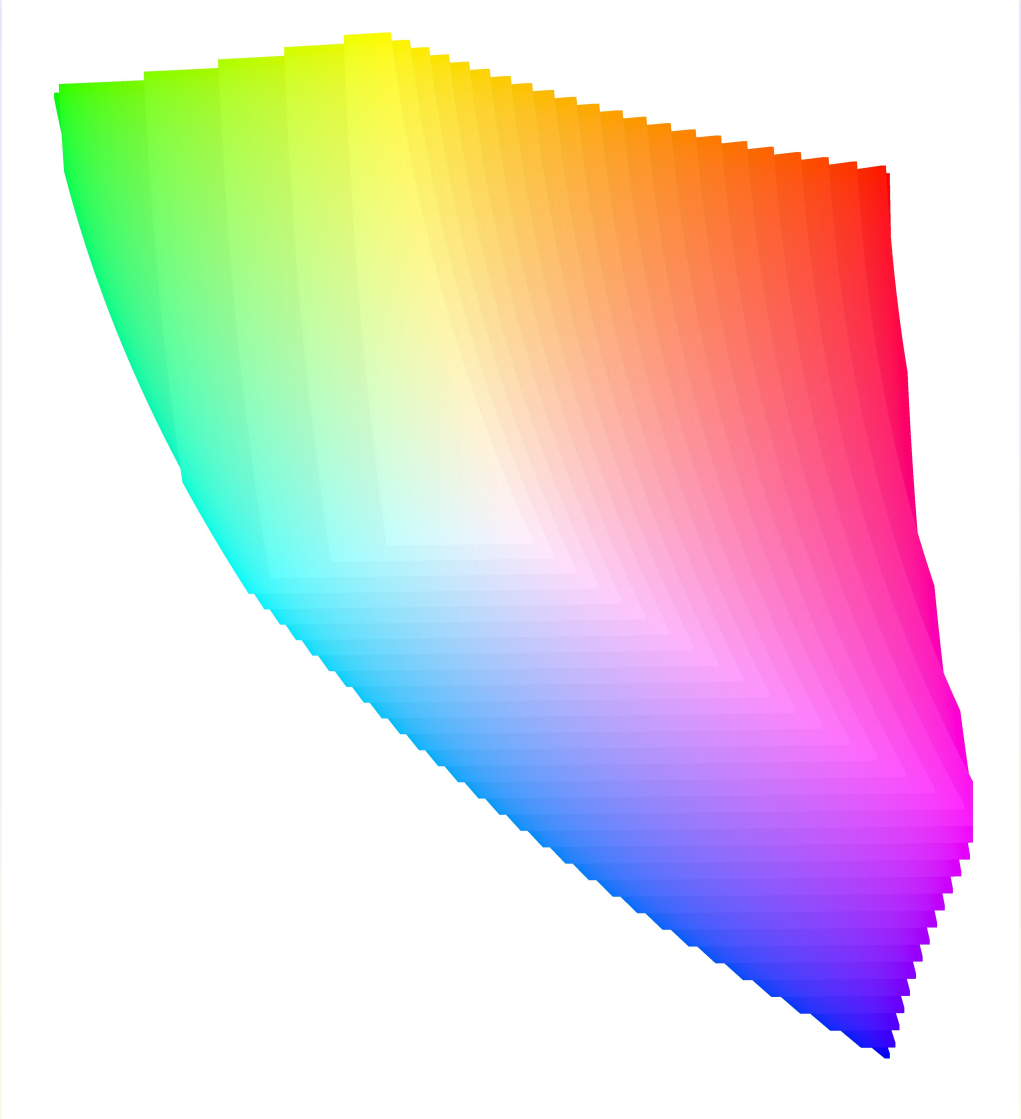
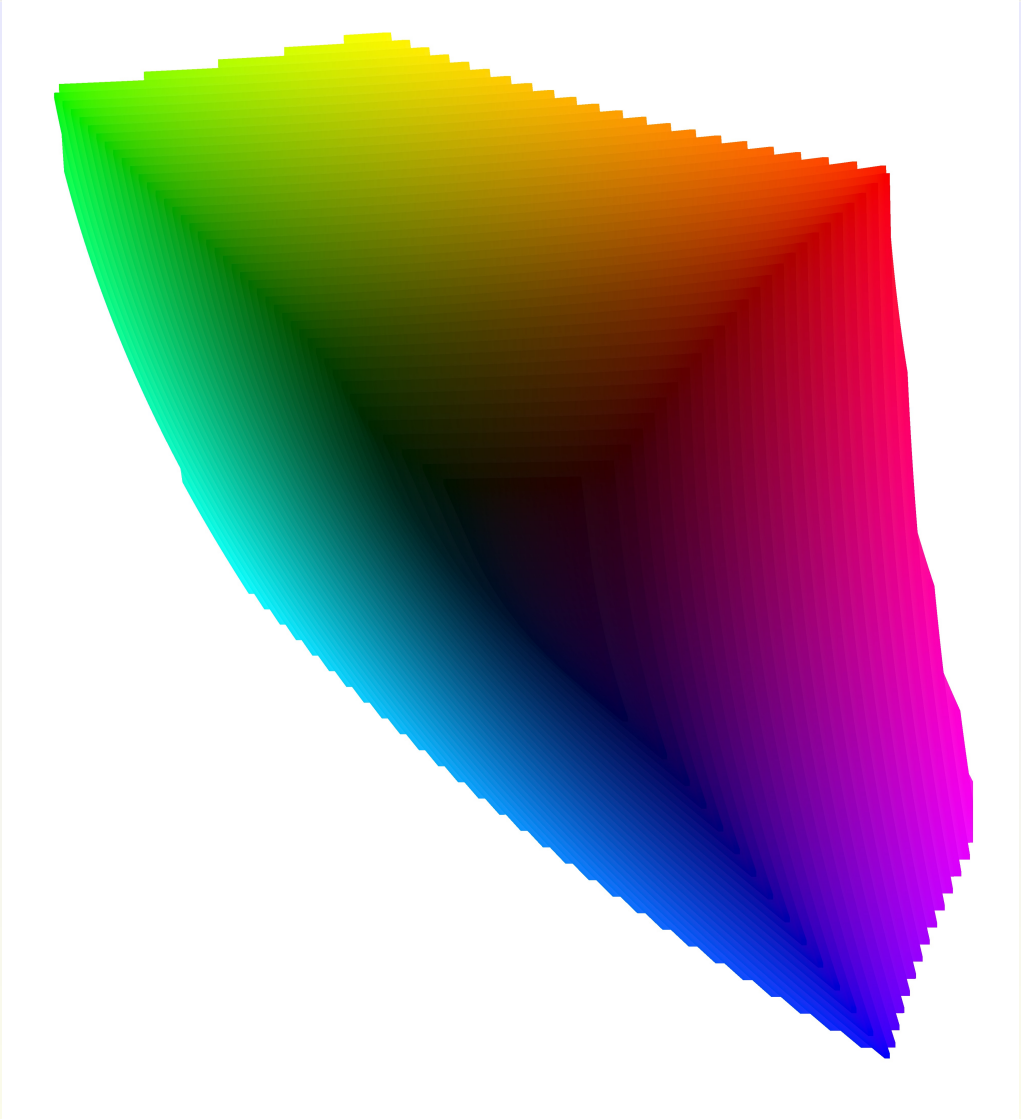
CIE La*b* Color Space



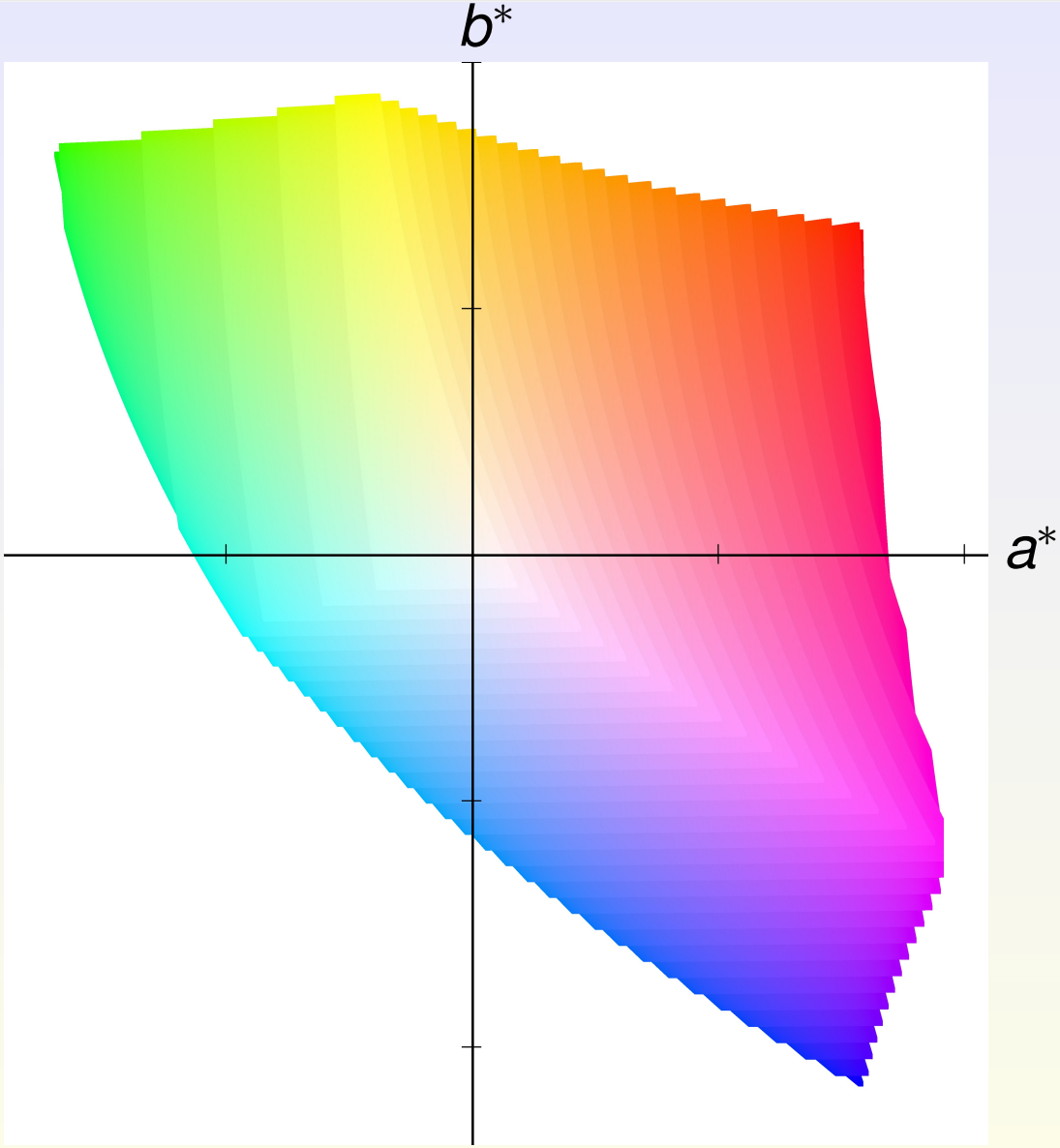
For a fixed (a^*, b^*), each location has the color of the highest L

CIE La*b* Color Space



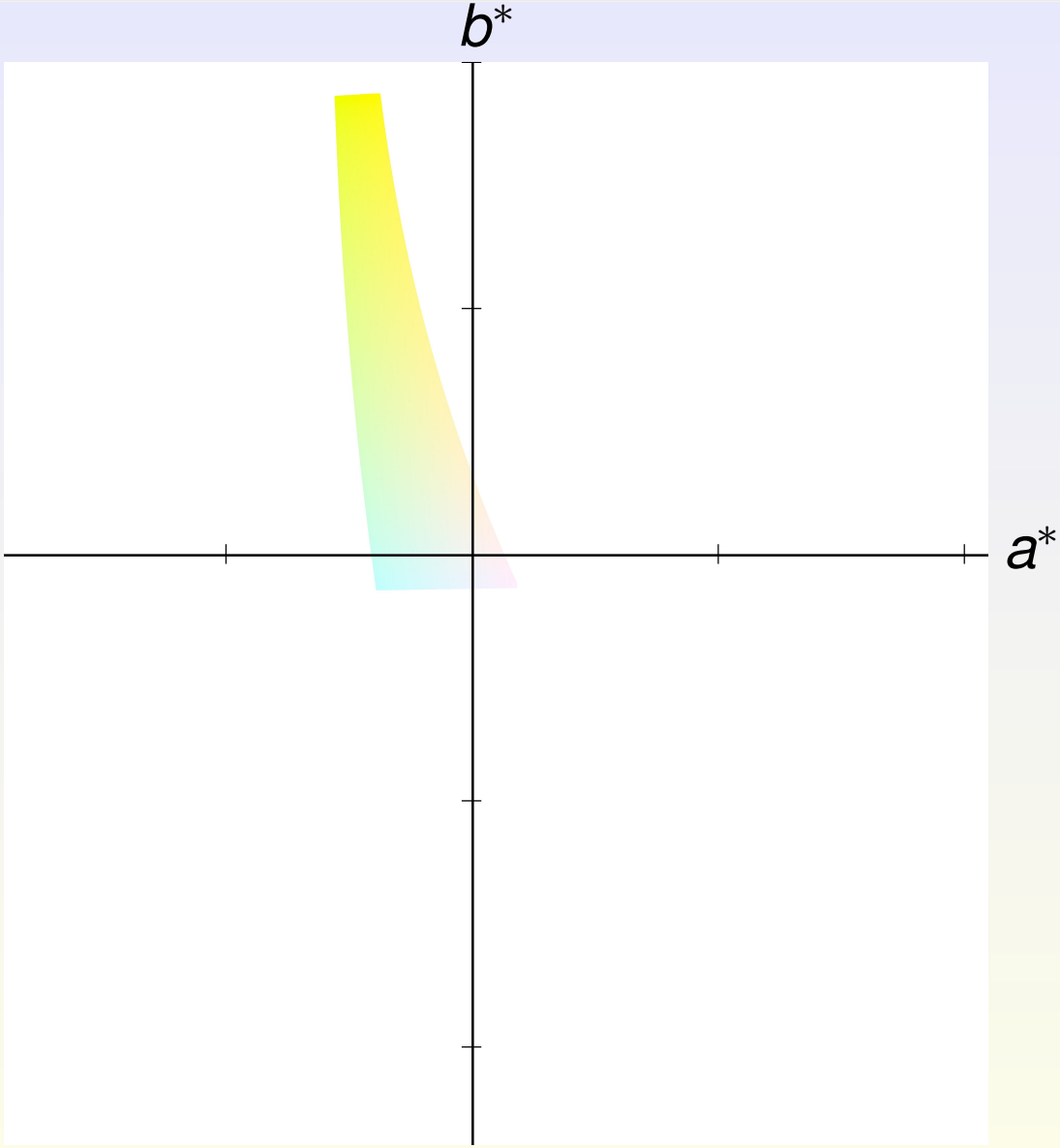
For a fixed (a^*, b^*), each location has the color of the lowest L

