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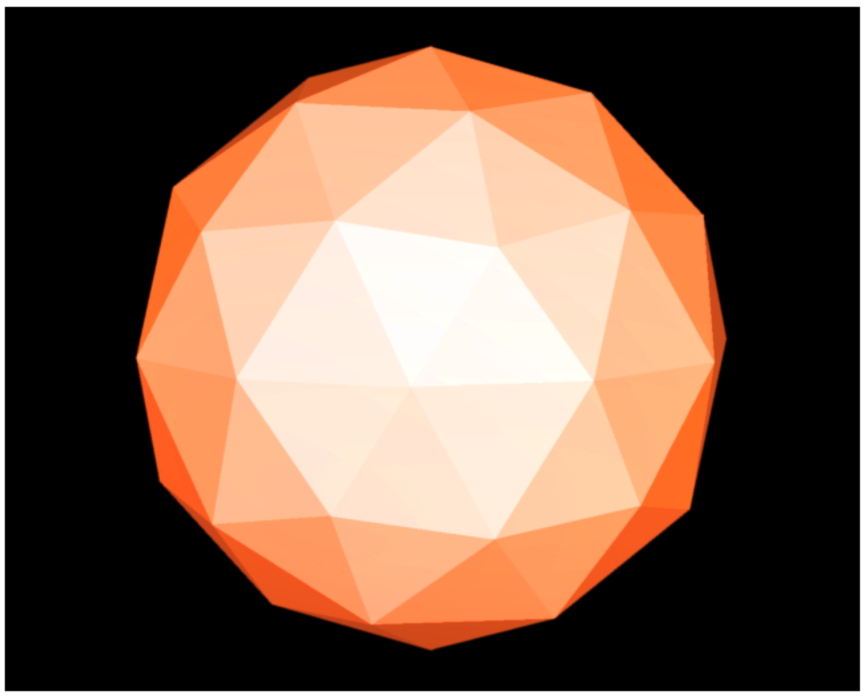
Correlated Color Temperature

