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:

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

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

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

The unnormalized purity data $a_n$and $b_n$are defined in LabMUN 1969 as follows:

$a_n=X_3/X_1=x_3/x_1$ (3) $b_n=X_1/X_1=x_1/x_1$ (4) $x_2=1-x_2-x_1$ (5)

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$a_n=[(b_{21}-b_{23})x+(b_{22}-b_{23})y+b_{23}]/y$

$=(3,0757x-2,5702y-0,0960)/y$ (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

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$=2,8(3,0757x-2,5702y-0,0960)/y$

$=(8,6119x-7,1965y-0,2688)/y$ (6)

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Linear model equations between spectral colour values in both directions:

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

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DE160–7N

Transformation between the *Judd* purity and chromaticity

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

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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:

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

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

The unnormalized purity data a_u and b_u are defined in LabMUN 1969 as follows:

$a_u=X_3/X_1=x_3/x_1$ (3) $b_u=X_1/X_1=x_1/x_1$ (4) $x_2=1-x_2-x_1$ (5)

Use of equations (2) to (5) leads to:

$$\begin{pmatrix}X\\ Y\\ Z\end{pmatrix}=\begin{pmatrix}a_{11} & a_{12}a_u & a_{13}b_u\\ a_{21} & a_{22}a_u & a_{23}b_u\\ a_{31} & a_{32}a_u & a_{33}b_u\end{pmatrix}\cdot\begin{pmatrix}X_1\\ X_1\\ X_1\end{pmatrix} \quad (6) \quad \text{and with } x=X/(X+Y+Z) \text{ and } y=Y/(X+Y+Z) \quad (7)$$

$x=[a_{11}+a_{12}a_u+a_{13}b_u]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})a_u+(a_{13}+a_{23}+a_{33})b_u]$

$y=[a_{21}+a_{22}a_u+a_{23}b_u]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})a_u+(a_{13}+a_{23}+a_{33})b_u]$ (8)

$x=(a_{11}+a_{12}a_u+a_{13}b_u)/(a_{31}+a_{32}a_u+a_{33}b_u)$

$=(0,9093+0,3338a_u-0,0133b_u)/(2,3587+0,2764a_u-0,4269b_u)$ (9)

$y=(a_{21}+a_{22}a_u+a_{23}b_u)/(a_{31}+a_{32}a_u+a_{33}b_u)$

$=(1,000+0,000a_u+0,000b_u)/(2,3587+0,2764a_u-0,4269b_u)$ (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

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$x=[a_{11}+a_{12}a_u+a_{13}b_u]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})a_u+(a_{13}+a_{23}+a_{33})b_u]$

$y=[a_{21}+a_{22}a_u+a_{23}b_u]/[a_{11}+a_{21}+a_{31}+(a_{12}+a_{22}+a_{32})a_u+(a_{13}+a_{23}+a_{33})b_u]$ (8)

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DE160–7N