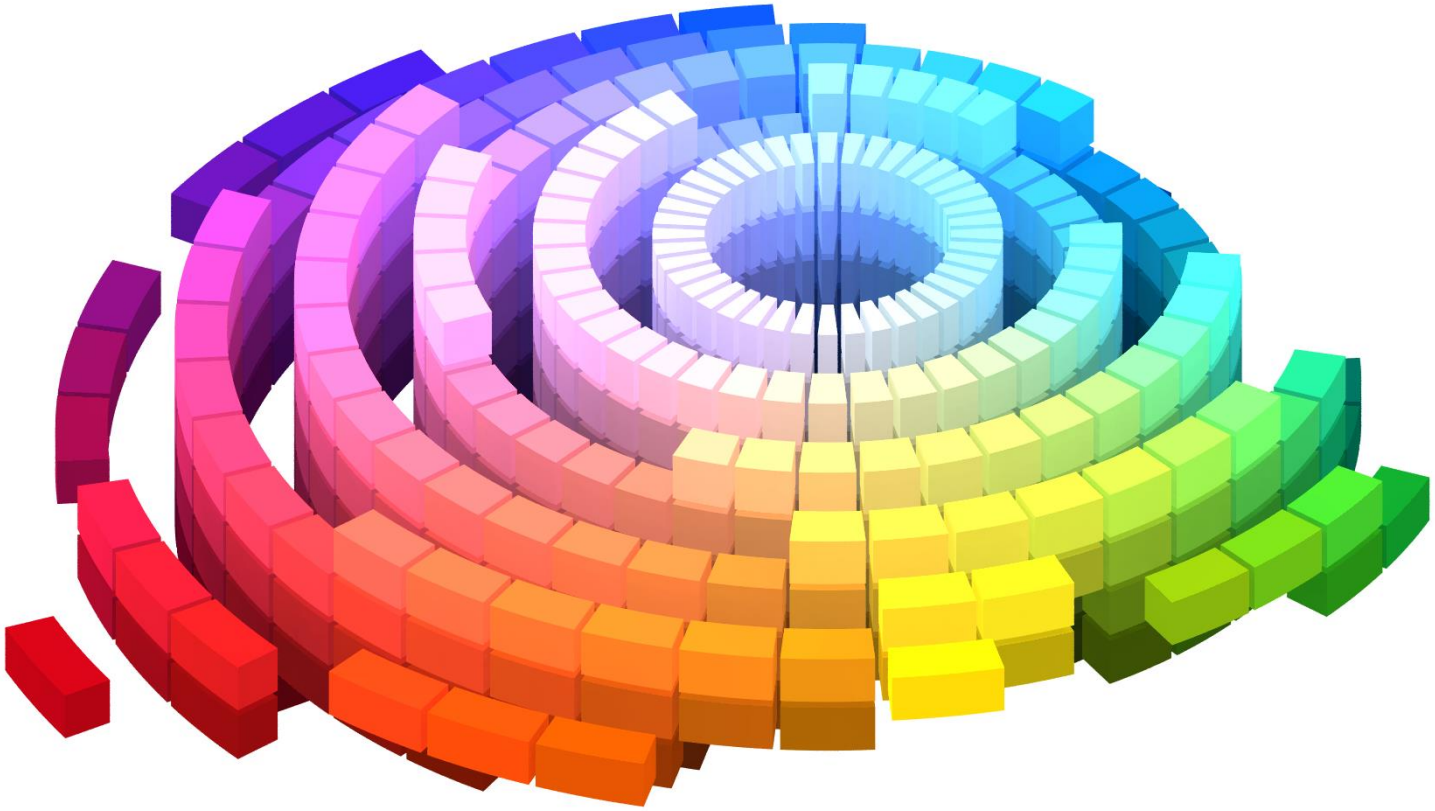
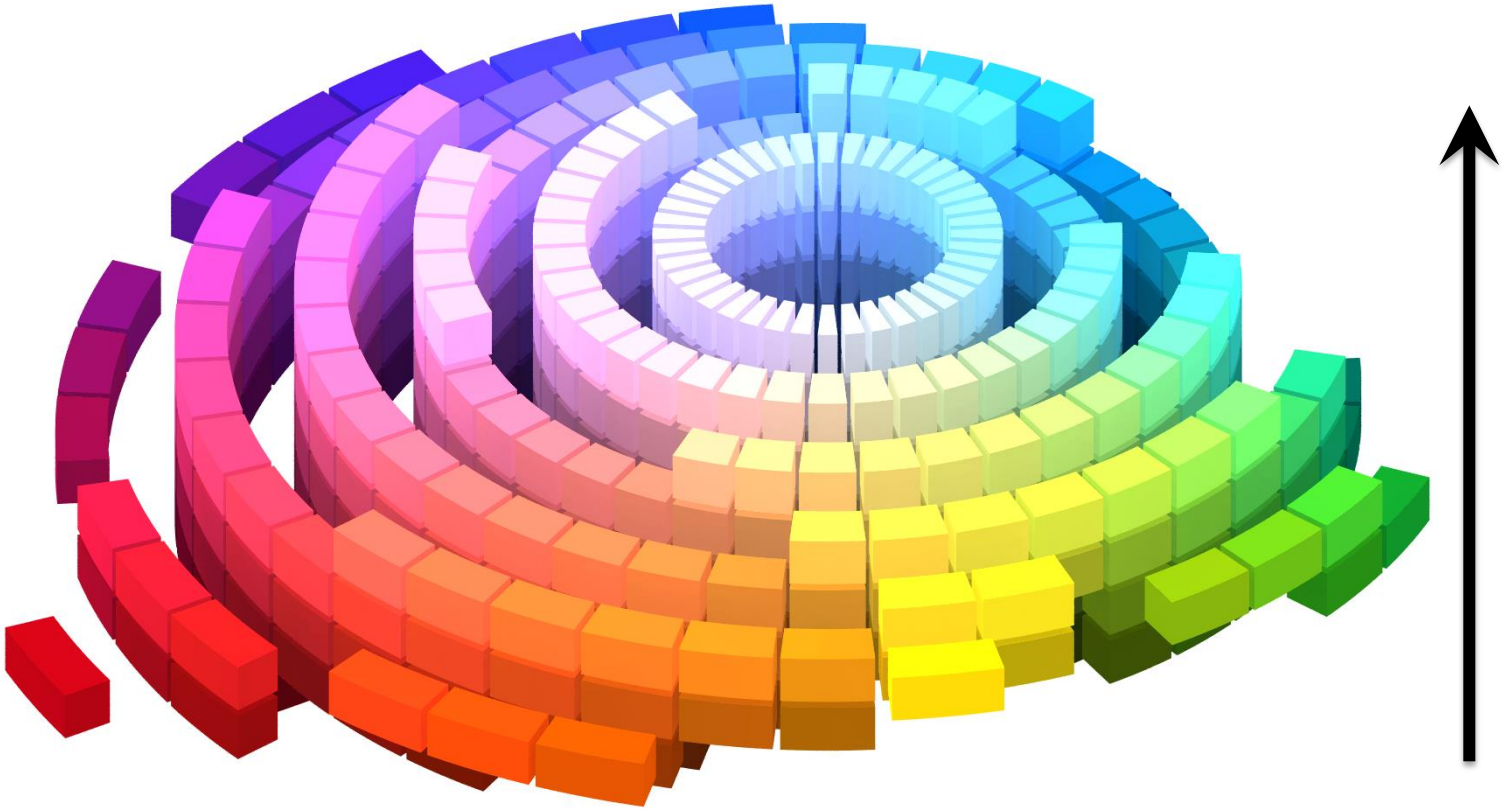
Why the Planckian Radiator *Remains* the Ideal Low CCT Colour Rendering Reference Illuminant