CIE La*b* Color Space



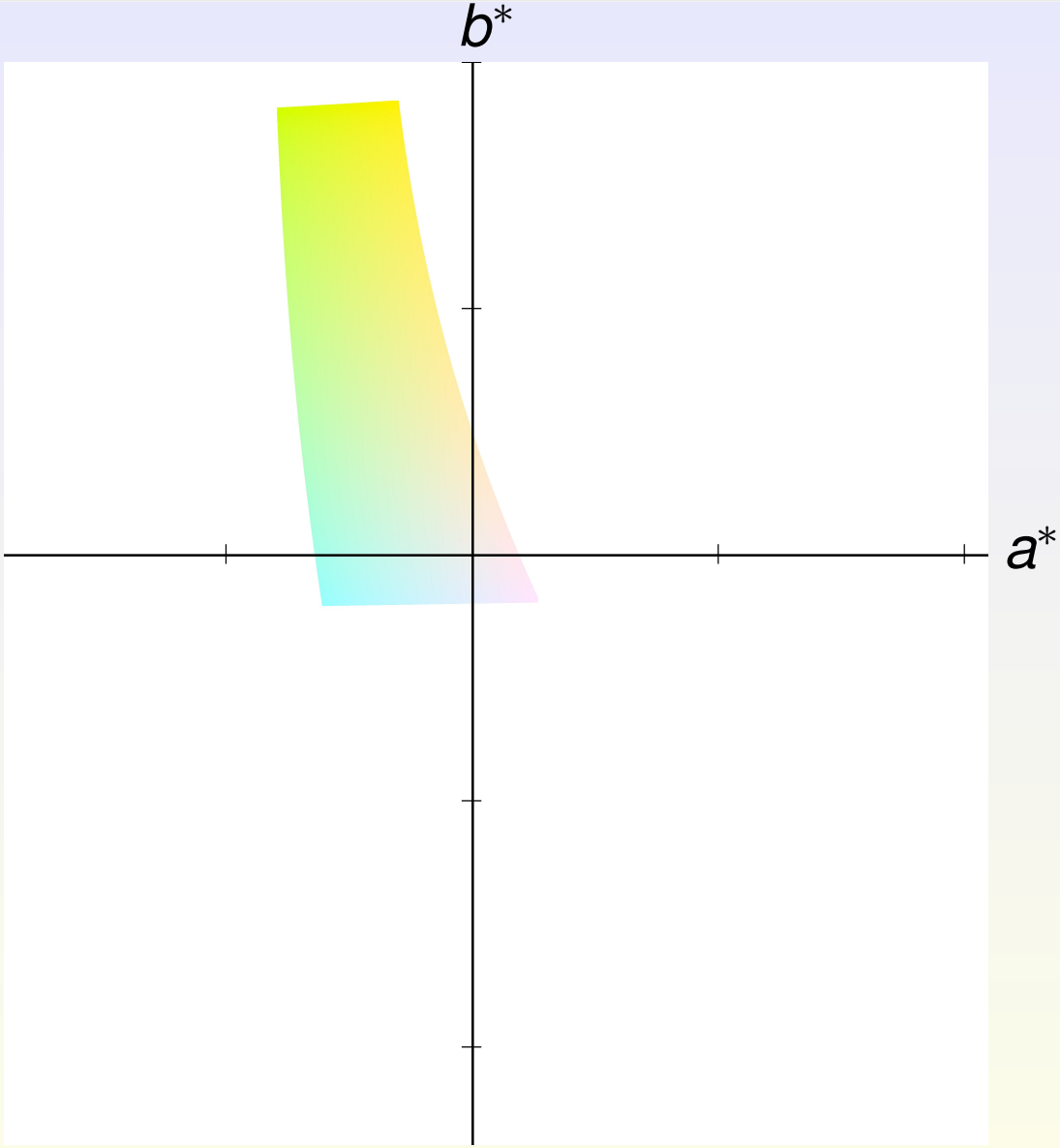
For a fixed (a^*, b^*), each location has the color of the highest L

