{a}(\lambda)$, $\bar{b}(\lambda)$**

Data see *K. Richter*, PhD thesis, University of Basel (Switzerland), 1969, page 27.



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