Lorne Whitehead (University of British Columbia)
October 19, 2015

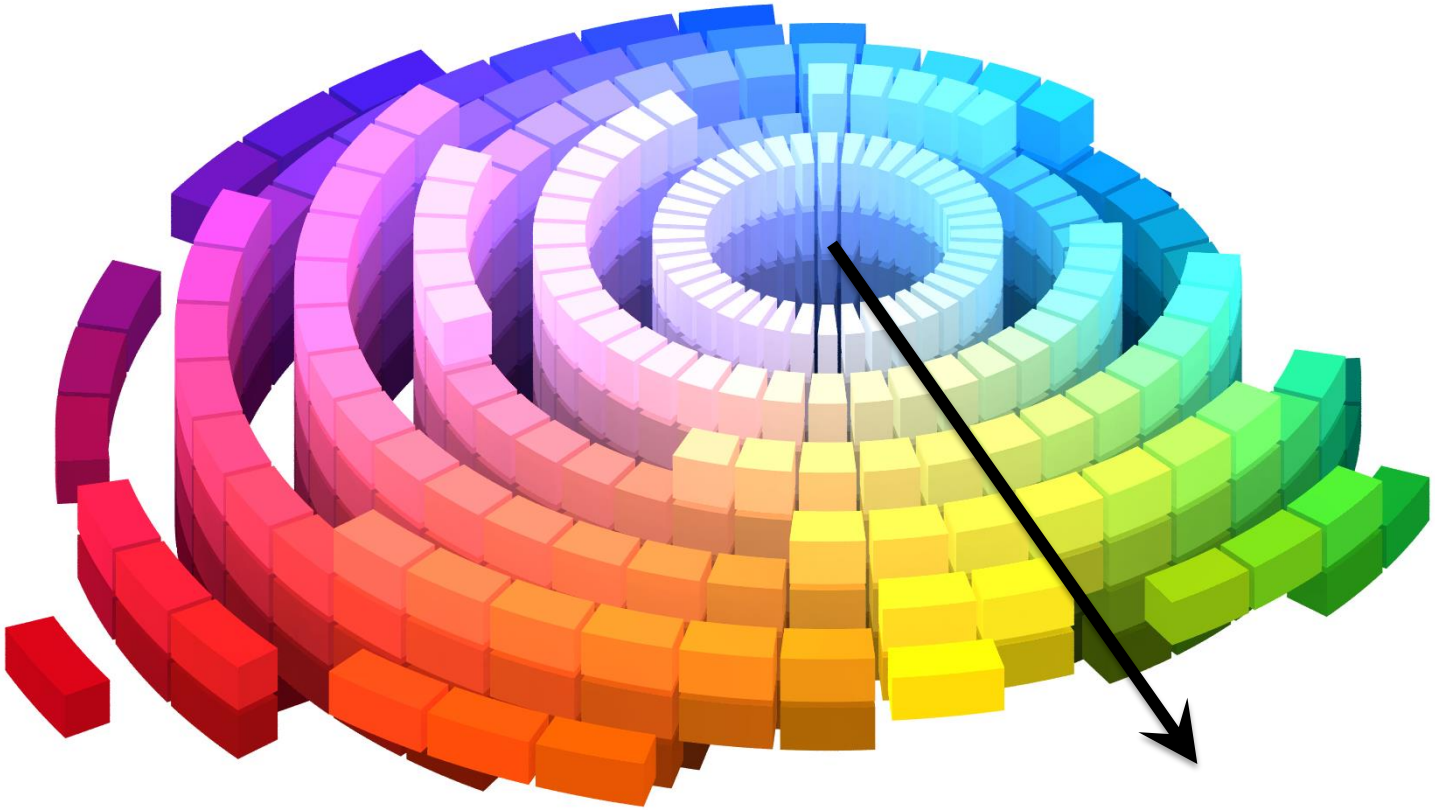
The 3D Organization of colour Proximity



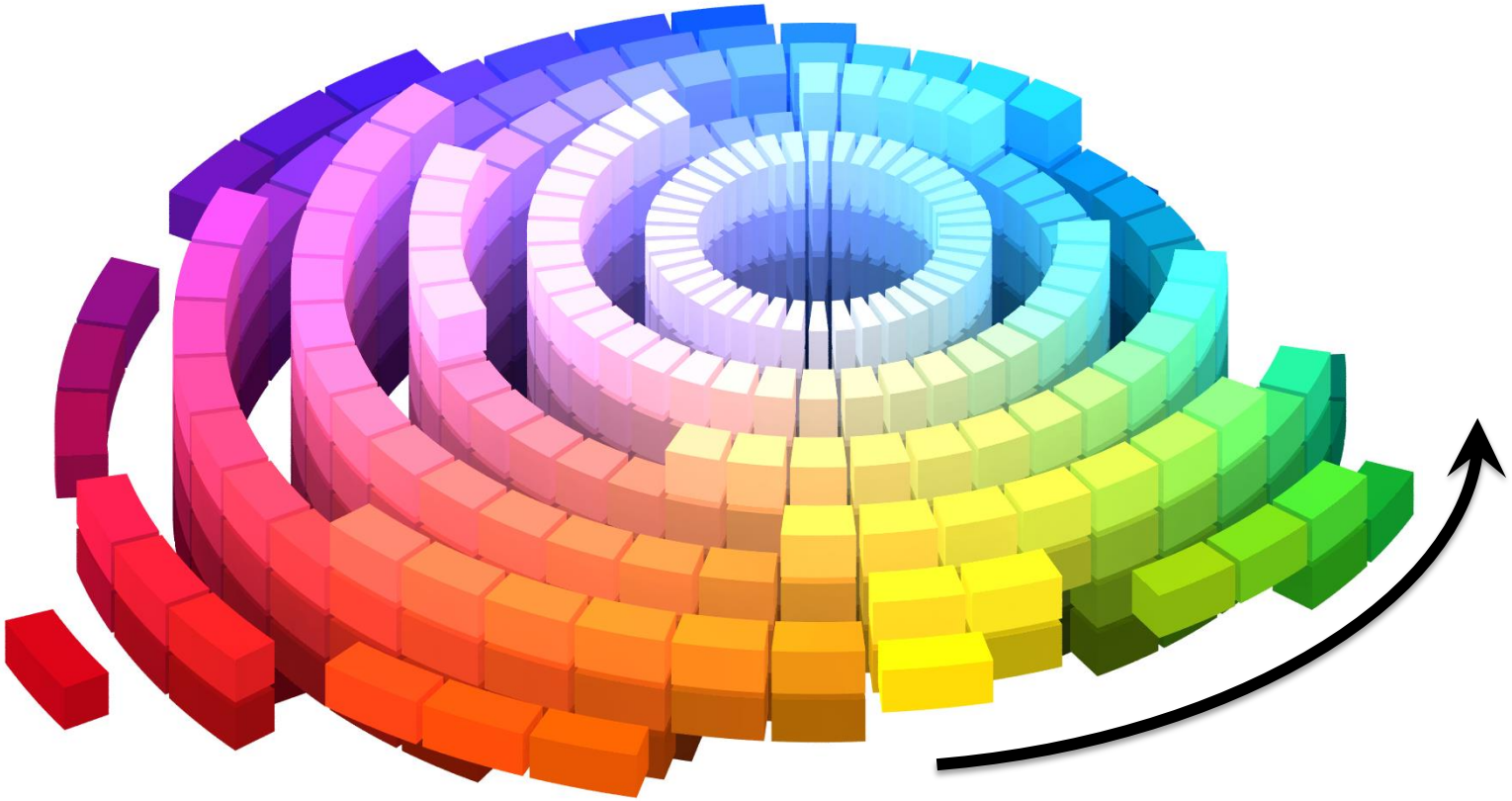
Lightness:



Chroma

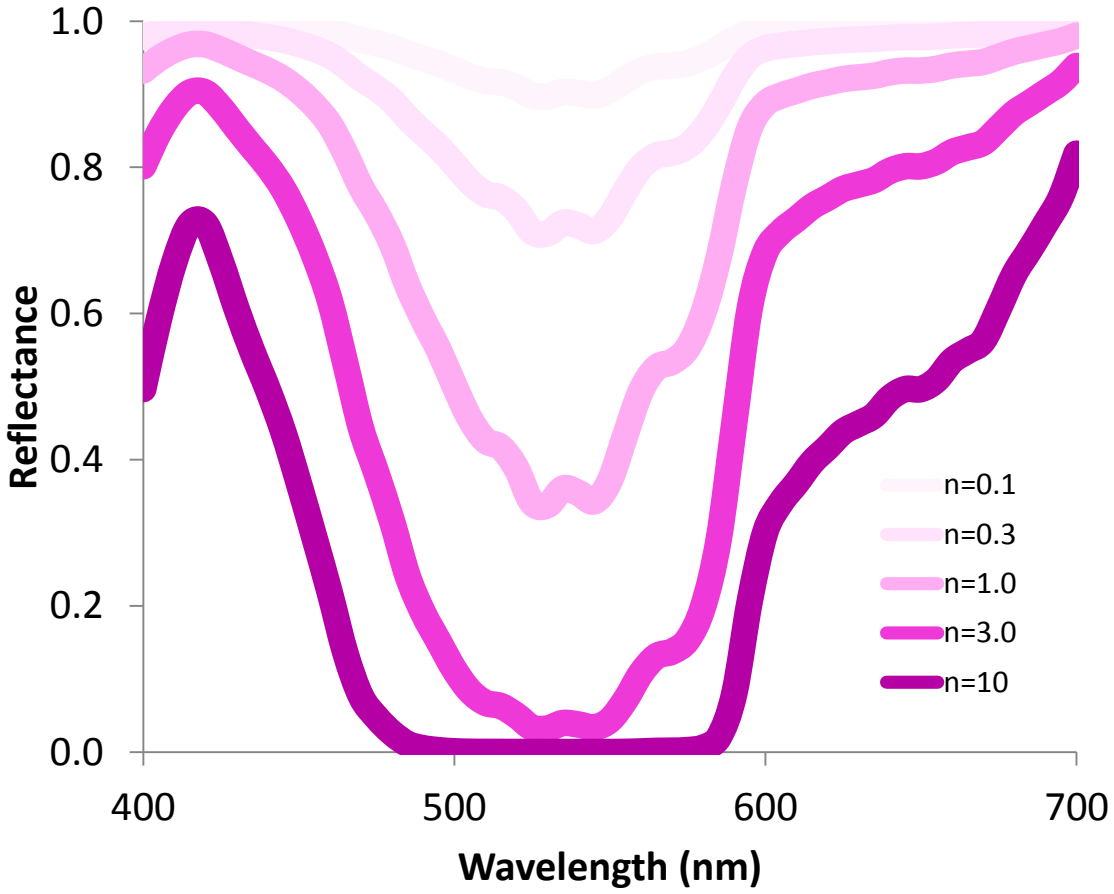


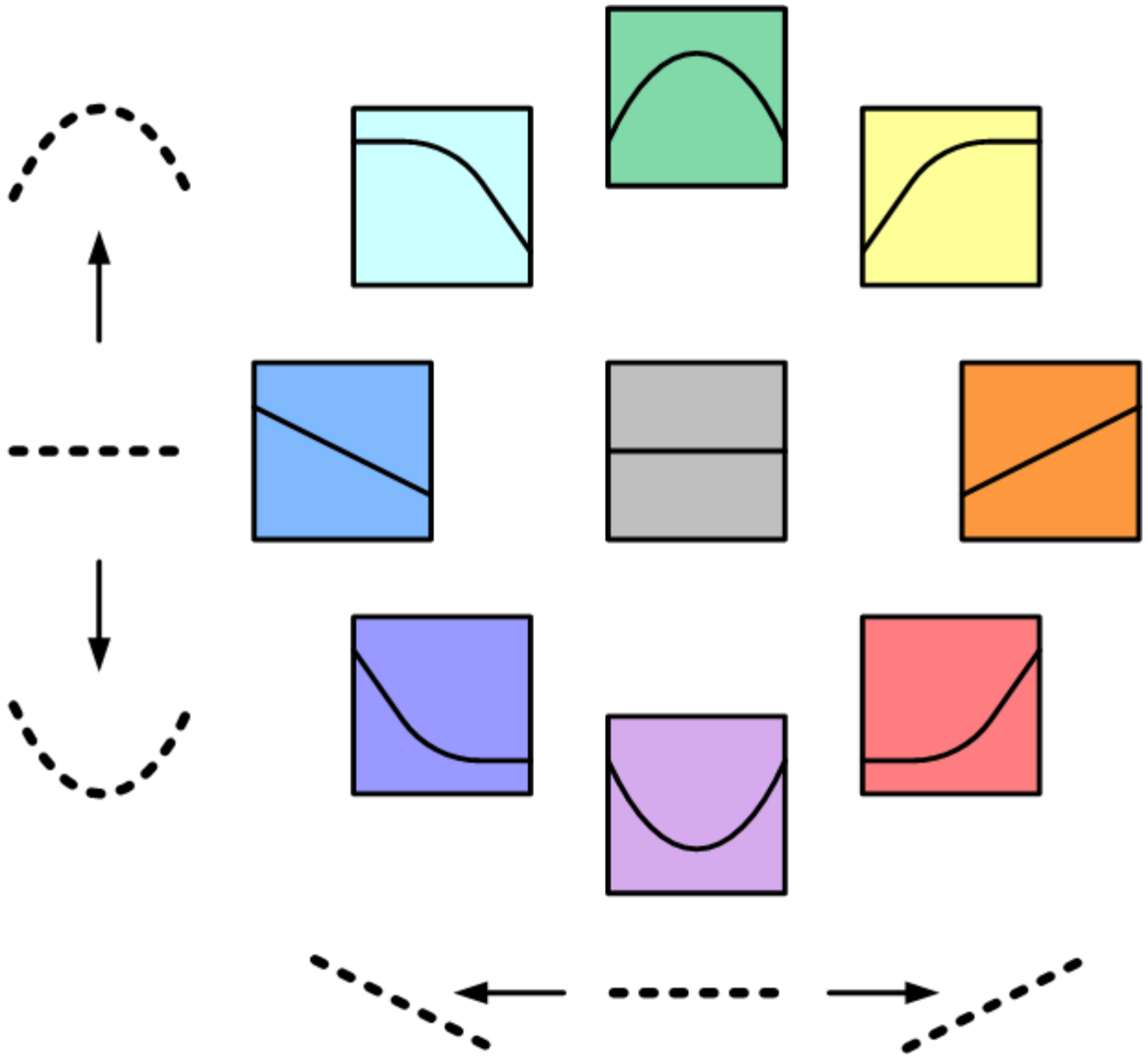
Hue:

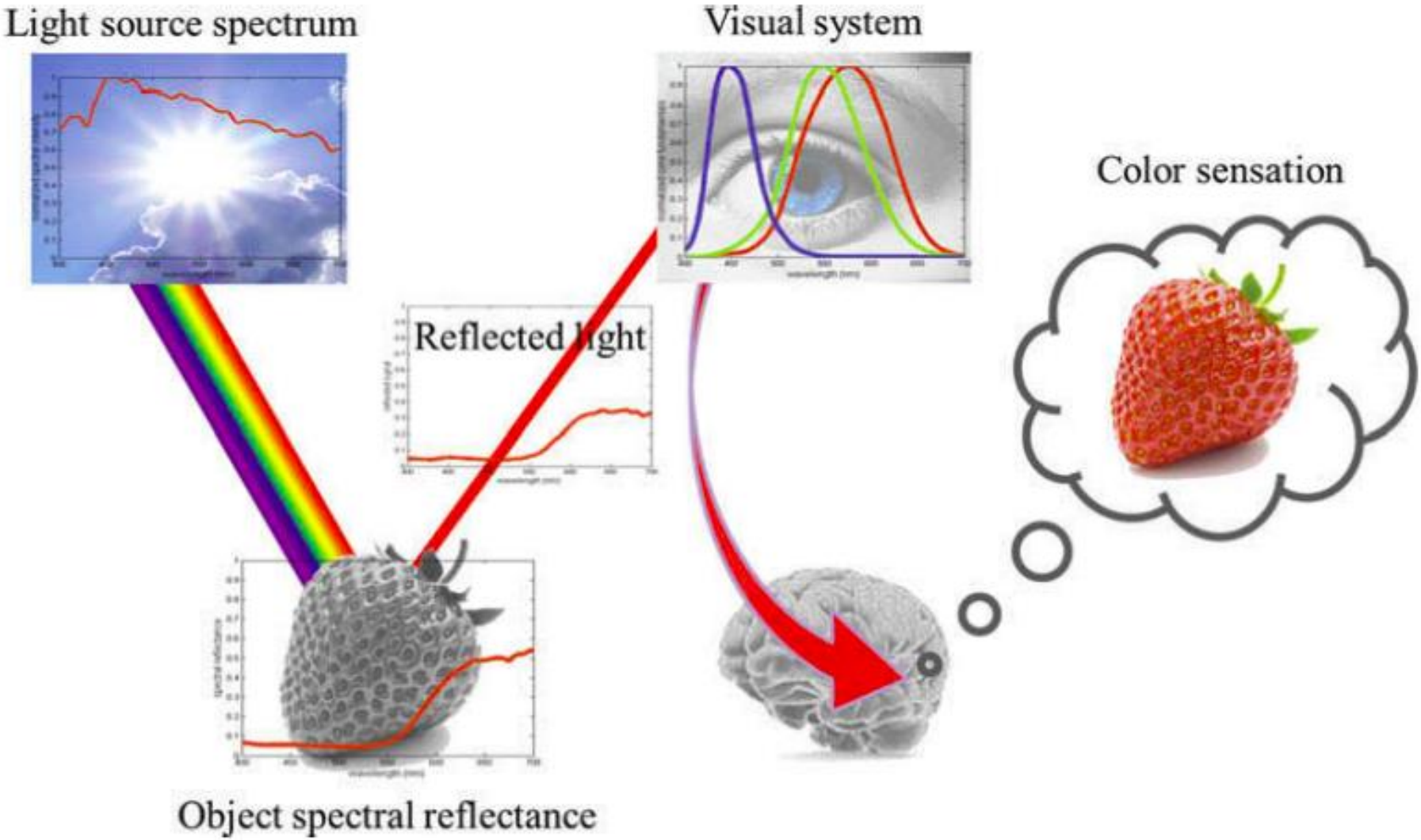


Hue is a clue!


$KMnO_4$

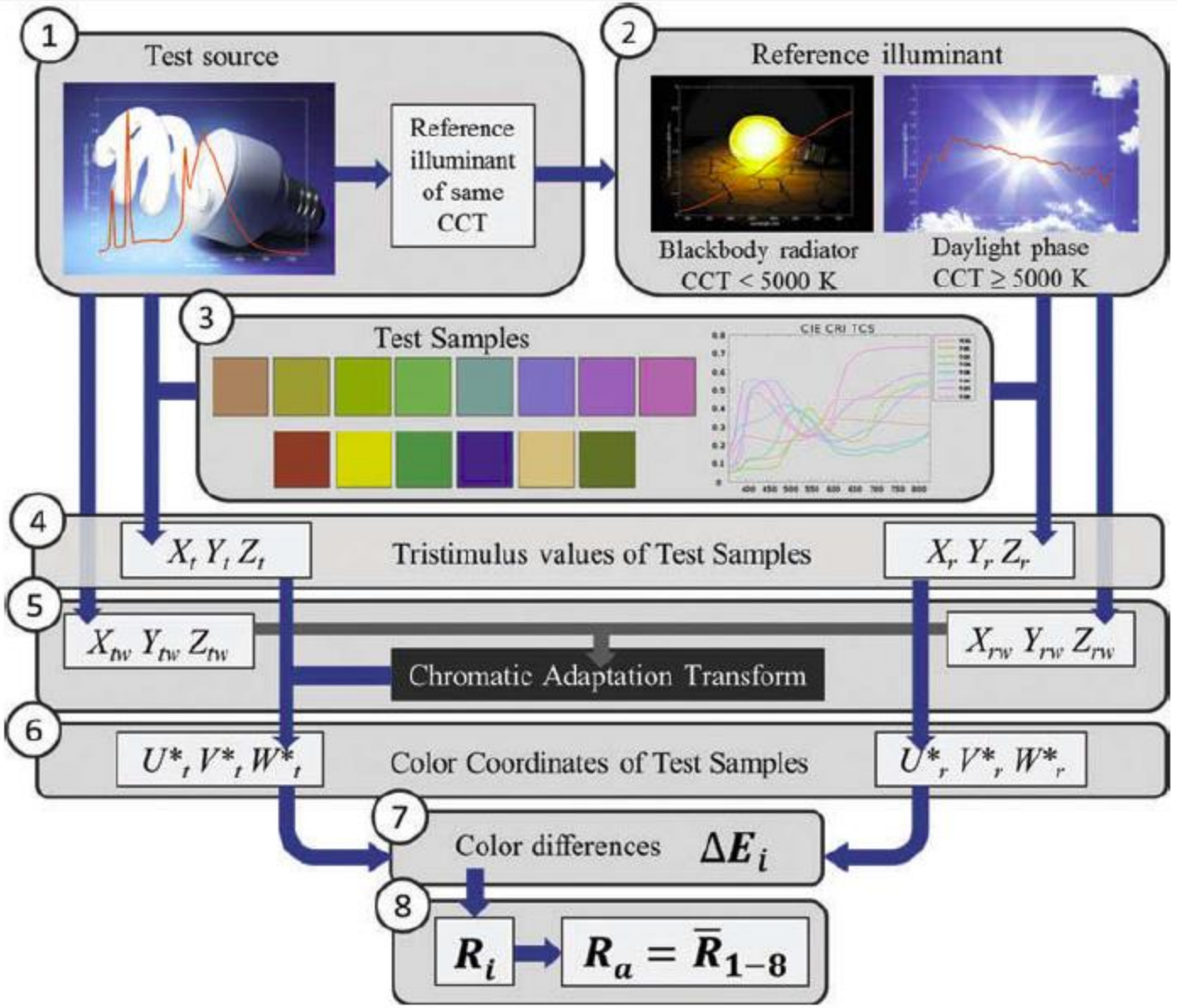

1.0
0.8
0.6
0.4
0.2
0.0
Reflectance
400
500
600
700
Wavelength (nm)
n=0.1
n=0.3
n=1.0
n=3.0
n=10