CIE La*b* Color Space



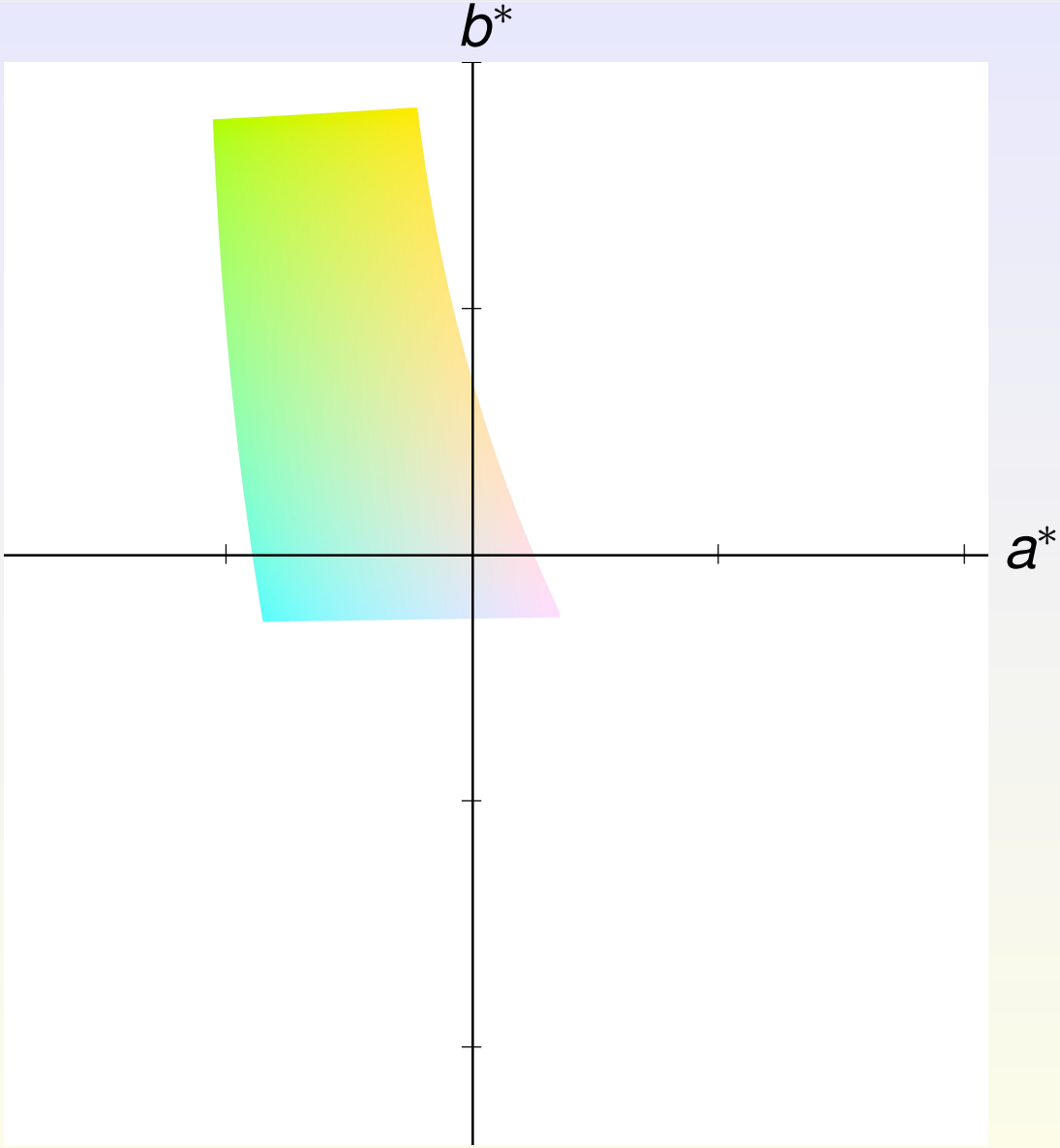
$L = 96$

CIE La*b* Color Space



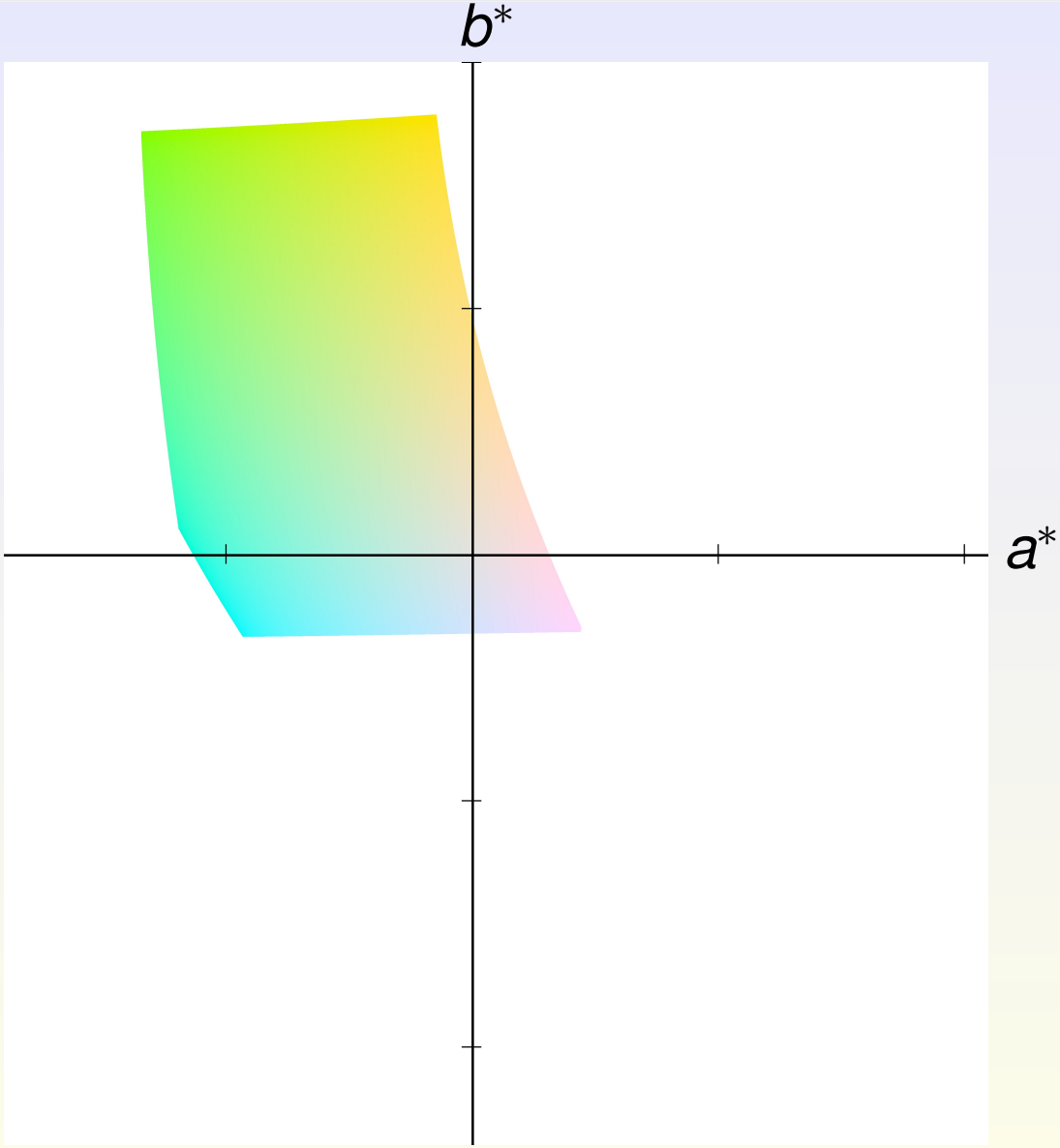
$L = 94$

CIE La*b* Color Space



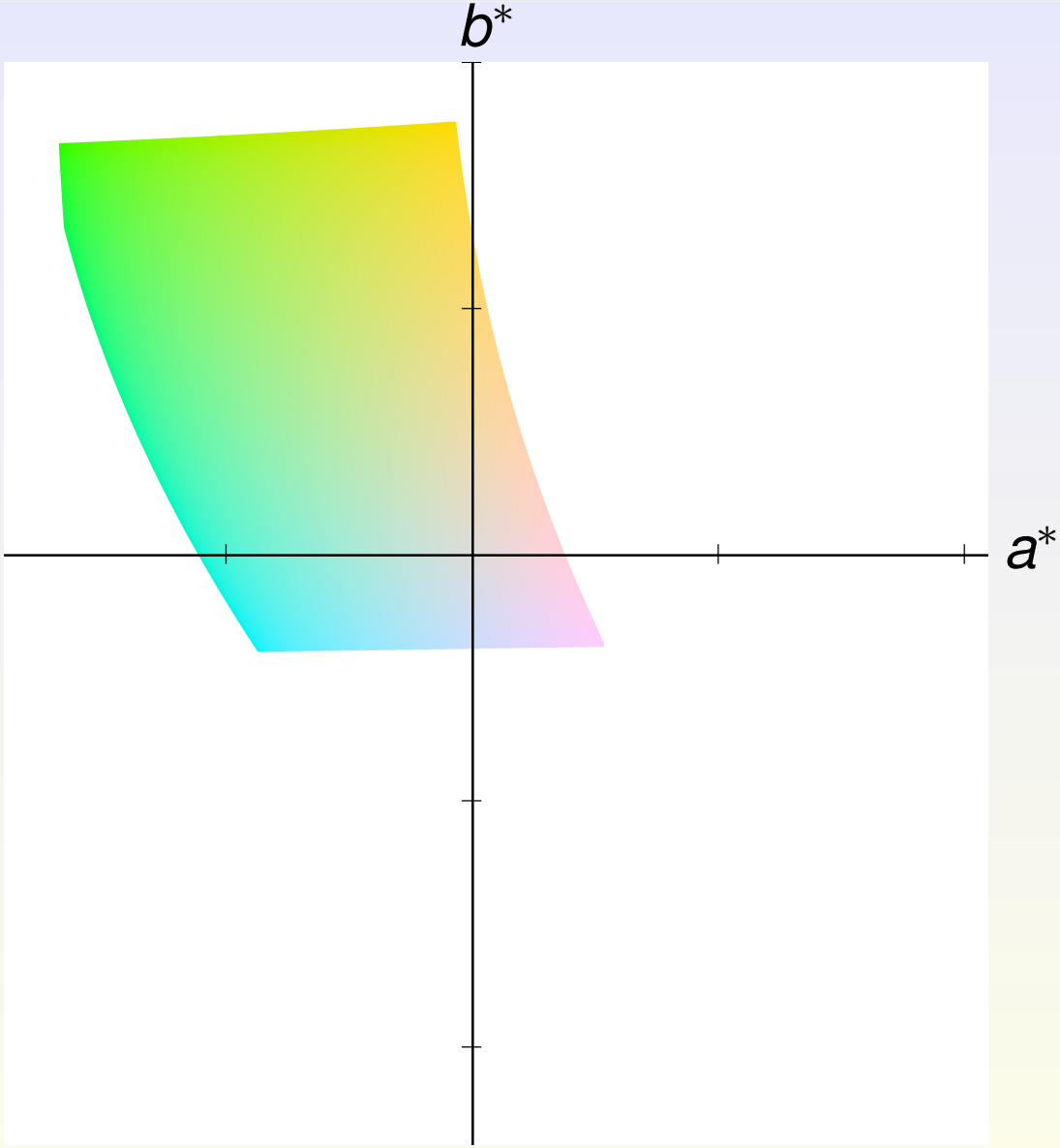
$L = 92$

CIE La*b* Color Space



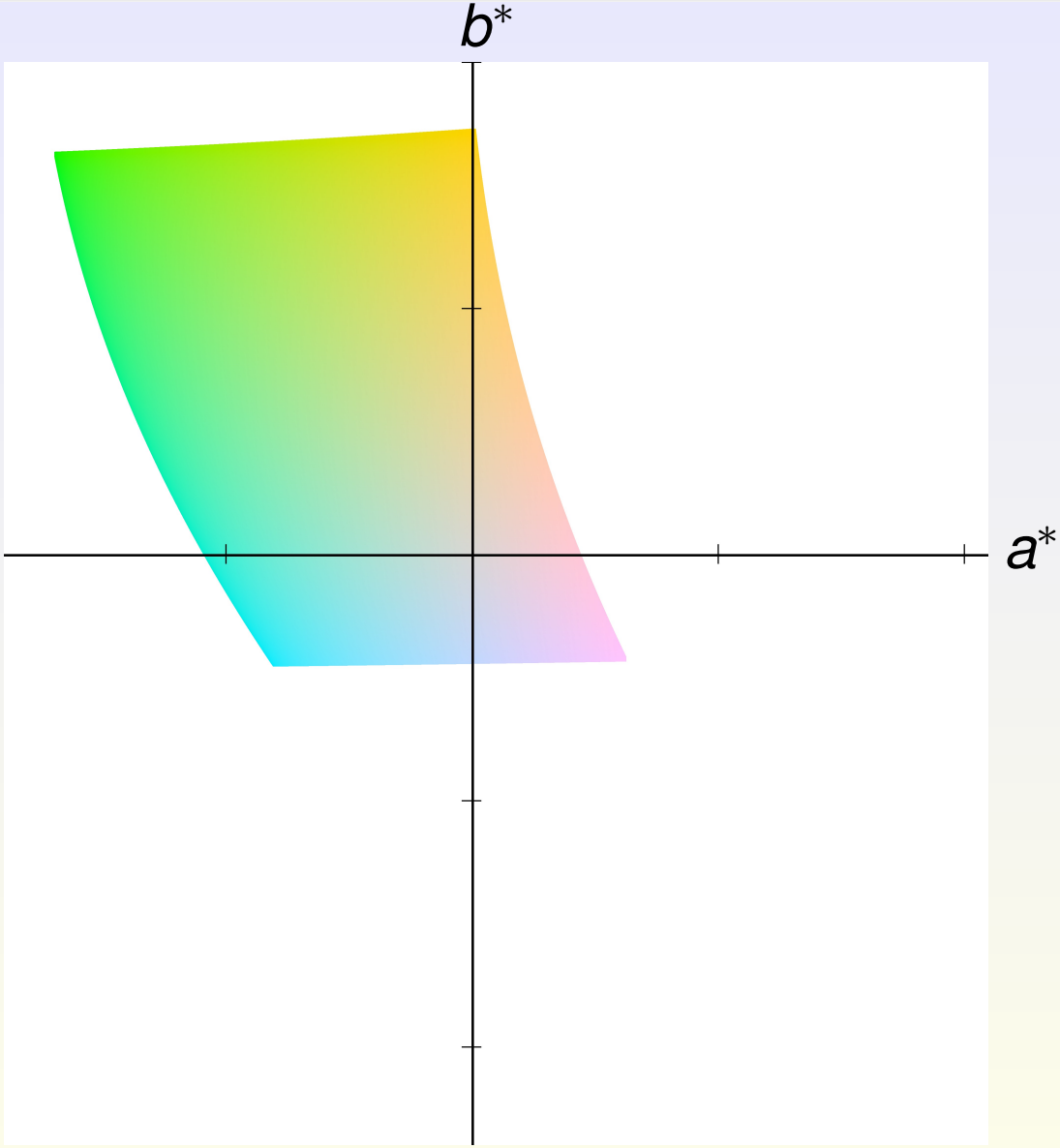
$L = 90$

CIE La*b* Color Space



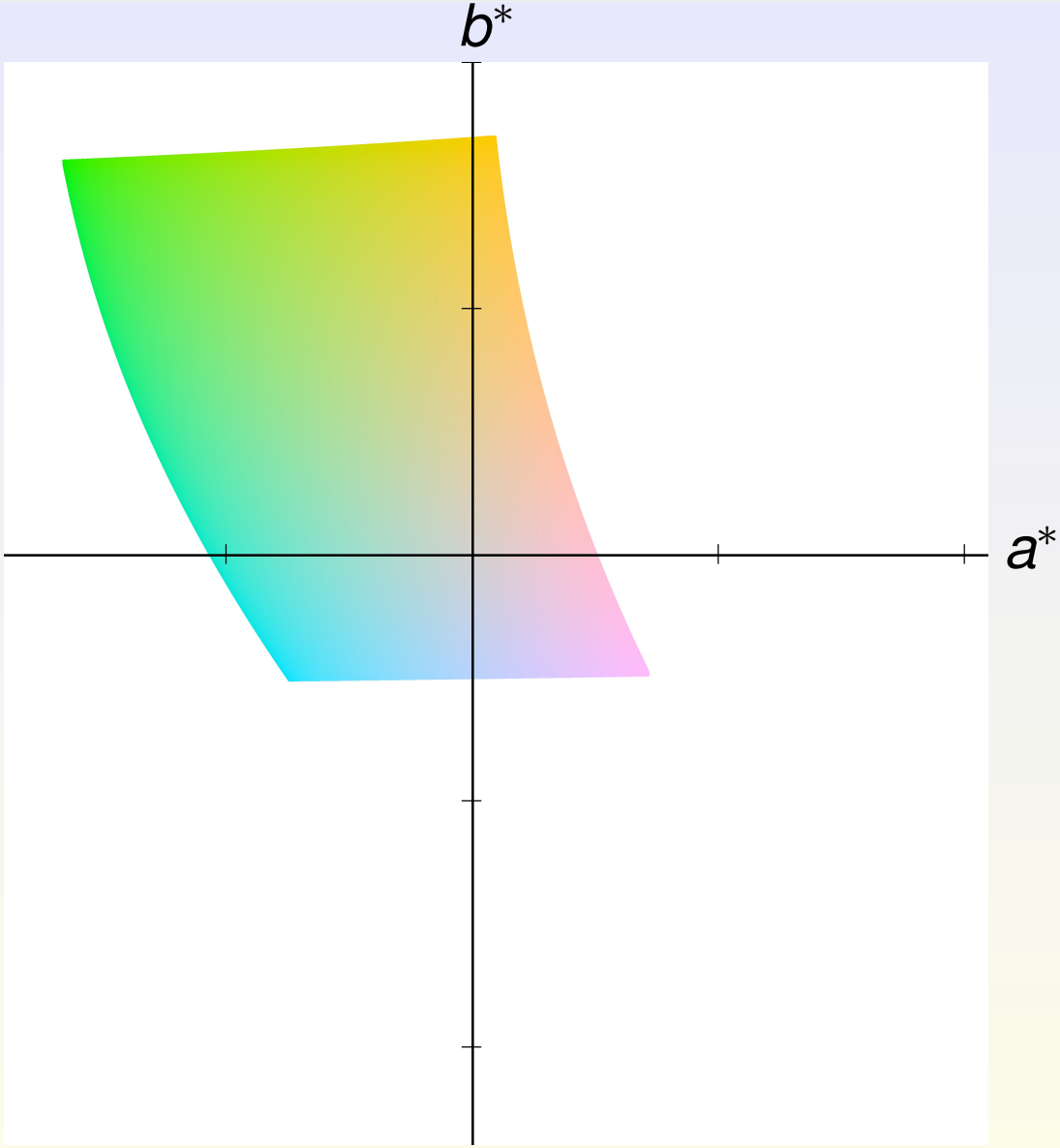