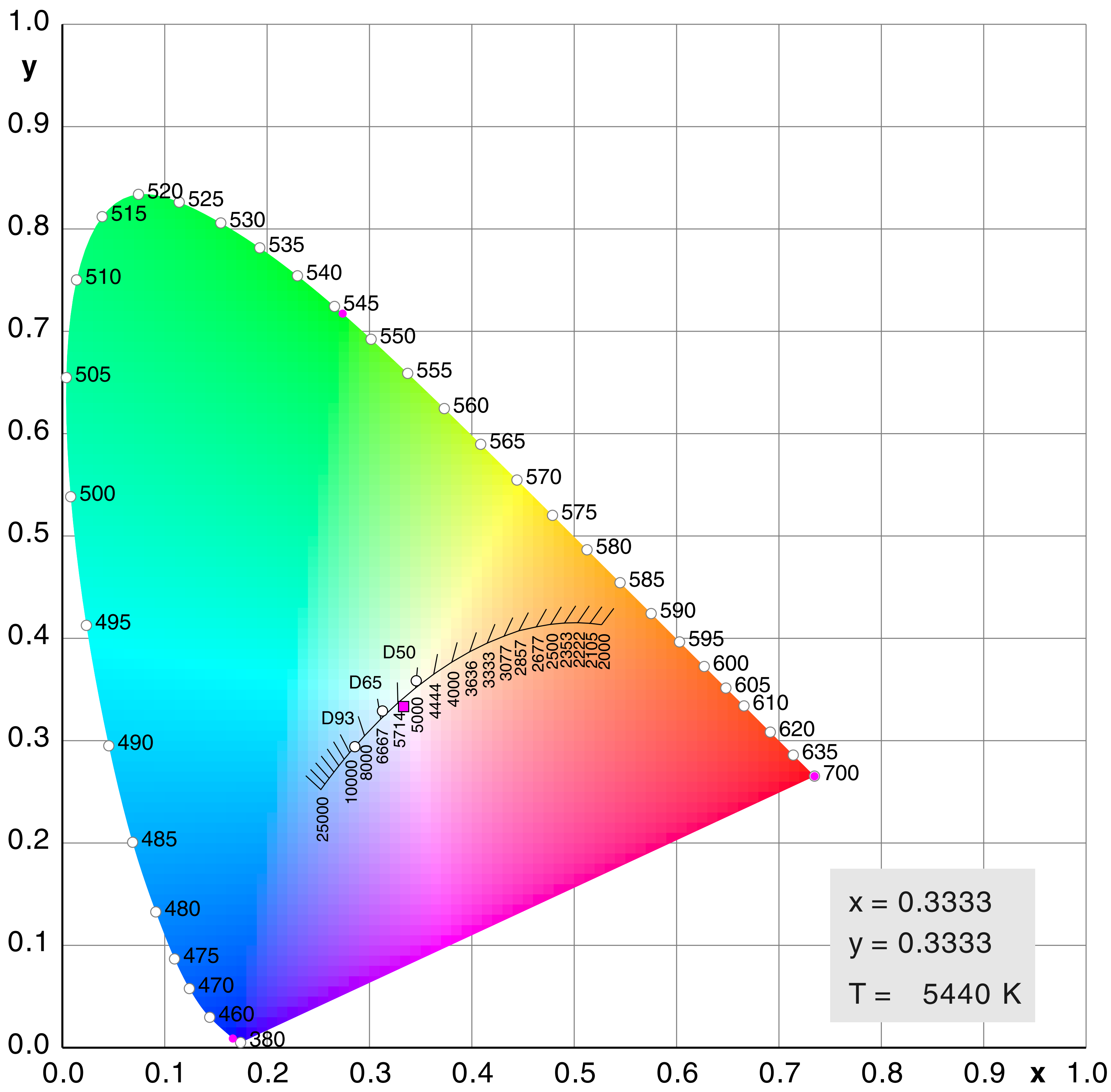


Contents

1. Introduction

Color temperature is the physical temperature of a heated *Planck* radiator. The color coordinates for the emitted light are shown below in the CIE chromaticity diagram for temperatures 2000K to 25000K.
Correlated color temperature (CCT) is calculated by the projecting the actual color coordinates x,y along a line of constant CCT onto the curve for the *Planck* radiator.
Coordinates and the slope of the Iso-CCT lines are given in [3]. The algorithm is described there as well, it´s the method by *Robertson*.
Here we use a modern nomenclature for vector geometry. The final step is done by inverse linear interpolation because the inverse temperatures are approximately equally spaced on the curve.

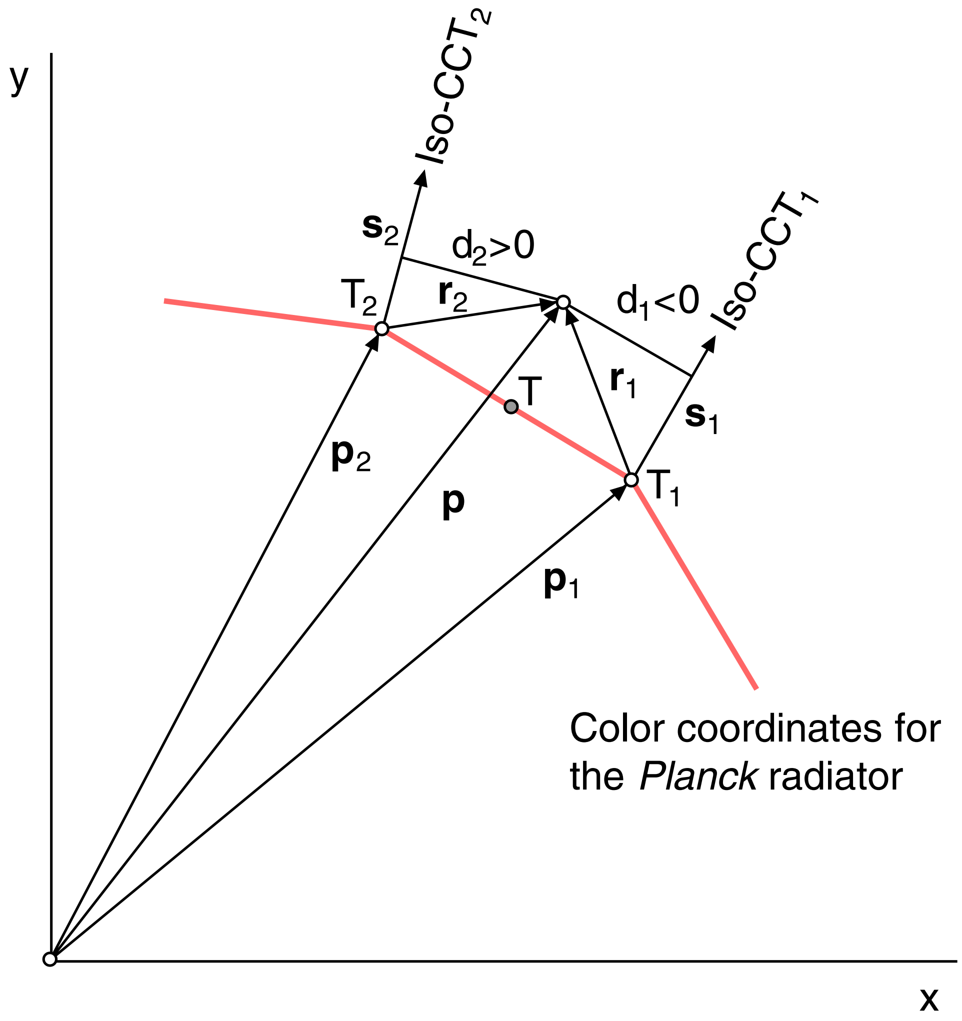
A correlated color temperature doesn´t make any sense if the actual color is too far away from the *Planck* curve.