Light source spectrum
Visual system
Color sensation
Reflected light
Object spectral reflectance

Requirements for Accurate Hue Perception:

- Sufficient light, to minimize the Hunt effect
- Sufficient chroma, (by limiting glare)
- Spatially uniform illuminant SPD
- High Colour Rendering Index illuminant SPD


1
Test source
Reference illuminant of same CCT
2
Reference illuminant
Blackbody radiator
CCT < 5000 K
Daylight phase
CCT ≥ 5000 K
3
Test Samples
CIE CRI TCS
4
$X_t\ Y_t\ Z_t$
Tristimulus values of Test Samples
$X_r\ Y_r\ Z_r$
5
$X_{tw}\ Y_{tw}\ Z_{tw}$
Chromatic Adaptation Transform
$X_{rw}\ Y_{rw}\ Z_{rw}$
6
$U^*_t\ V^*_t\ W^*_t$
Color Coordinates of Test Samples
$U^*_r\ V^*_r\ W^*_r$
7
Color differences ΔE_i
8
R_i
$R_a = \overline{R}_{1-8}$

Argument against Planckian Radiator Reference

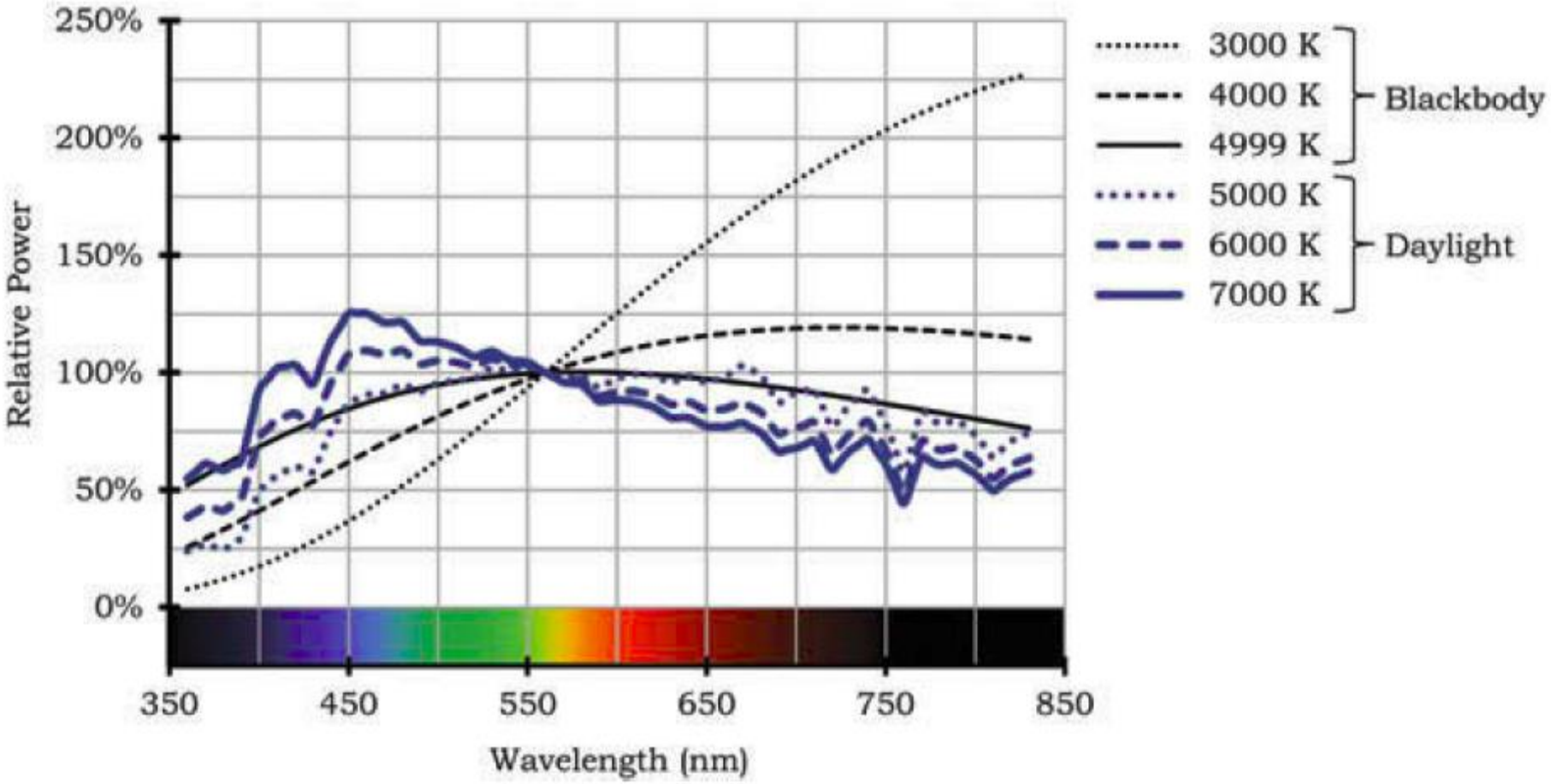
- Everyone accepts daylight as reference for high CCT lighting, its free and universal, ***but…***