$L = 88$

CIE La*b* Color Space



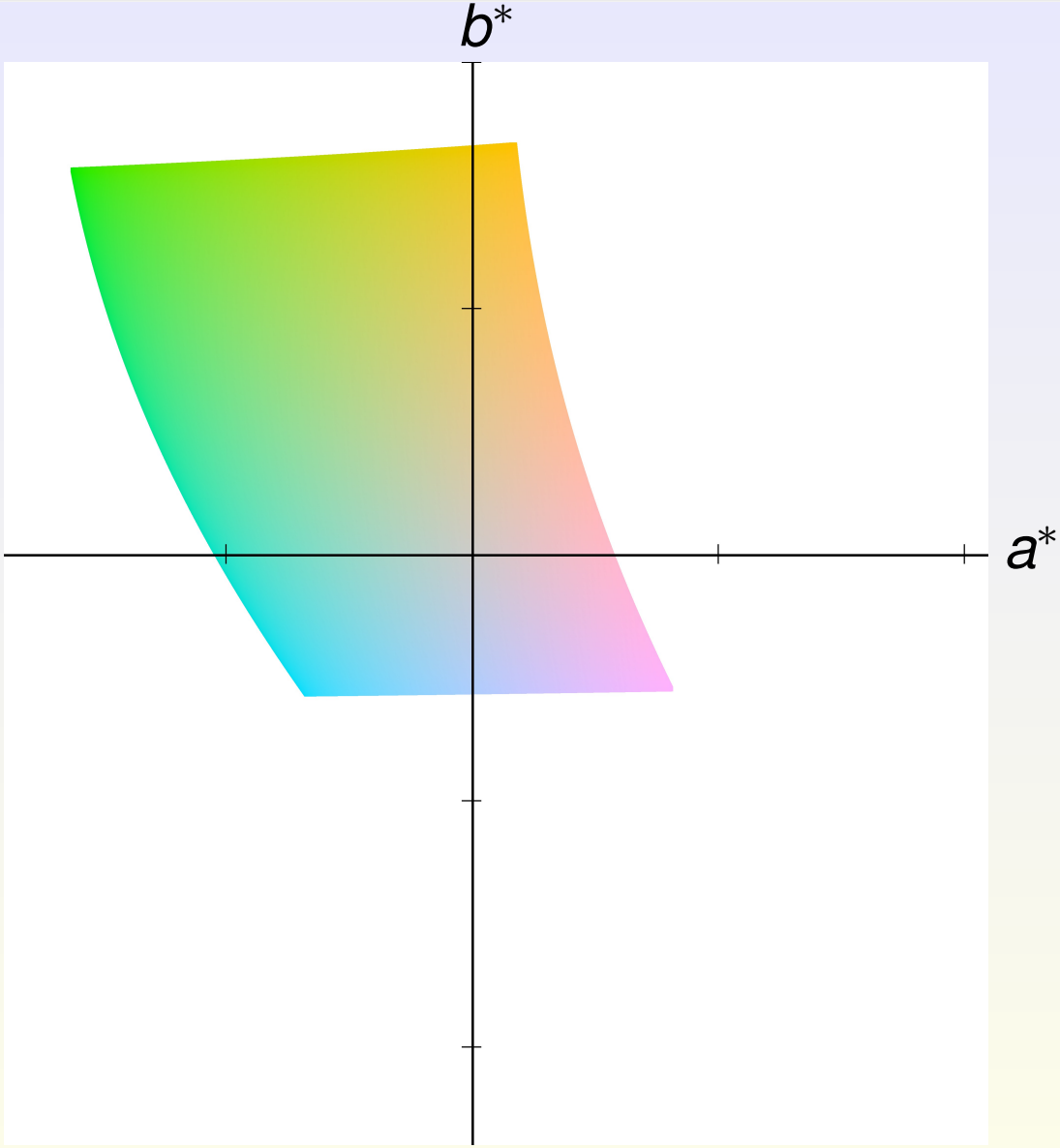
$L = 86$

CIE La*b* Color Space



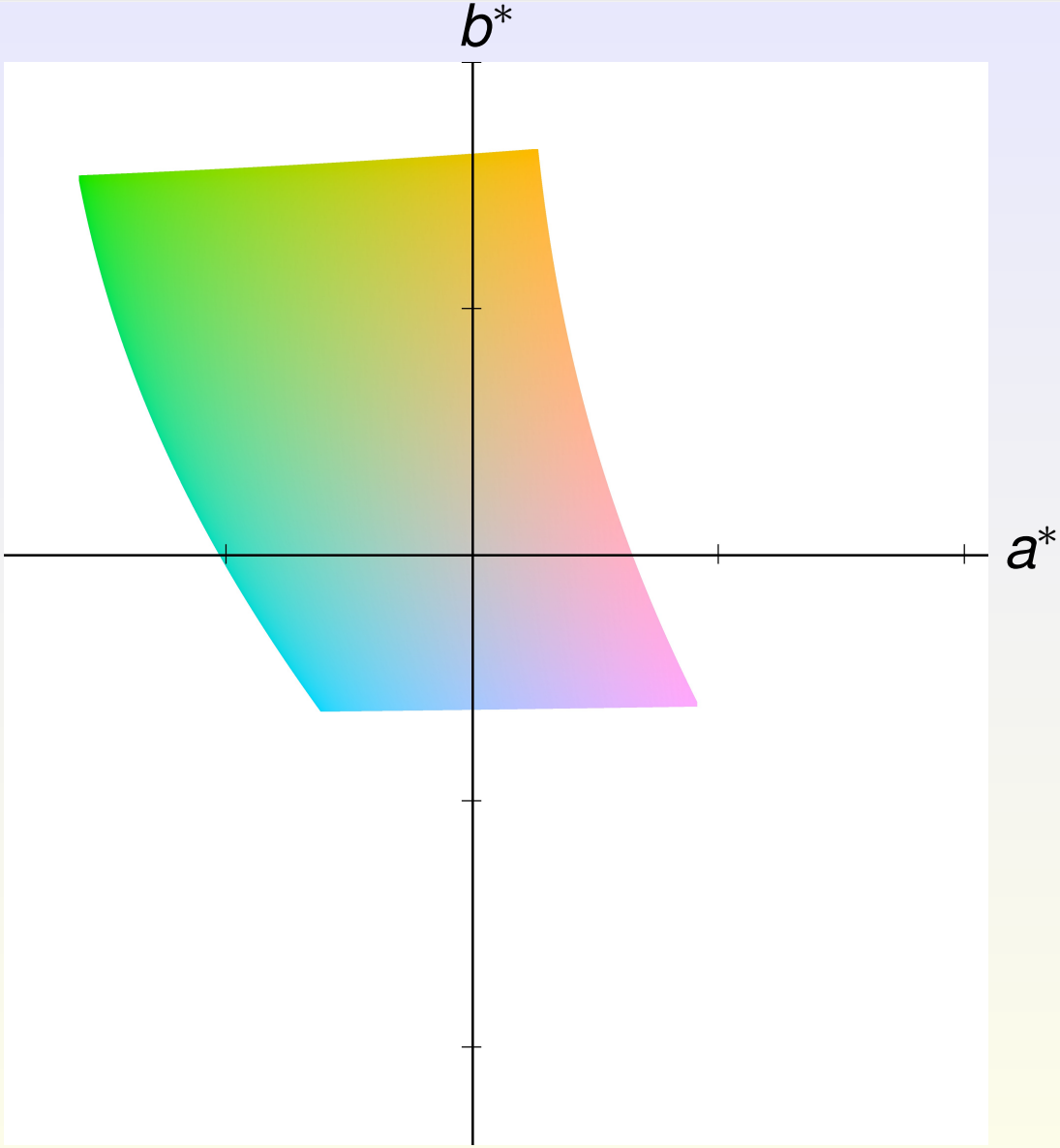
$L = 84$

CIE La*b* Color Space



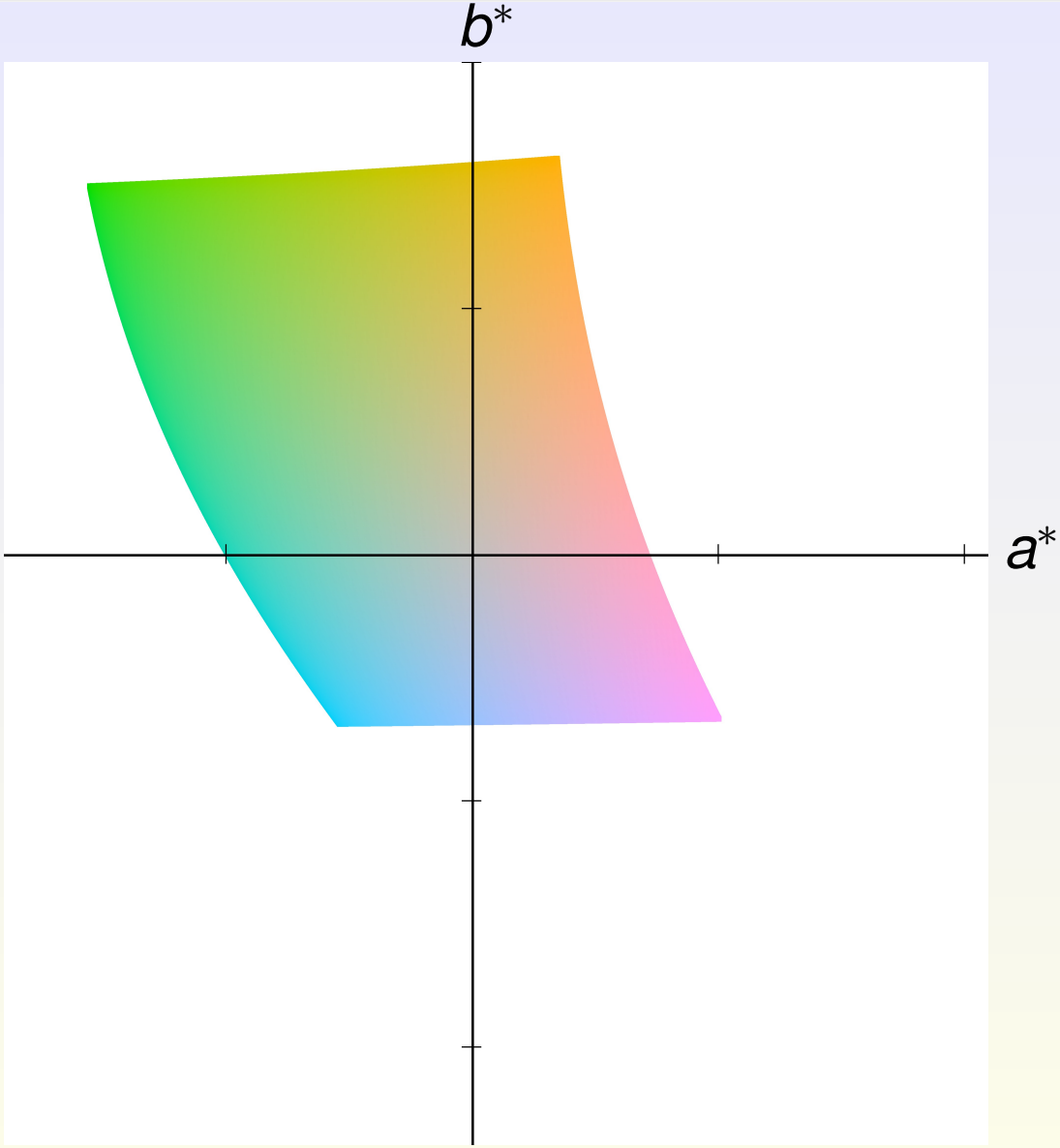
$L = 82$

CIE La*b* Color Space



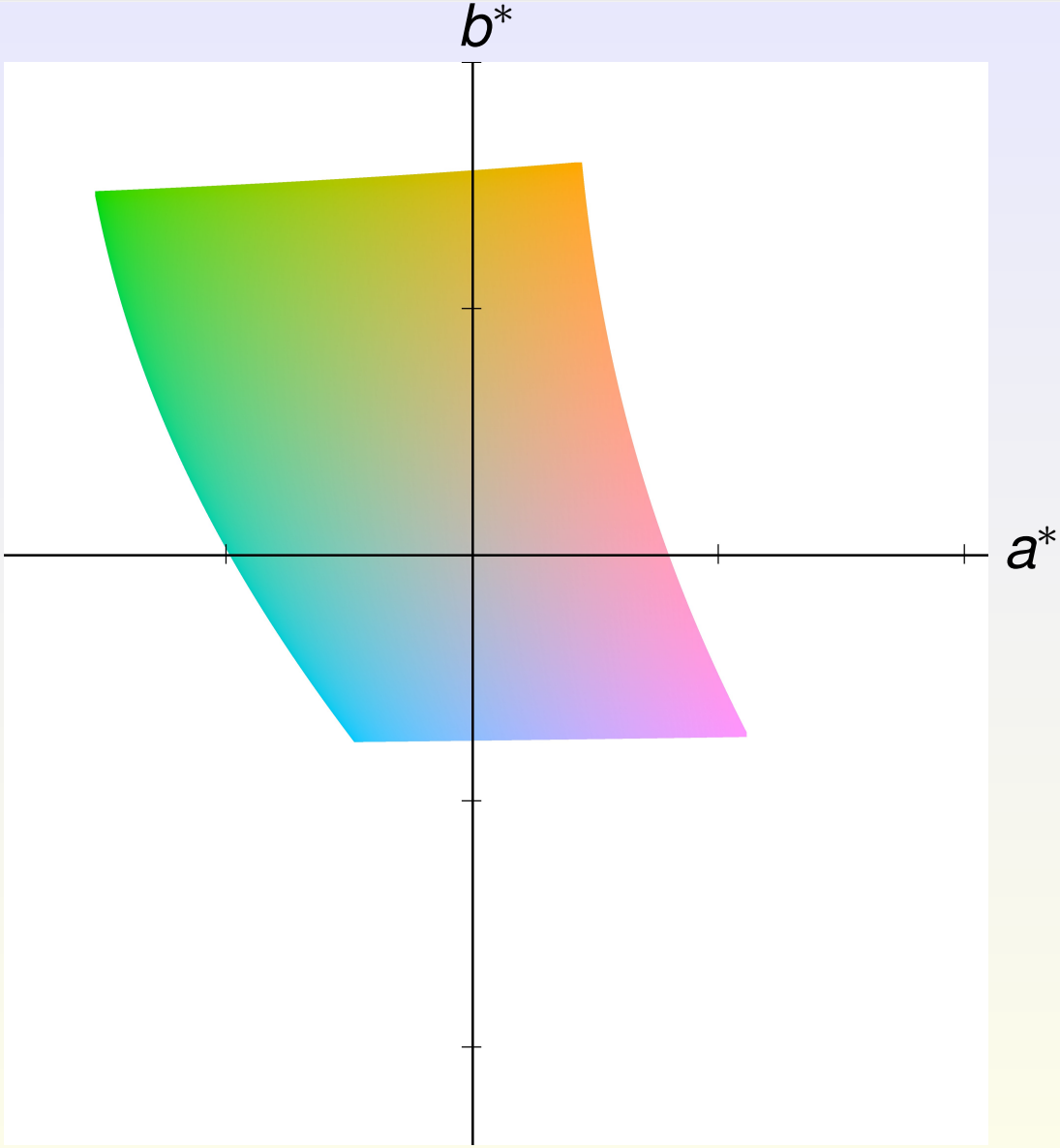
$L = 80$

CIE La*b* Color Space