2. Algorithm

Given are i=0...n points x,y in the CIE chromaticity diagram for n line segments on the curve for the *Planck* radiator by a table (next page). Calculate the CCT for a color x,y. The algorithm is described in pseudo-code. PostScript code is available.

```
i=0
Calculate values(2) at i
Found=False
For i=1 to n Do
  Begin
    values(1)=values(2)
    Calculate values(2) at i
    If d1*d2 <= 0 Then
      Begin
        Found=True
        exit loop
      End
  End
If Found Then
Begin
  Calculate k and T
  Print 'T=',T
End Else
  Print 'Not found'
```



Equations for values(1). Use the same formulas for values(2):

$\mathbf{p}$	=	$\begin{bmatrix} x \\ y \end{bmatrix}$	coordinates in chromaticity diagram
$\mathbf{p}_1$	=	$\begin{bmatrix} x_1 \\ y_1 \end{bmatrix}$	coordinates at T_1 according to table
t_1	=	dy/dx	slope at T_1 according to table
$\mathbf{s}_1$	=	$\begin{bmatrix} 1 \\ t_1 \end{bmatrix} \frac{1}{\sqrt{1+t_1^2}}$	iso-CCT direction vector at T_1
$\mathbf{s}_1$	=	$-\mathbf{s}_1$	if $t_1<0$
$\mathbf{r}_1$	=	$\mathbf{p}-\mathbf{p}_1$	difference vector
d_1	=	$(\mathbf{r}_1 \times \mathbf{s}_1)_z$	signed distance
d_1	=	$r_{1x}s_{1y} - r_{1y}s_{1x}$	
$d_1 d_2 \le 0$			correct line segment
k	=	$\frac{\lvert d_1\rvert}{\lvert d_1\rvert+\lvert d_2\rvert}$	linearized inverse interpolation
T	=	$\frac{1}{1/T_1 + k(1/T_2 - 1/T_1)}$	

3. Table

Table for the color temperature of the *Planck* radiator and the Iso-CCT slope [3].

T/K	x	y	t	
2000	0.52669	0.41331	1.33101	
2105	0.51541	0.41465	1.39021	
2222	0.50338	0.41525	1.45962	
2353	0.49059	0.41498	1.54240	
2500	0.47701	0.41368	1.64291	
2677	0.463**	0.41121	1.76811	Error in table
2857	0.446**	0.40742	1.92863	Error in table
3077	0.43156	0.40216	2.14300	
3333	0.41502	0.39535	2.44455	
3636	0.39792	0.38690	2.90309	
4000	0.38045	0.37676	3.68730	
4444	0.36276	0.36496	5.34398	
5000	0.34510	0.35162	11.17883	
5714	0.32775	0.33690	-39.34888	
6667	0.31101	0.32116	-6.18336	
8000	0.29518	0.30477	-3.08425	
10000	0.28063	0.28828	-1.93507	
11111	0.27524	0.28182	-1.65981	
12500	0.27011	0.27547	-1.44313	
14286	0.26526	0.26930	-1.26959	
16667	0.26070	0.26333	-1.12891	
20000	0.25645	0.25763	-1.01403	
25000	0.25251	0.25222	-0.91976	

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