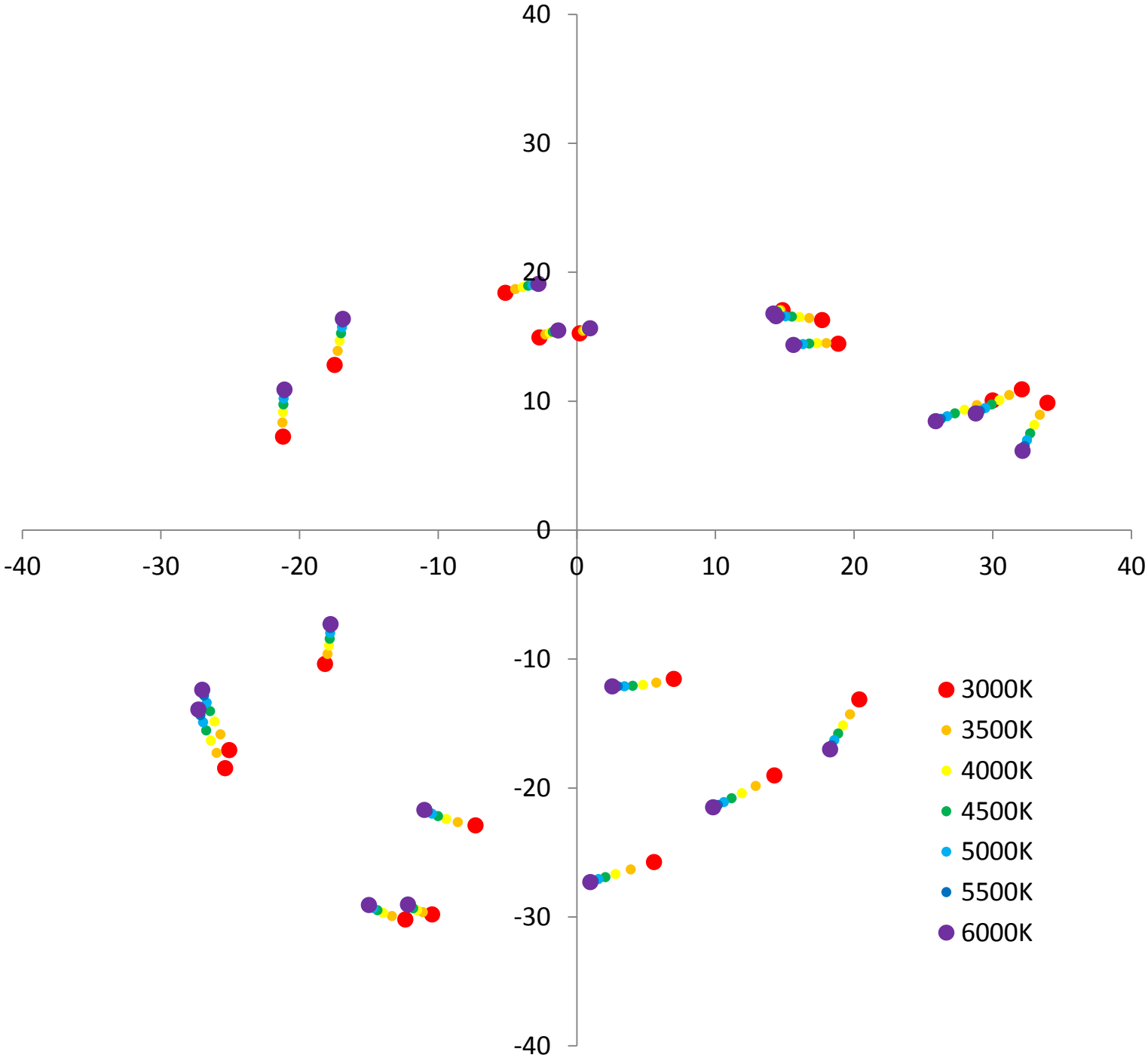
- Changing the CCT shifts an object's perceived hue, so there is no such thing as an object's true colour
- Therefore at low CCT, where there is no natural free daylight reference, the choice of reference is arbitrary