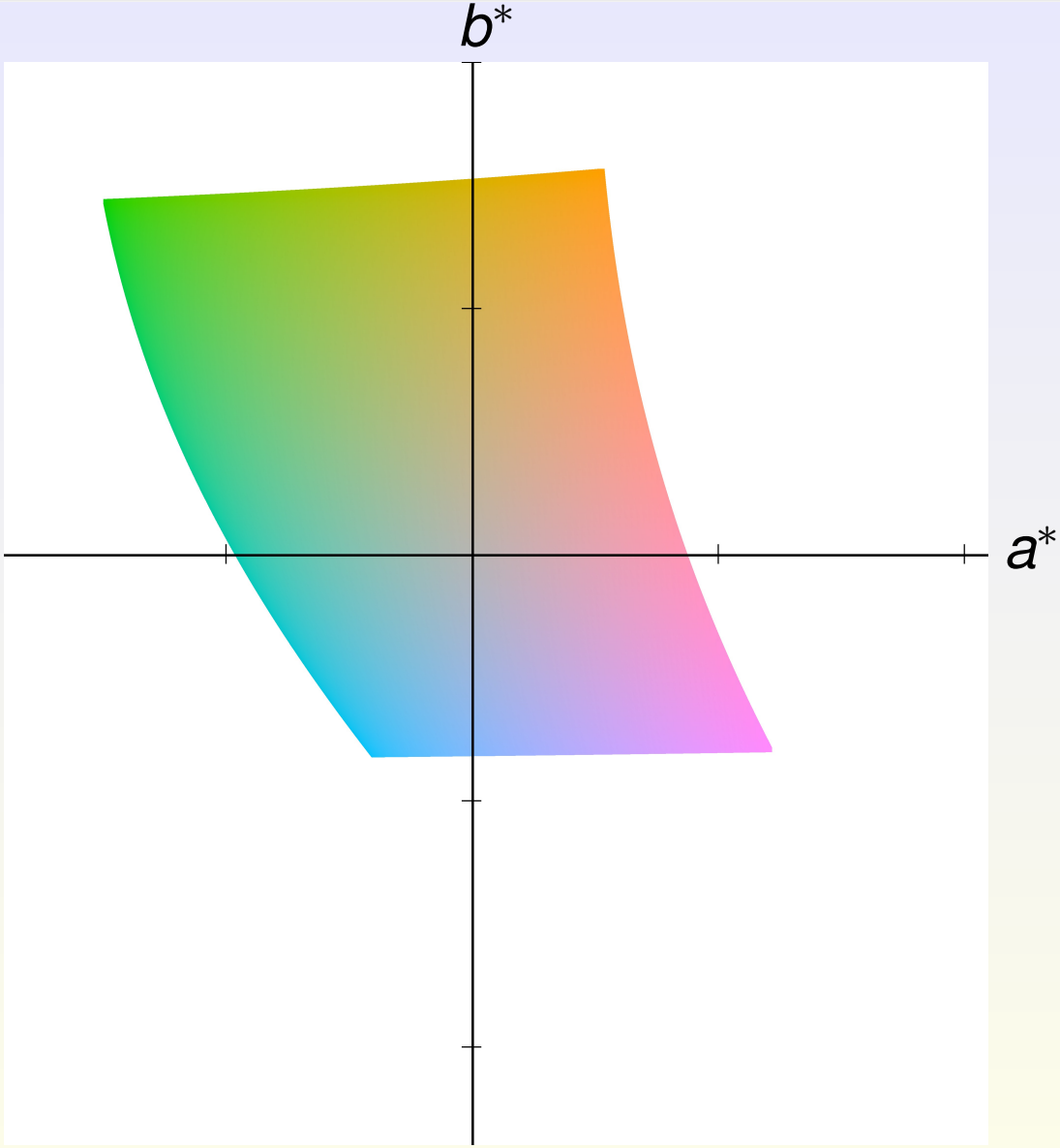
$L = 78$

CIE La*b* Color Space



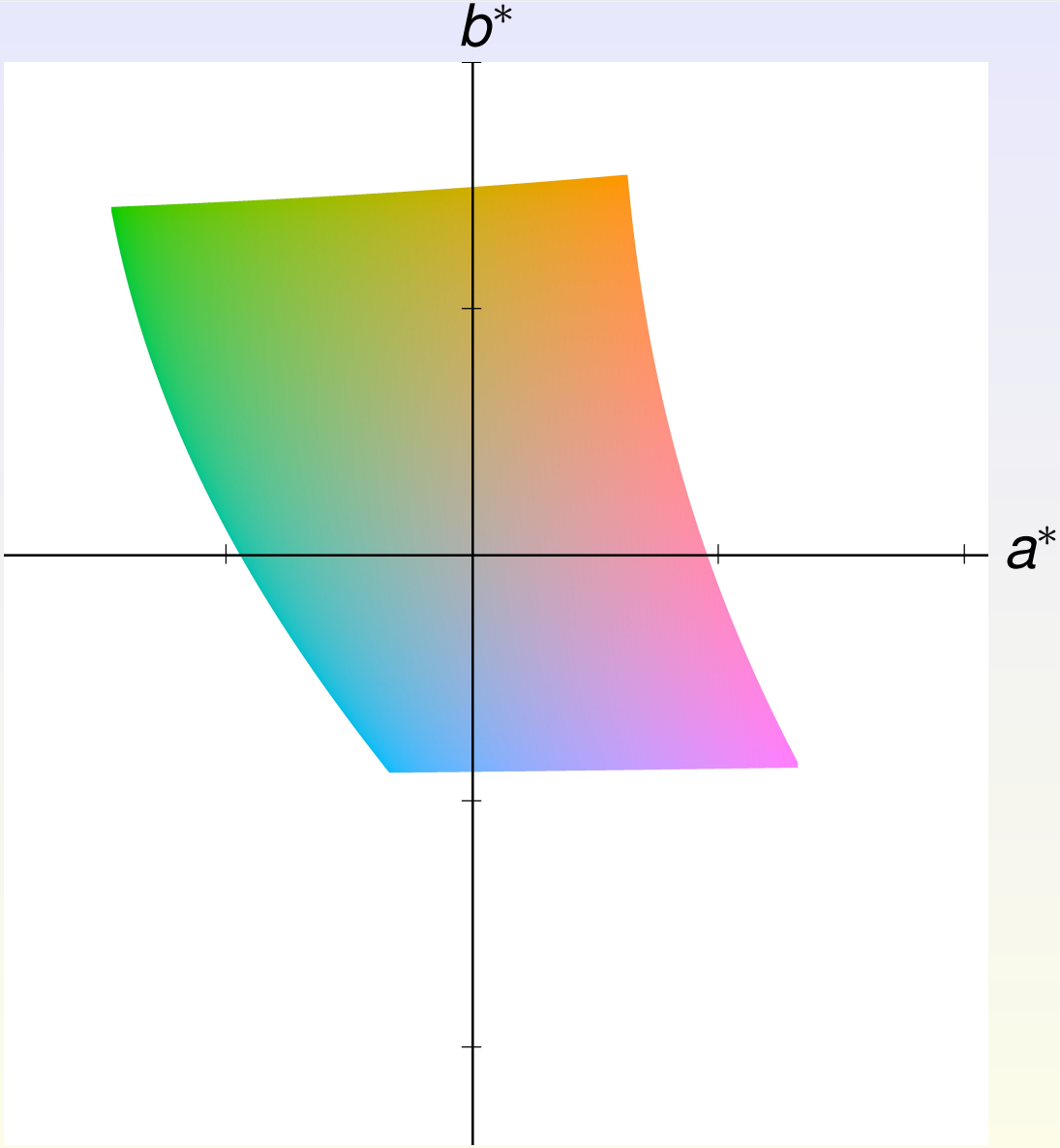
$L = 76$

CIE La*b* Color Space



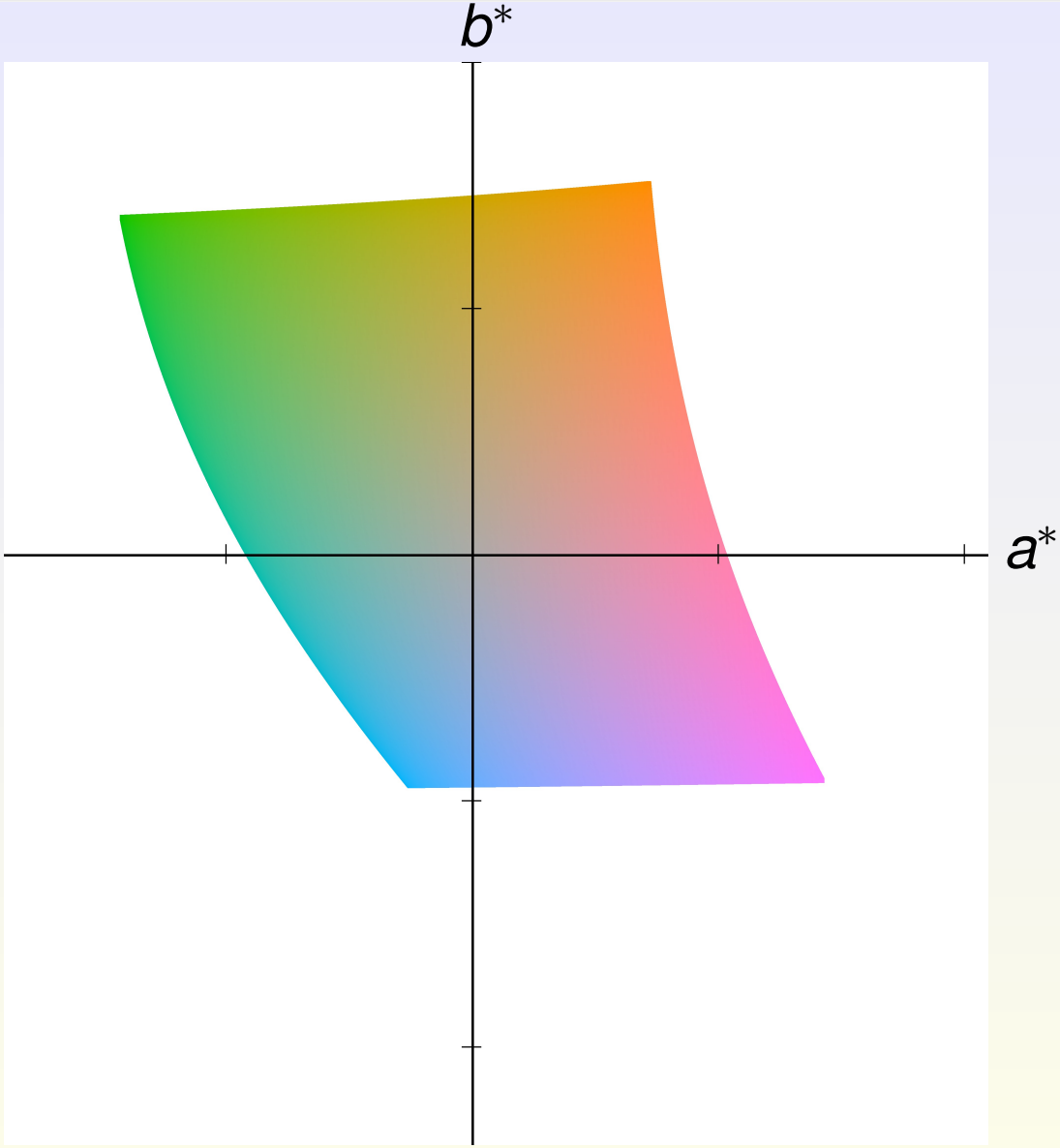
$L = 74$

CIE La*b* Color Space



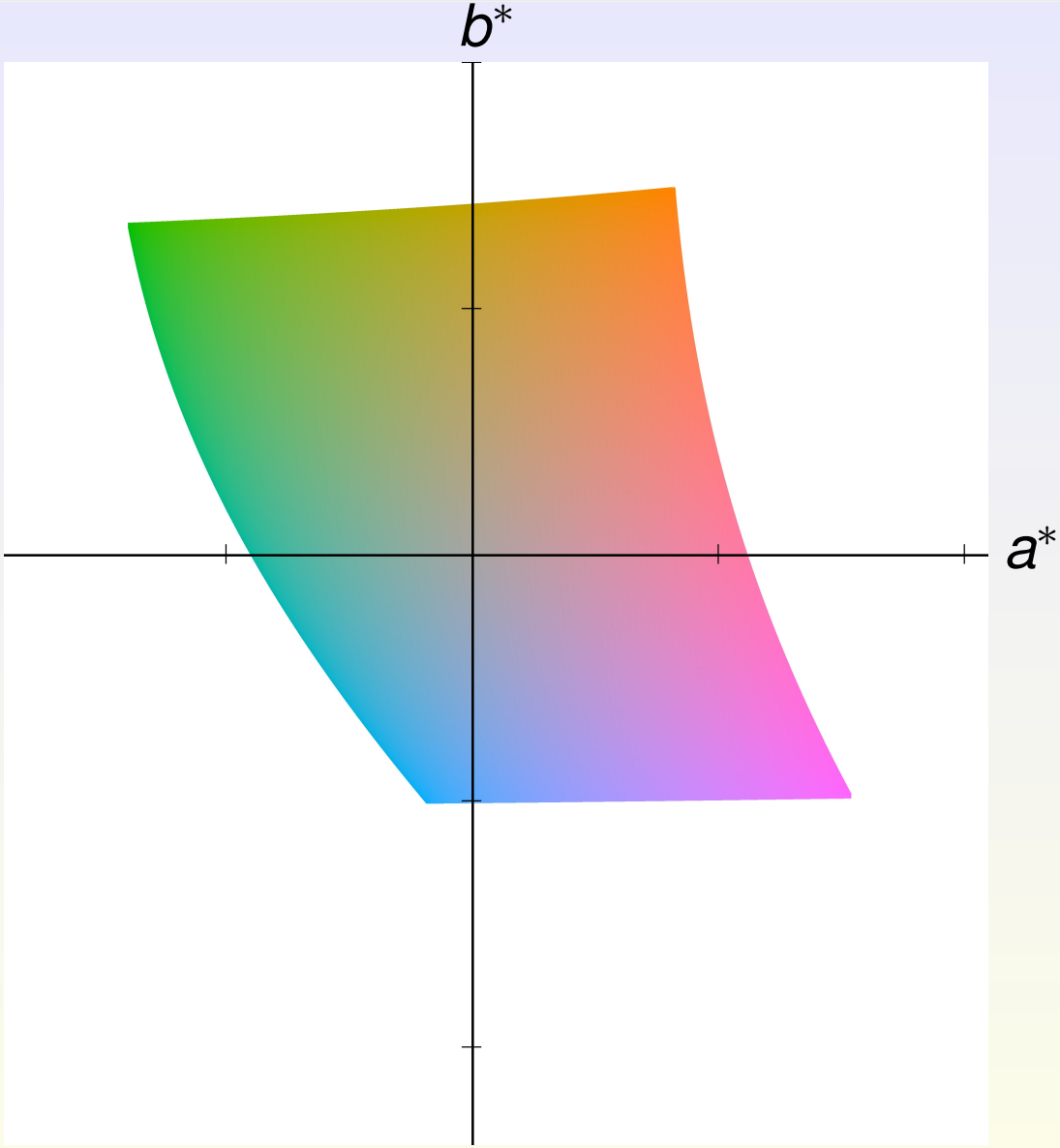
$L = 72$

CIE La*b* Color Space



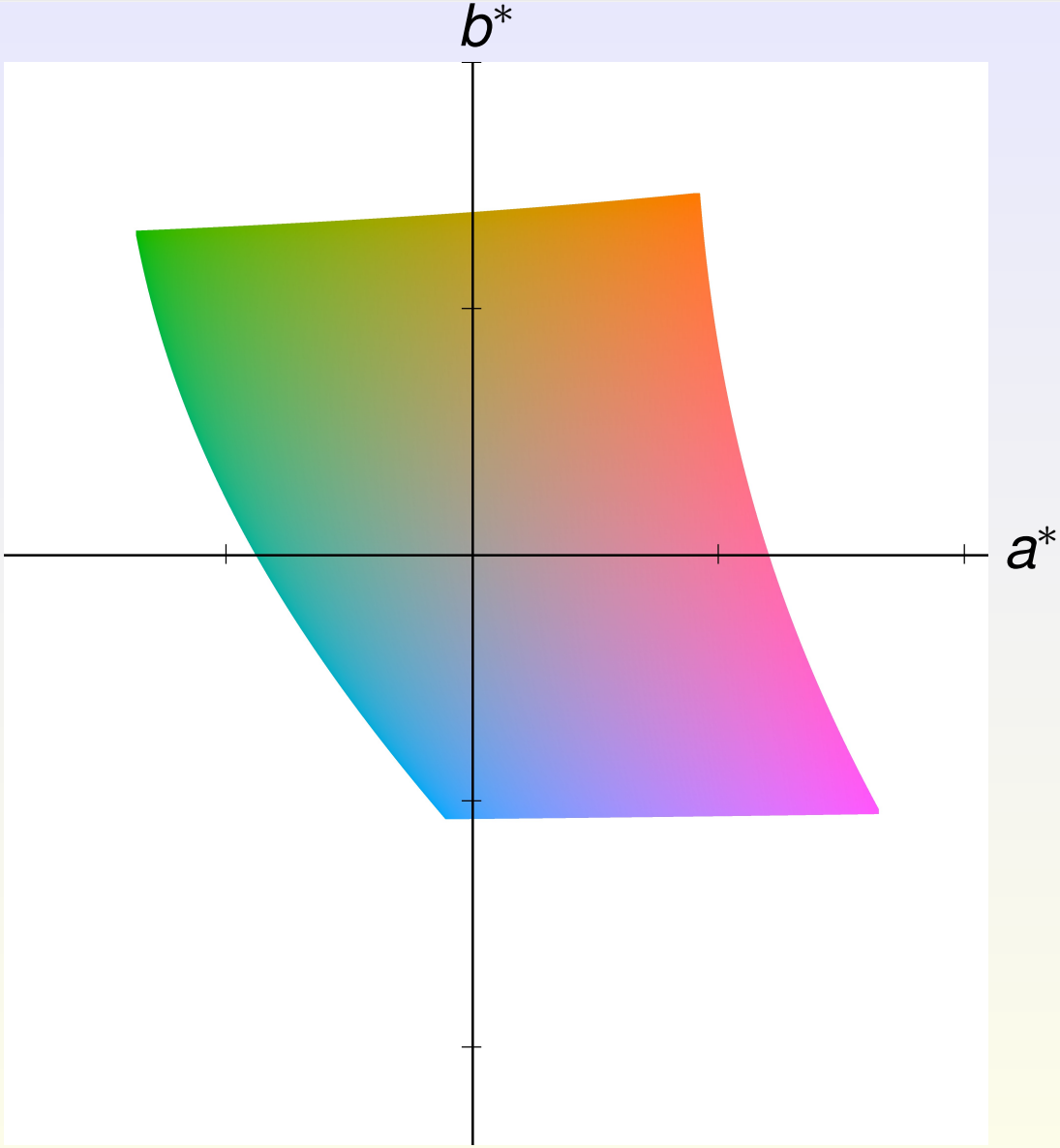
$L = 70$

CIE La*b* Color Space



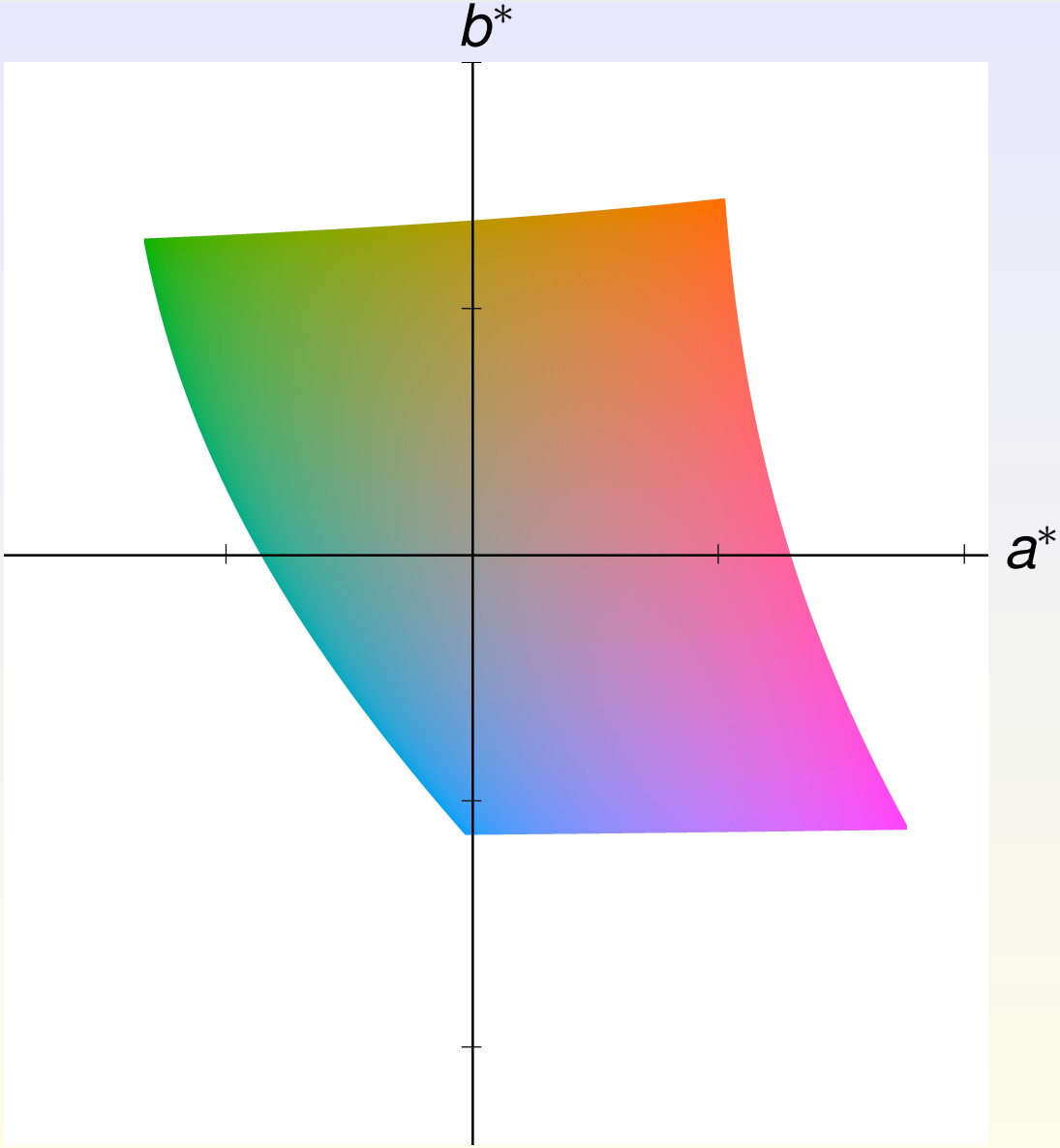
$L = 68$

CIE La*b* Color Space



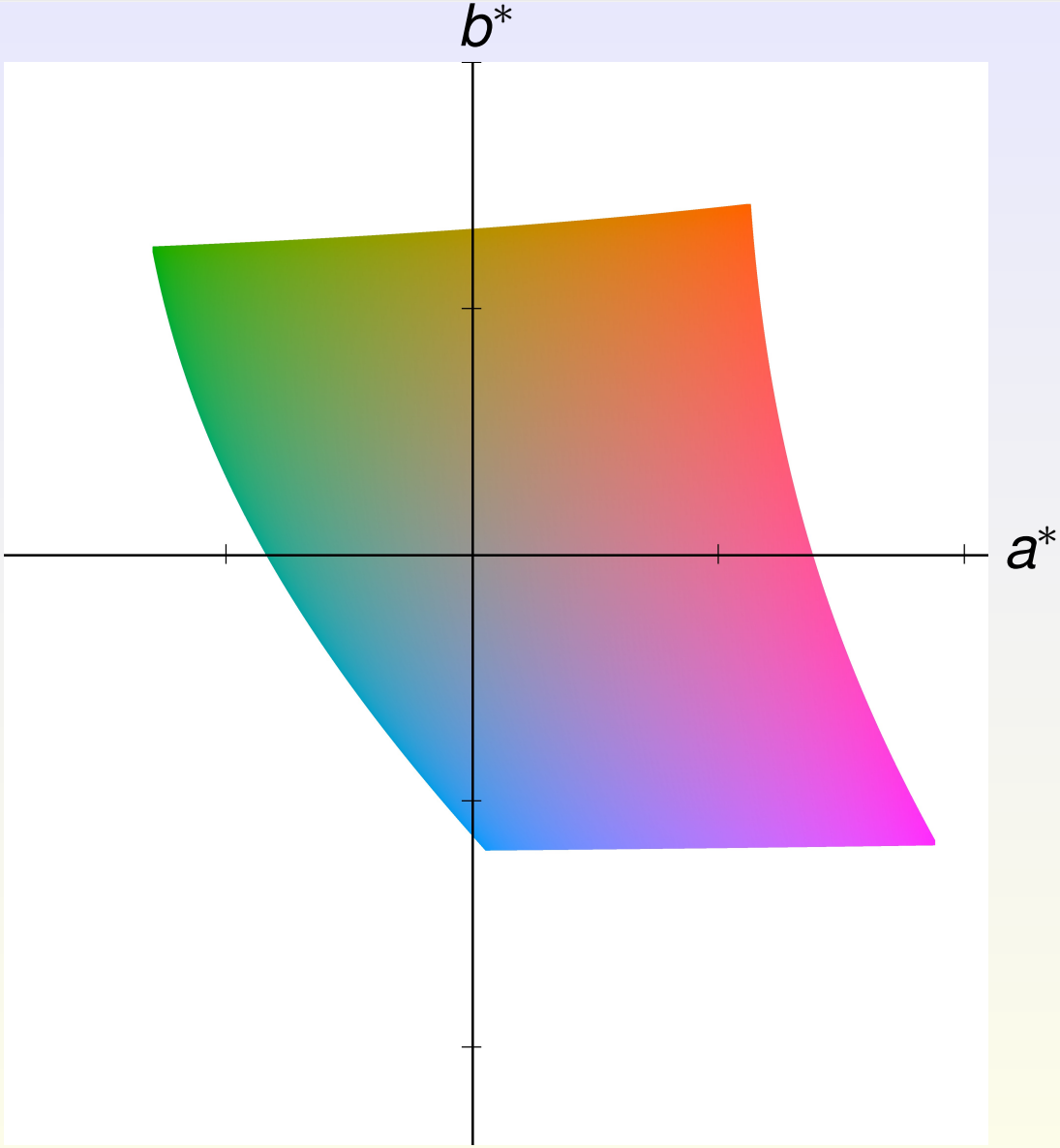
$L = 66$

CIE La*b* Color Space



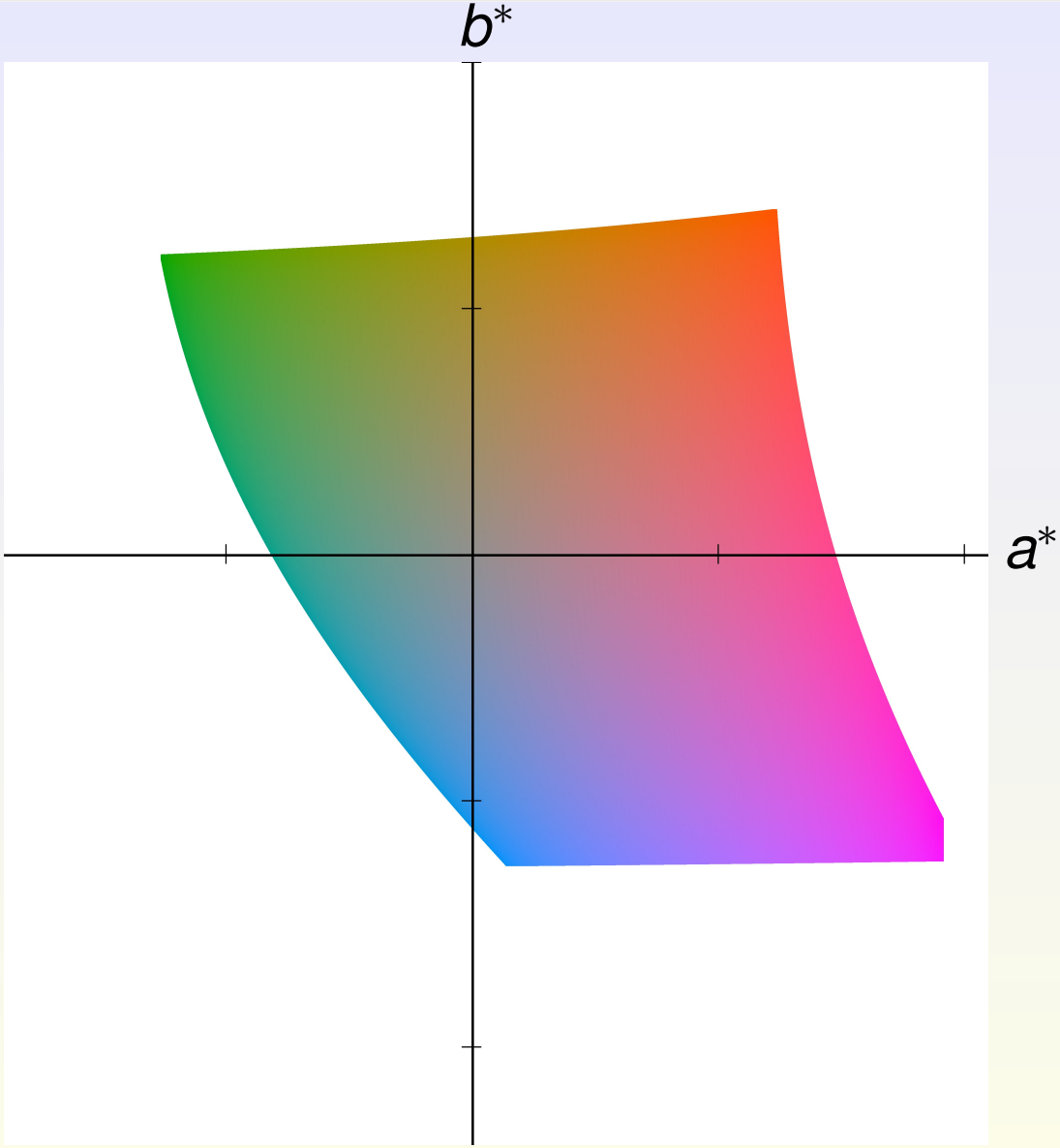
$L = 64$

CIE La*b* Color Space



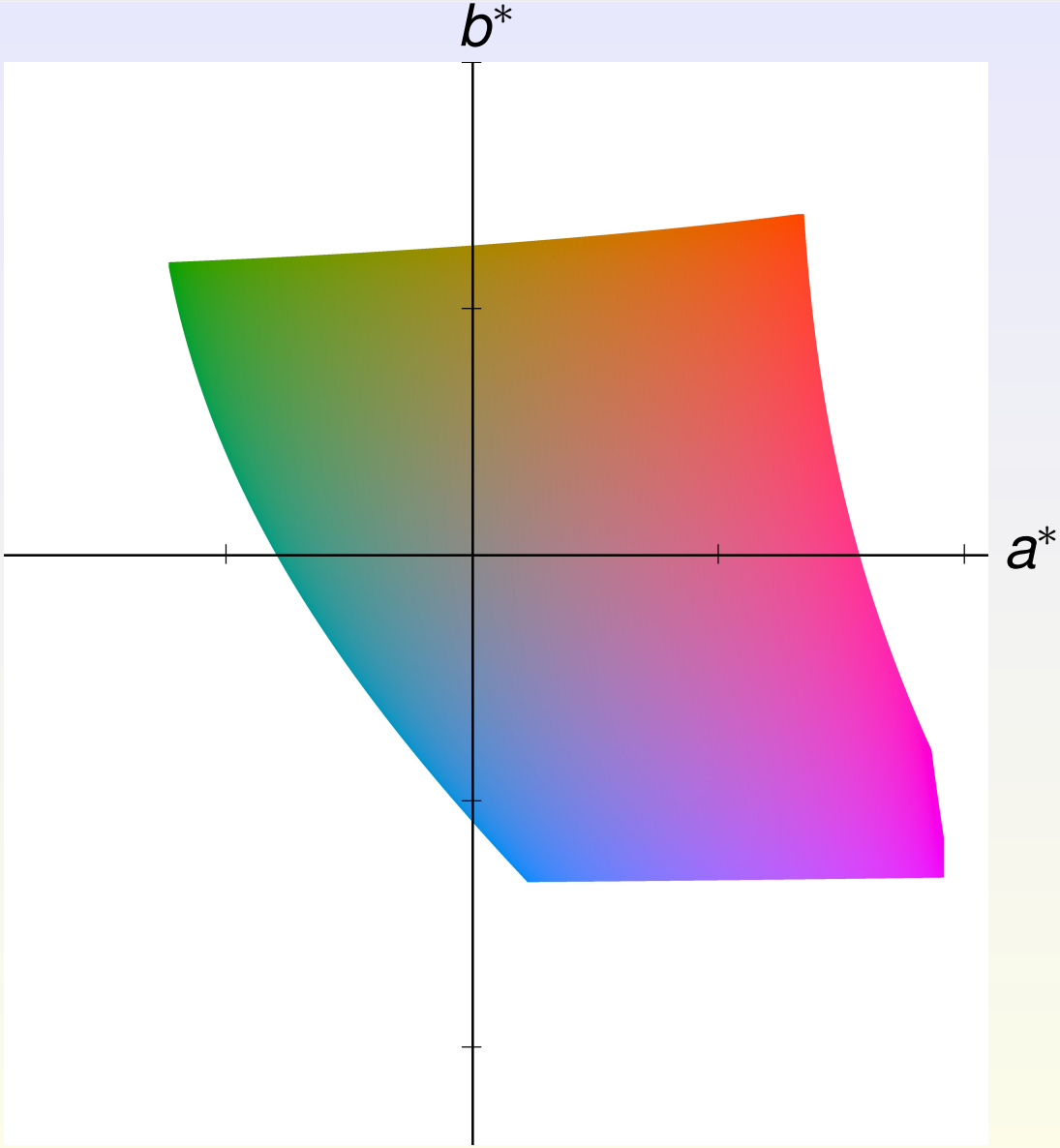
$L = 62$

CIE La*b* Color Space



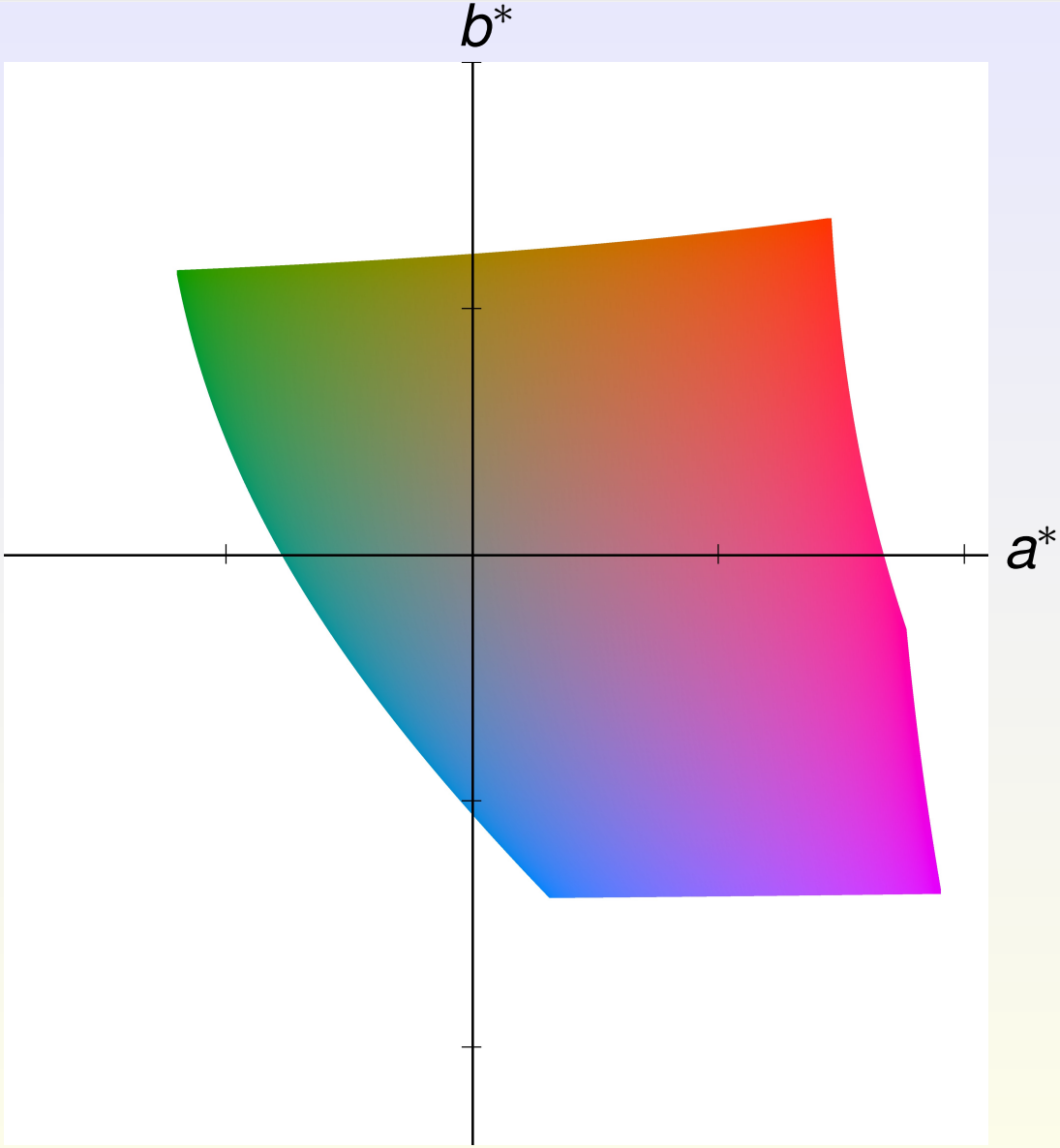