- The Planckian radiator was originally chosen only because it was the cheapest and most common source

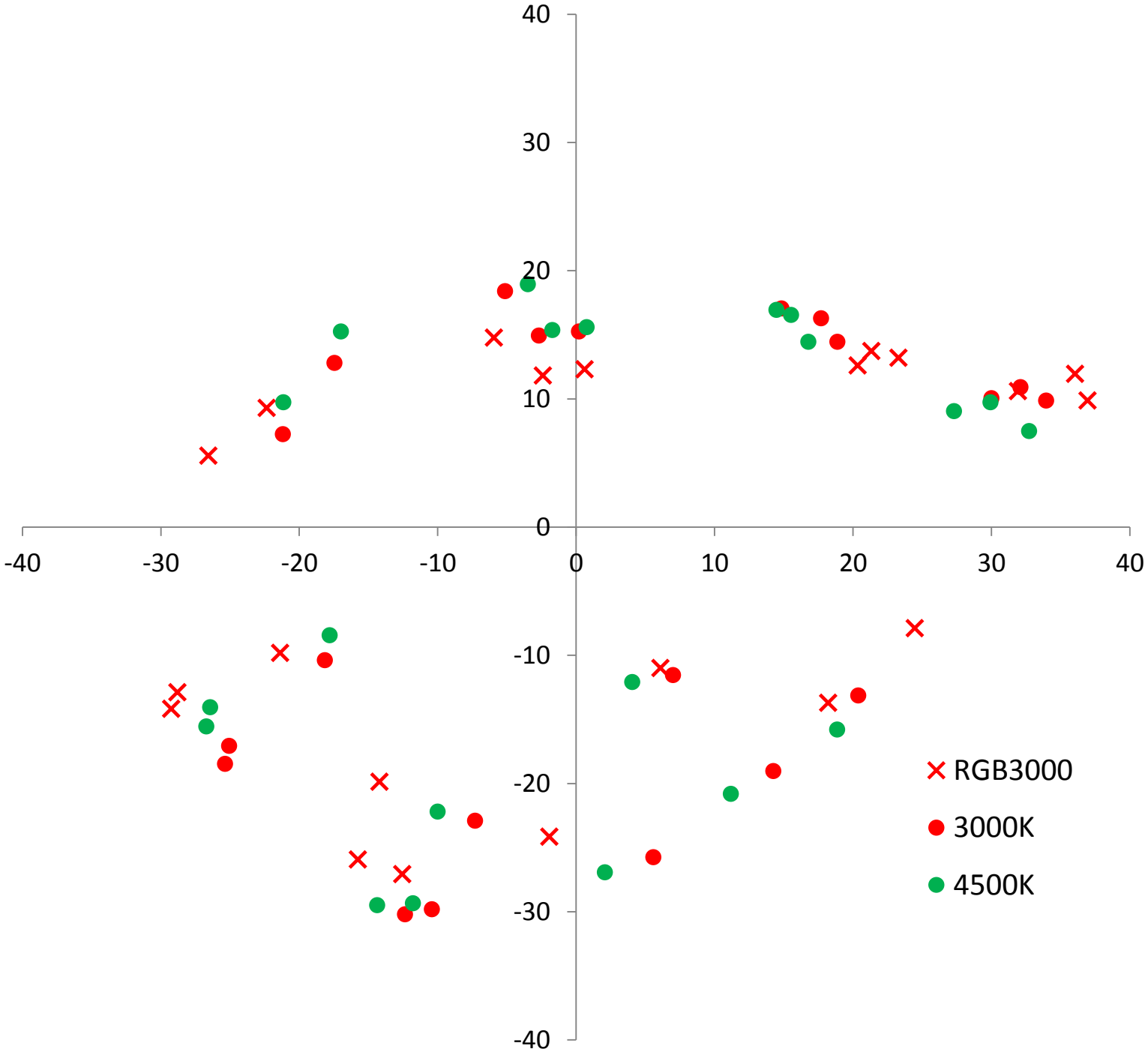
- Since that's no longer as true as it once was, let's choose a newer, more popular reference for the CRI