$L = 60$

CIE La*b* Color Space



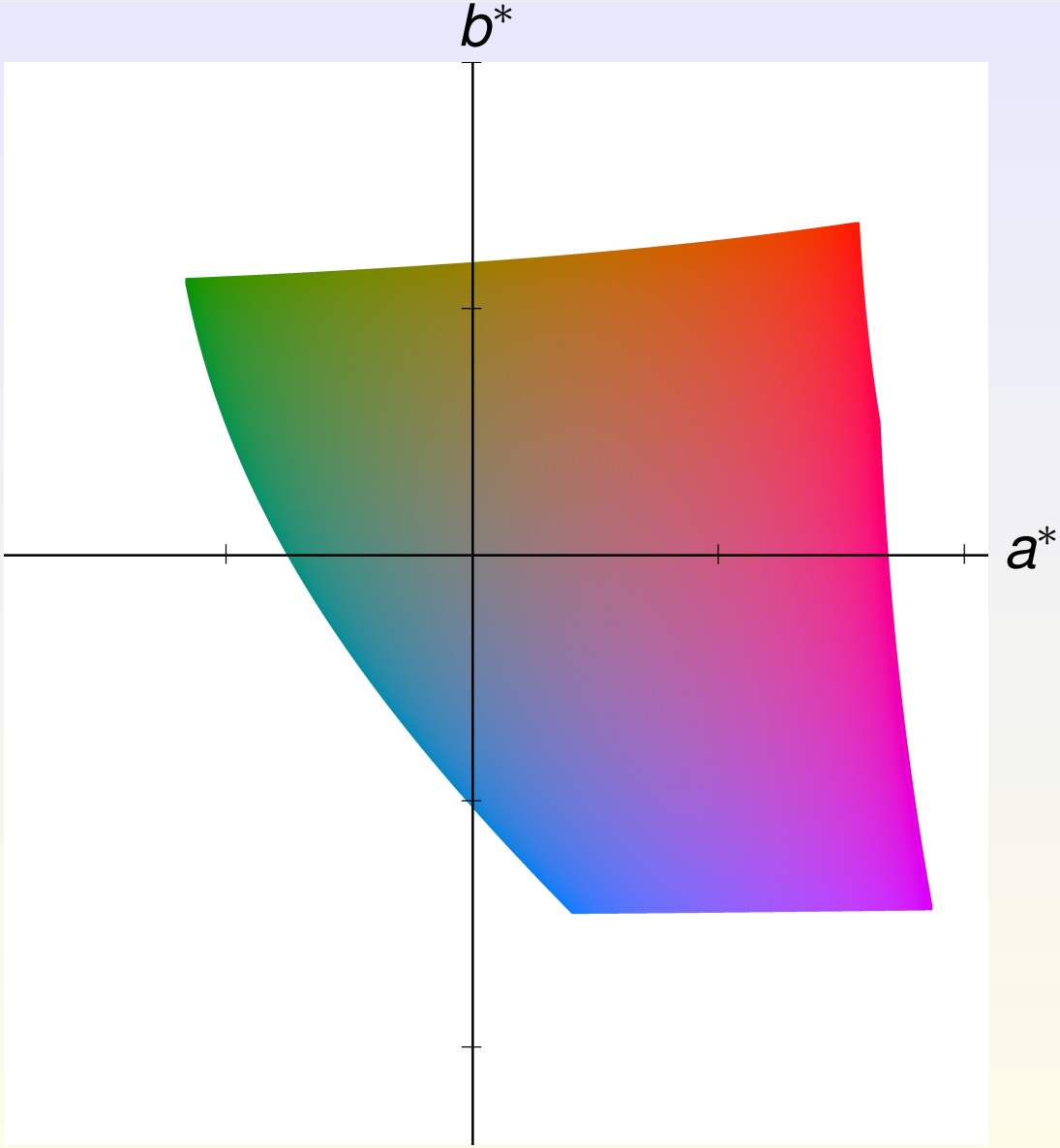
$L = 58$

CIE La*b* Color Space



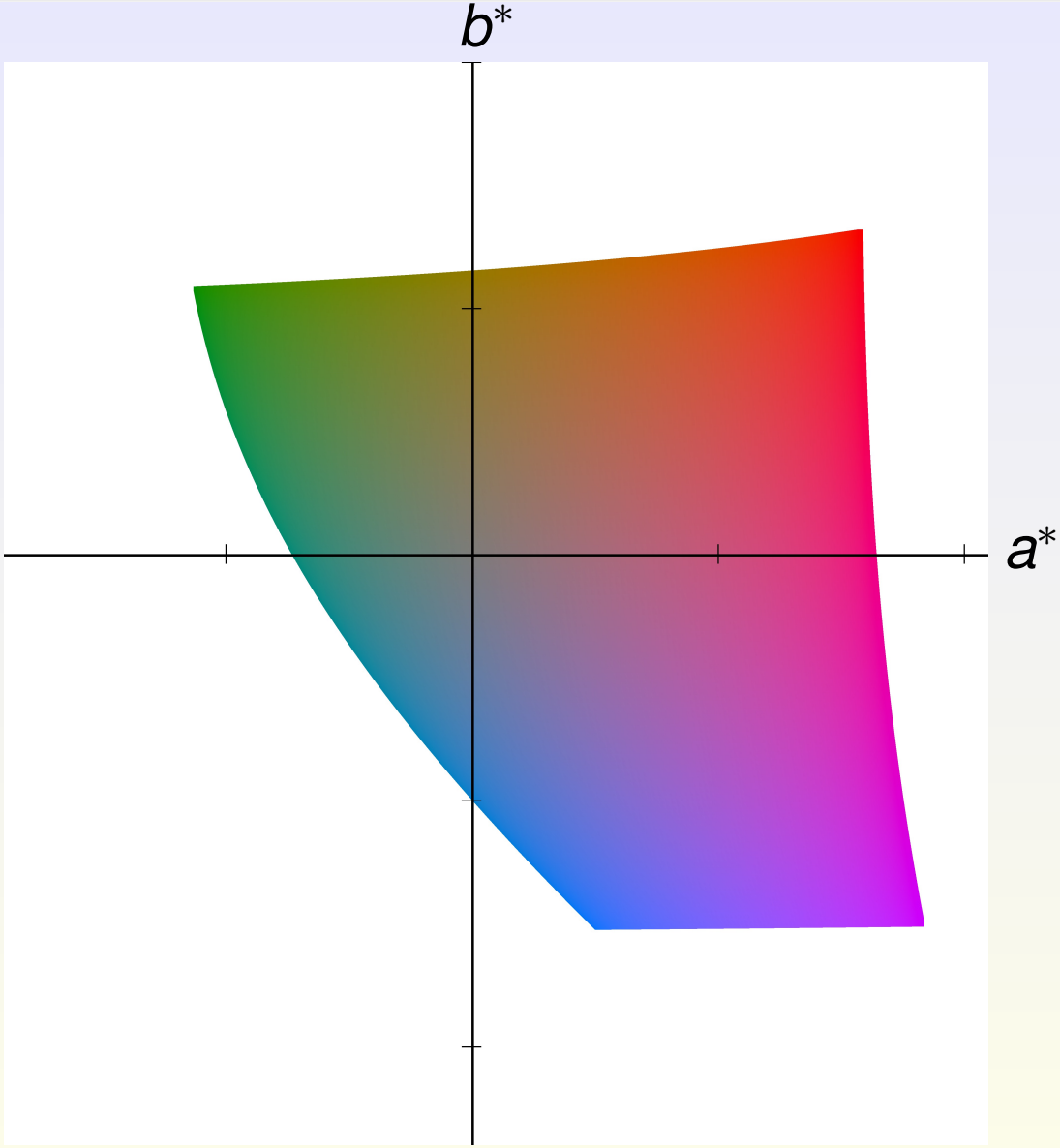
$L = 56$

CIE La*b* Color Space



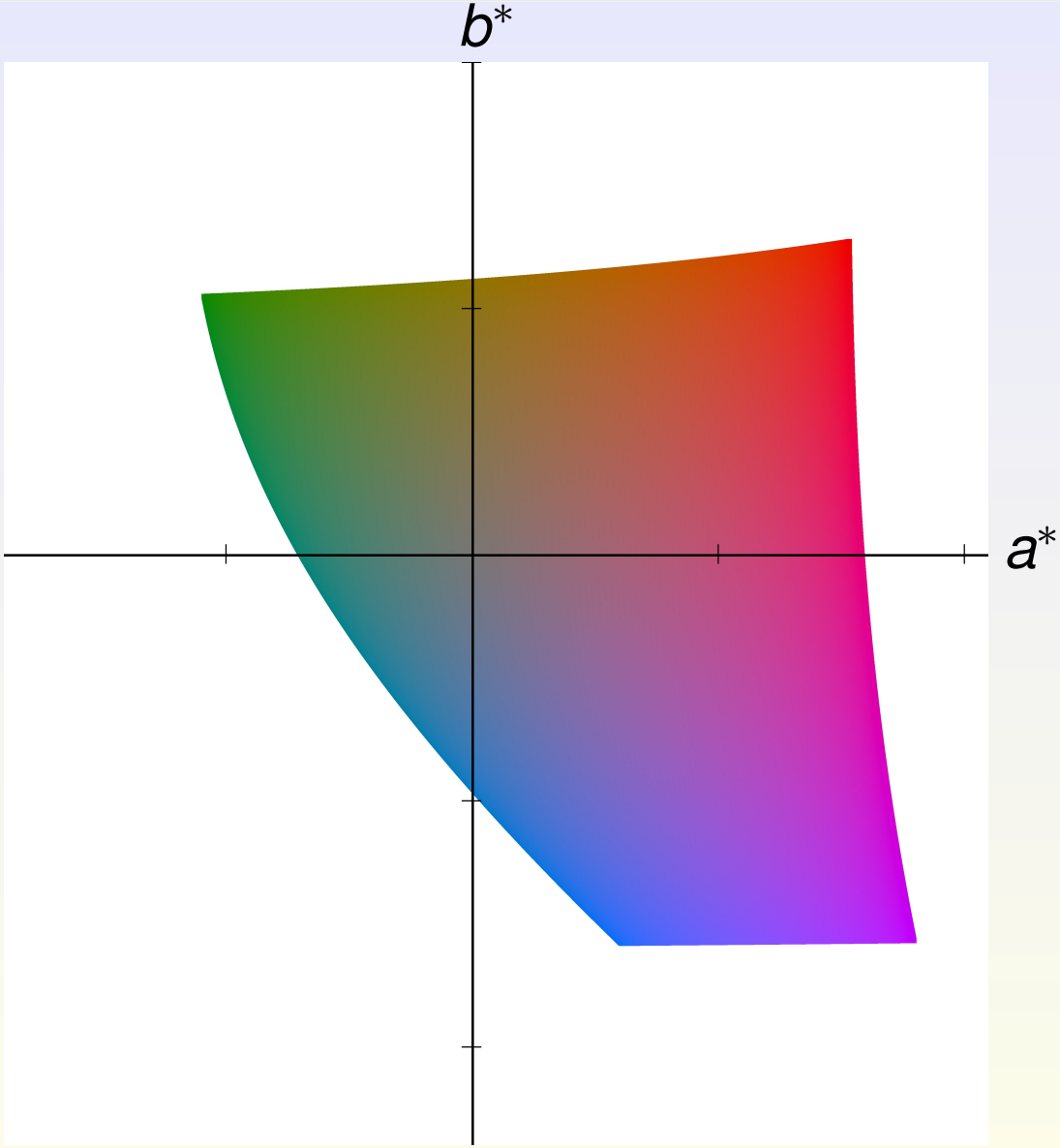
$L = 54$

CIE La*b* Color Space



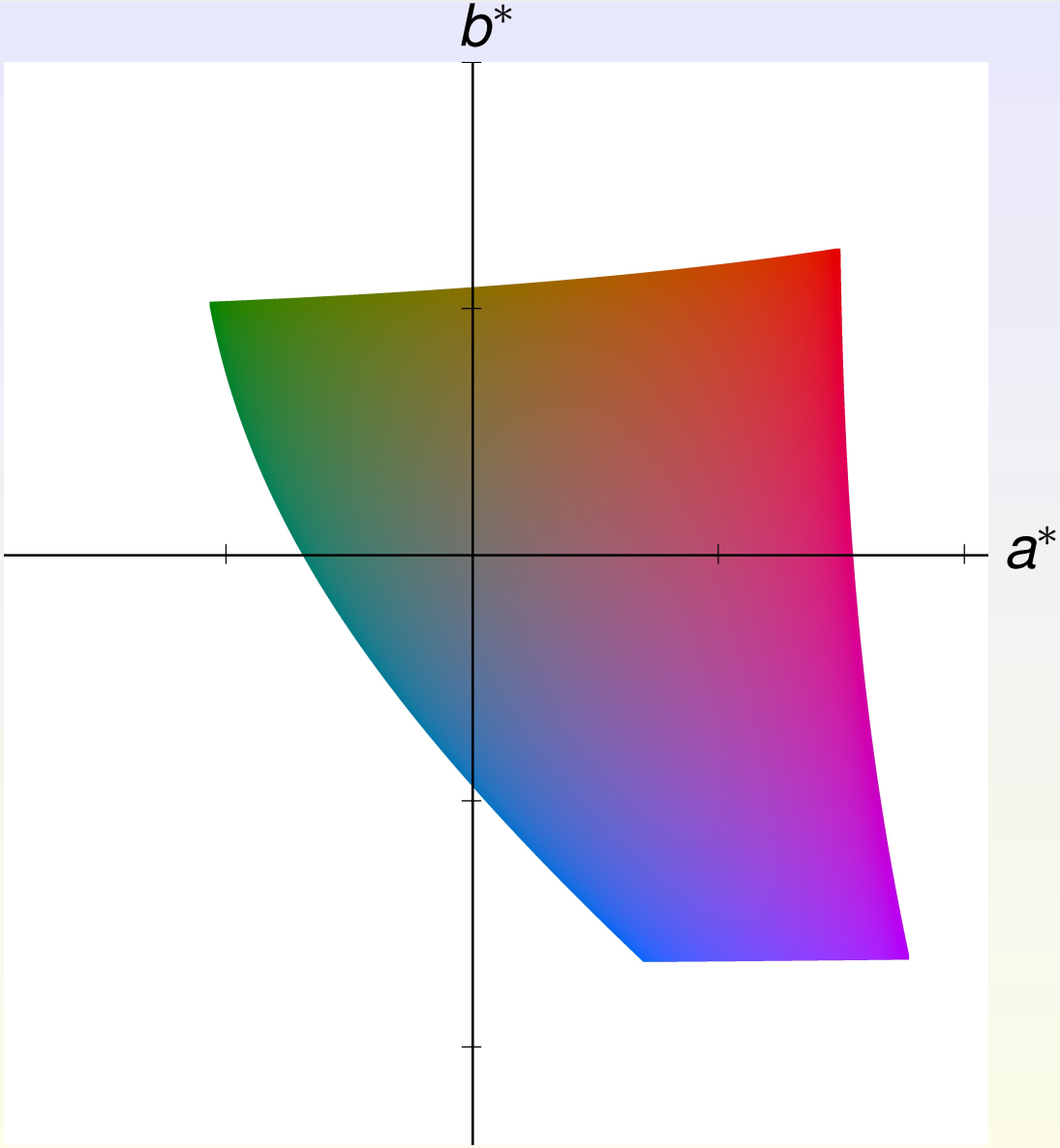
$L = 52$

CIE La*b* Color Space



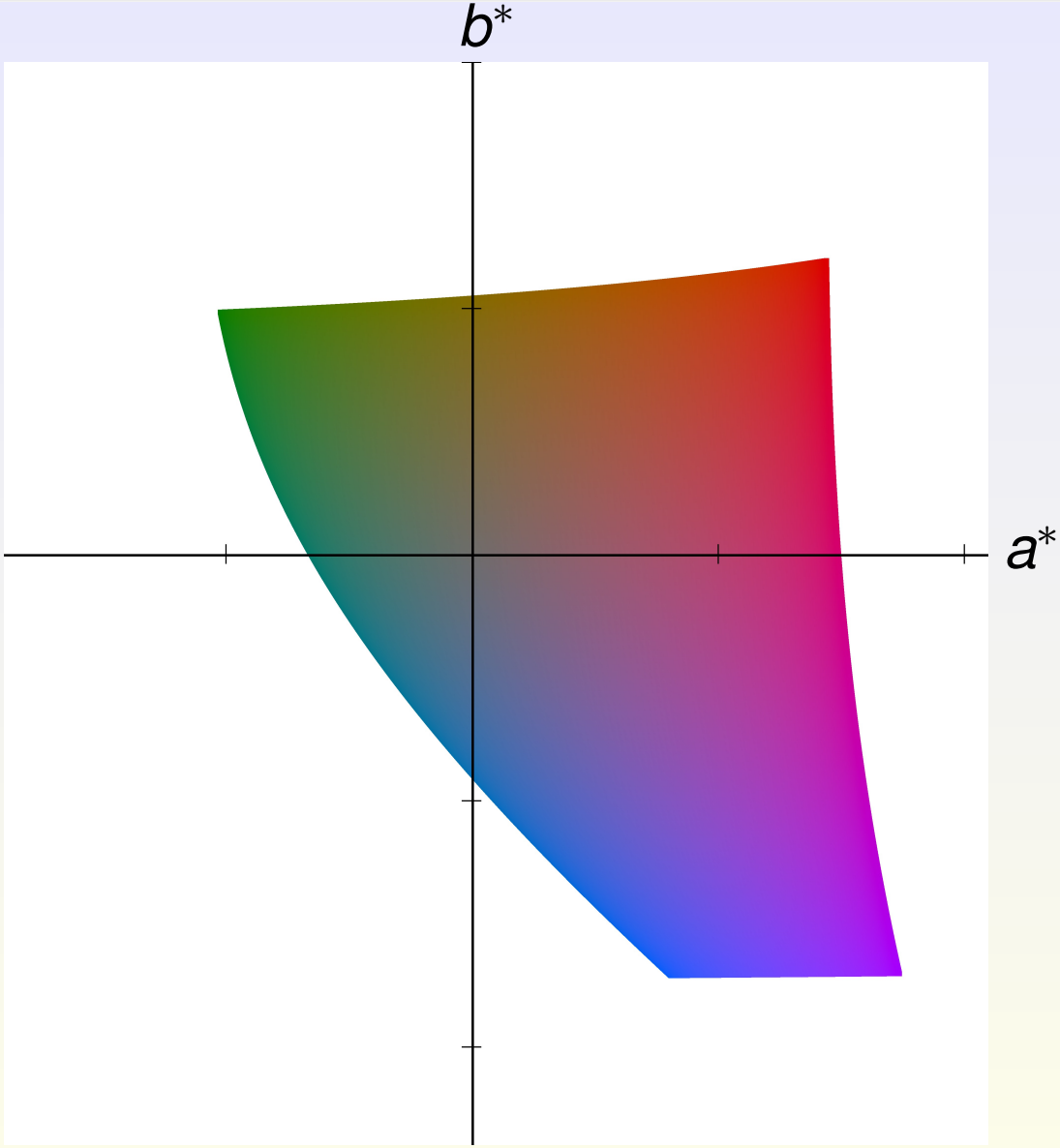