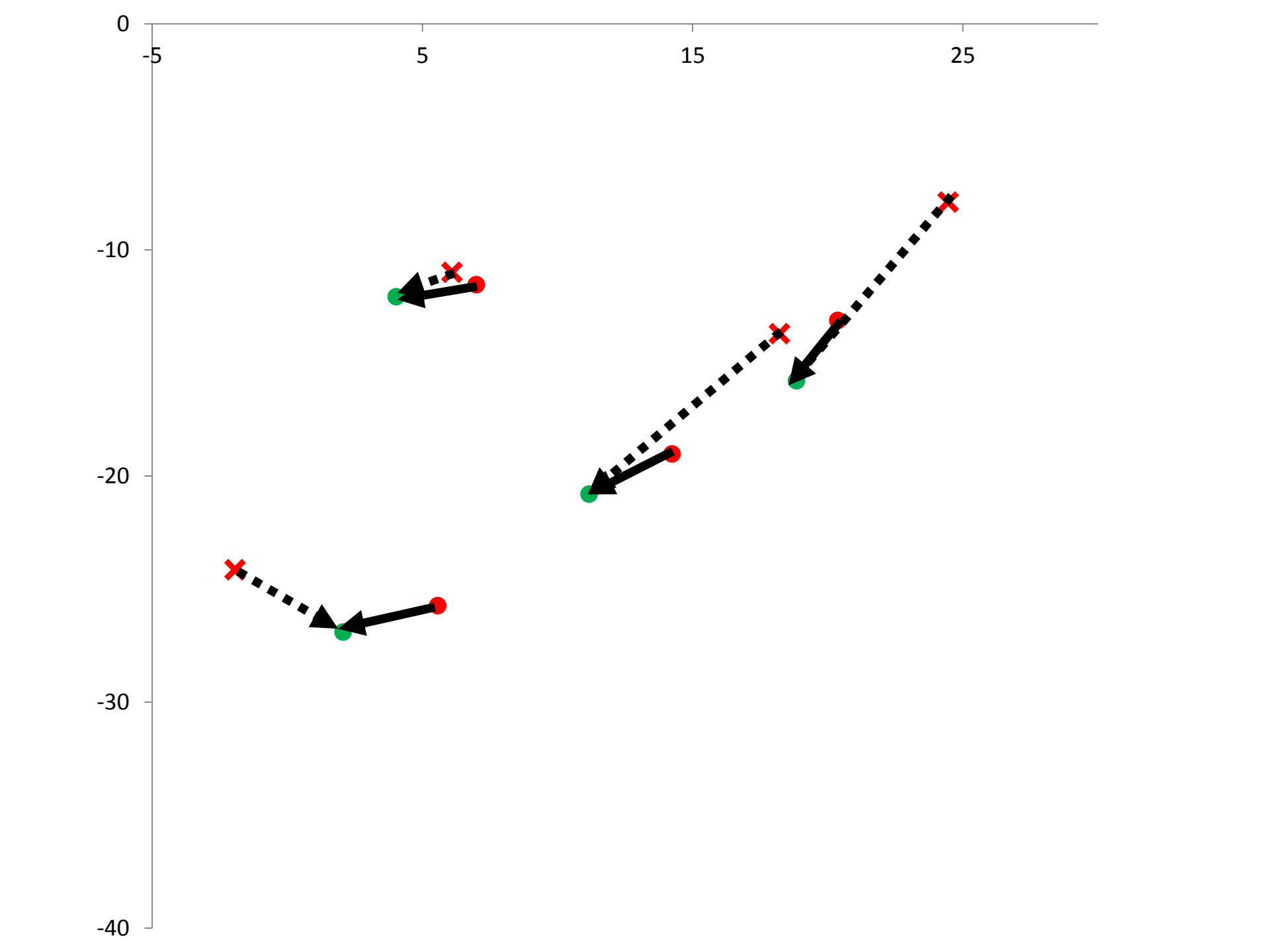
Arguments *for* Planckian Radiator Reference

- CCT-change-induced hue changes are small and non-problematic; daylight color is “real”
- The Planckian radiator is universal and easily reproduced and calculated.
- The Planckian radiator reference does not restrict lamps to the Planckian locus
- There is no valid reason to abandon the Planckian radiator reference illuminant


250%
200%
150%
100%
50%
0%
Relative Power
350
450
550
650
750
850
Wavelength (nm)
3000 K
4000 K
4999 K
Blackbody
5000 K
6000 K
7000 K
Daylight


40
30
20
10
0
-10
-20
-30
-40
-40
-30
-20
-10
0
10
20
30
40
3000K
3500K
4000K
4500K
5000K
5500K
6000K


40
30
20
10
0
-10
-20
-30
-40
-40
-30
-20
-10
0
10
20
30
40
RGB3000
3000K
4500K


0
-5
5
15
25
-10
-20
-30
-40

Arguments *for* Planckian Radiator Reference

- CCT-change-induced hue changes are small and non-problematic; daylight color is “real”
- The Planckian radiator is universal and easily reproduced and calculated
- The Planckian radiator reference does not restrict lamps to the Planckian locus
- There is no valid reason to abandon the Planckian radiator reference illuminant
- So let’s stop worrying about that