$L = 50$

CIE La*b* Color Space



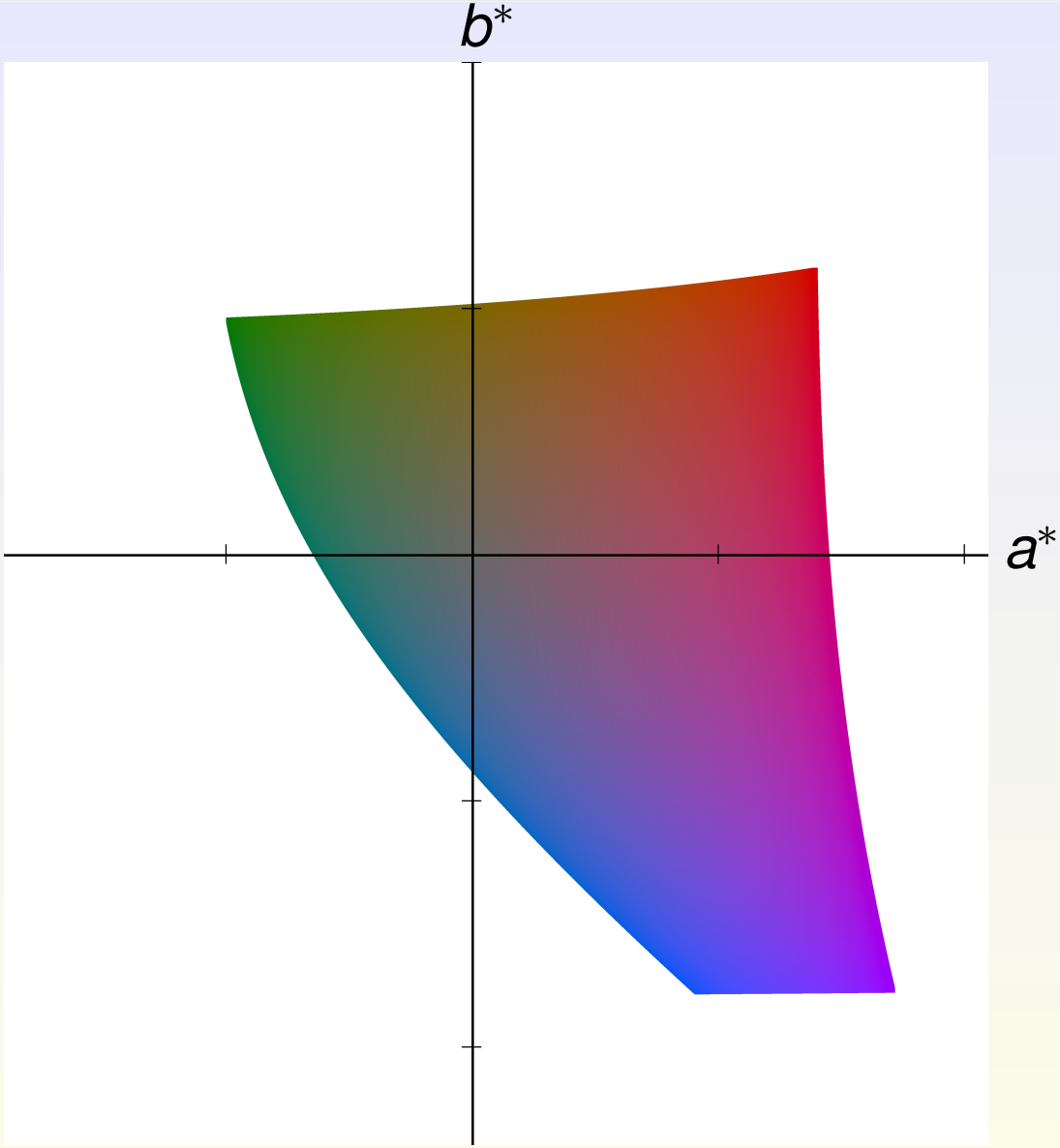
$L = 48$

CIE La*b* Color Space



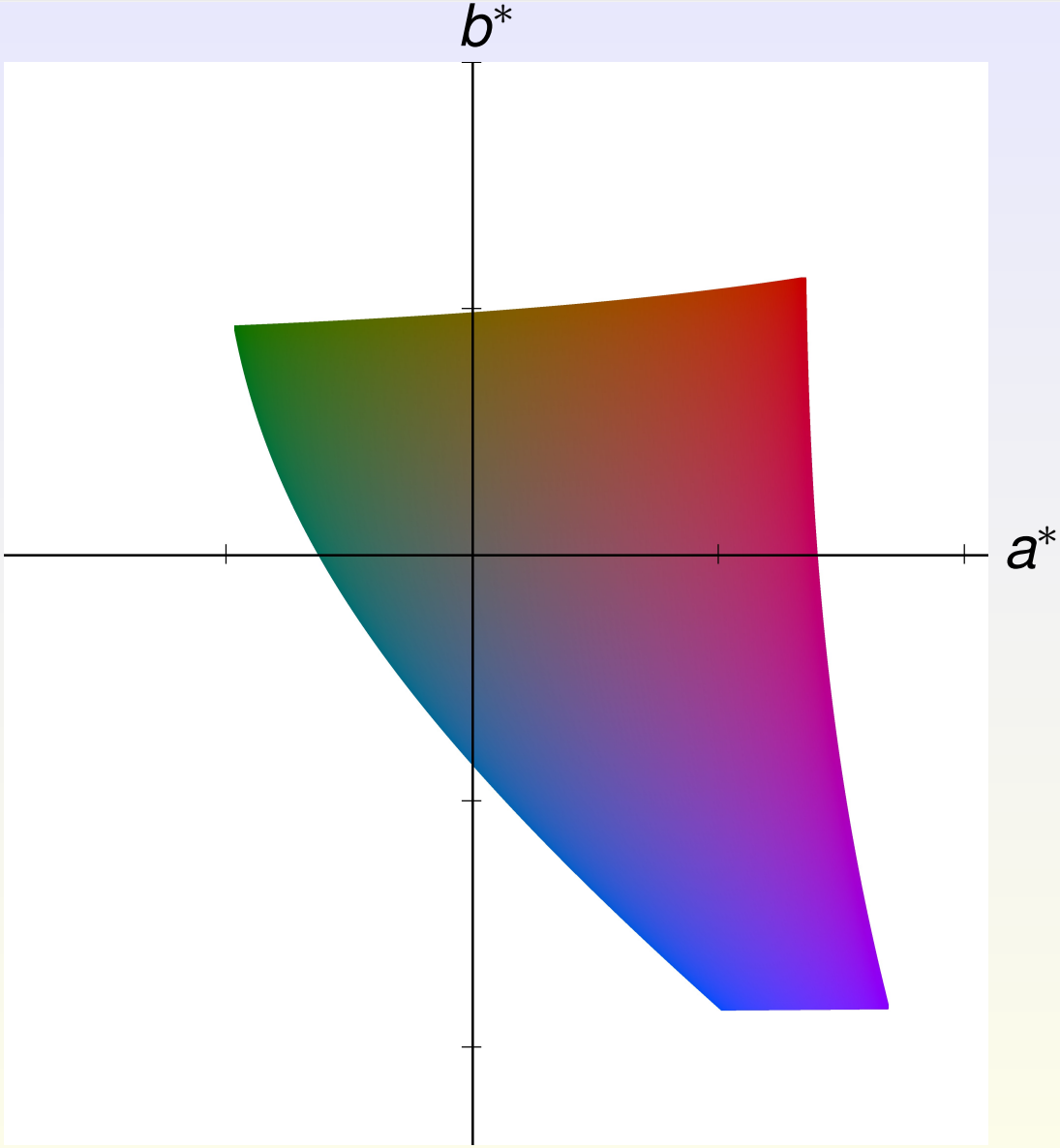
$L = 46$

CIE La*b* Color Space



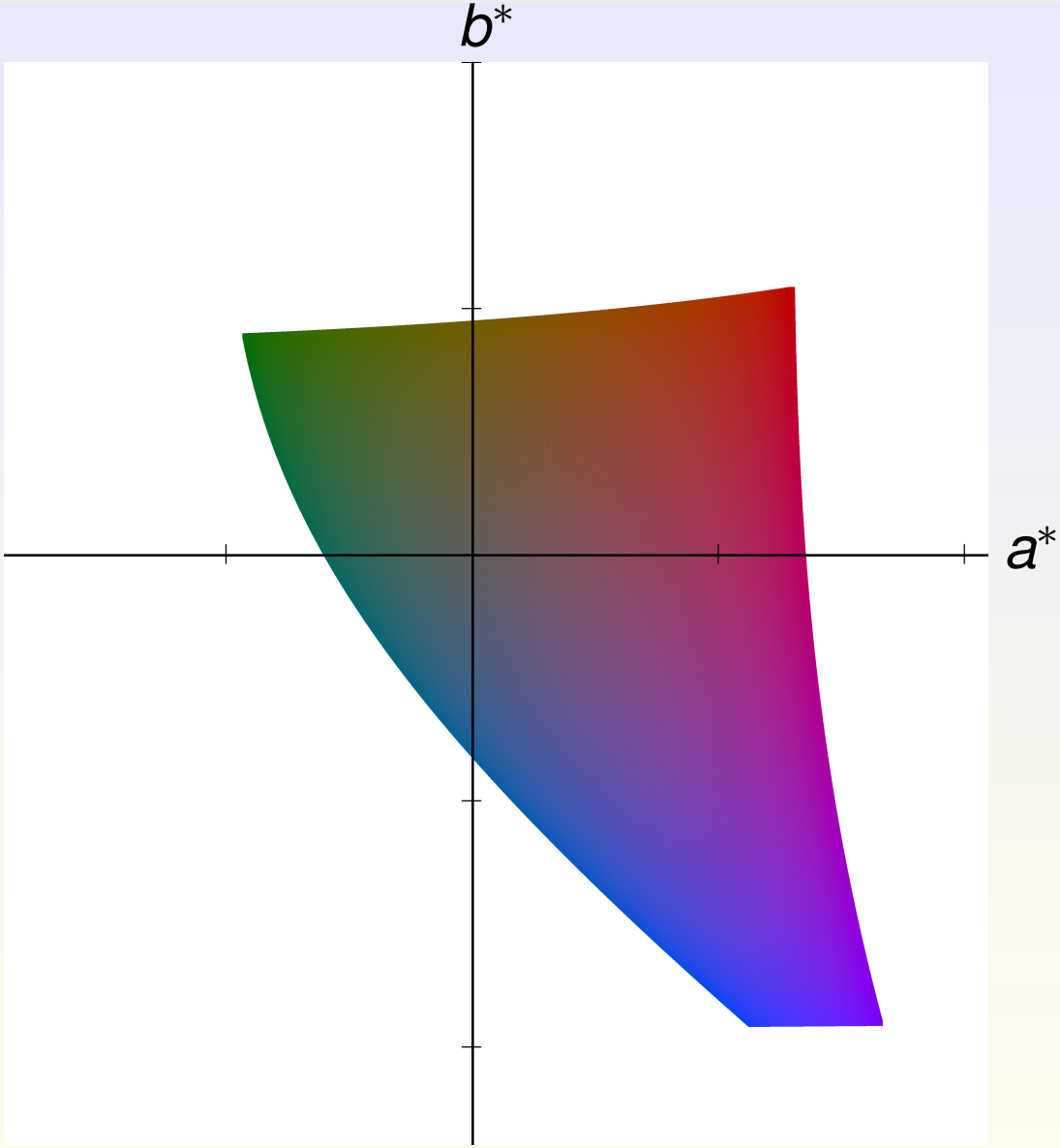
$L = 44$

CIE La*b* Color Space



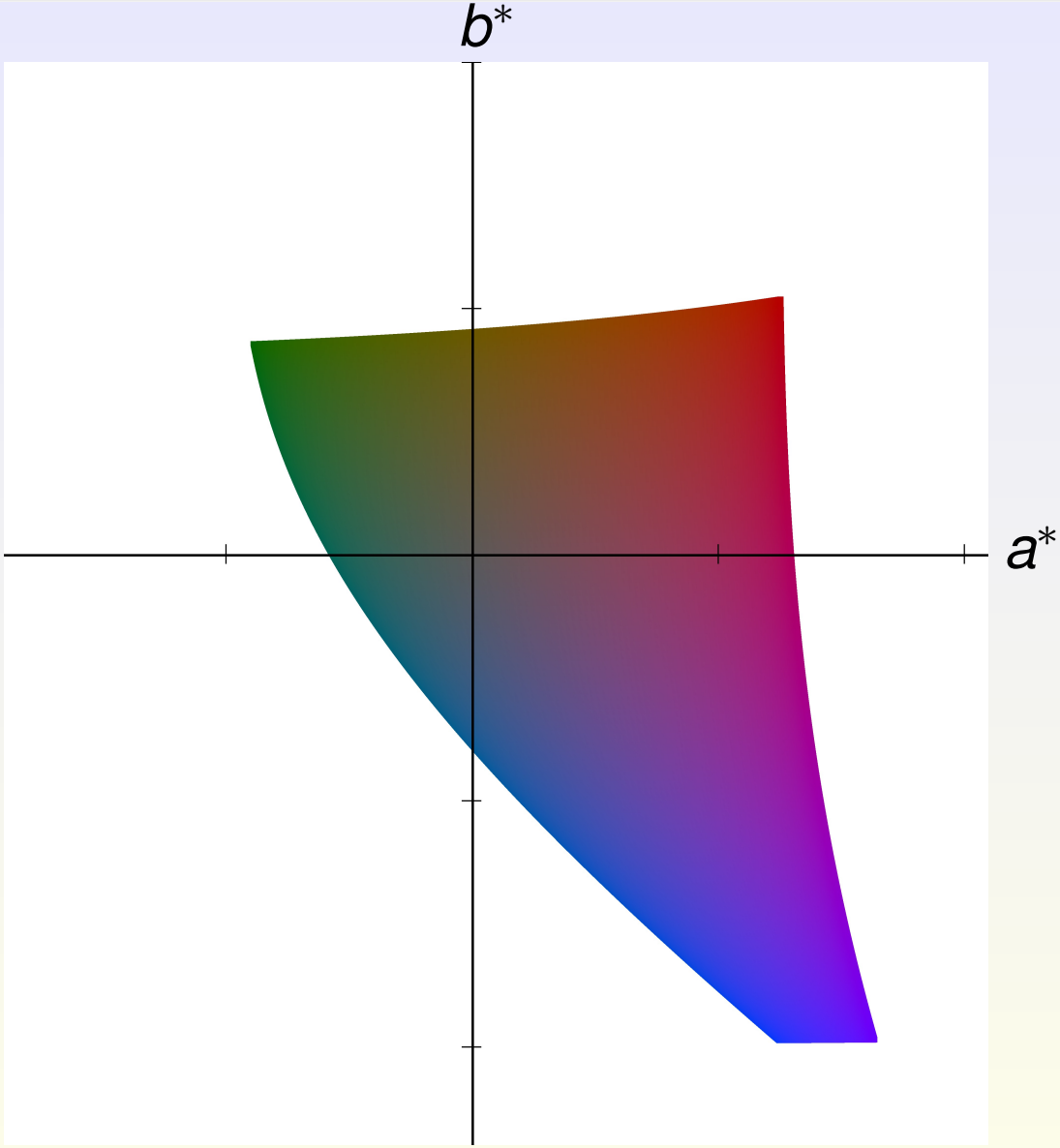
$L = 42$

CIE La*b* Color Space



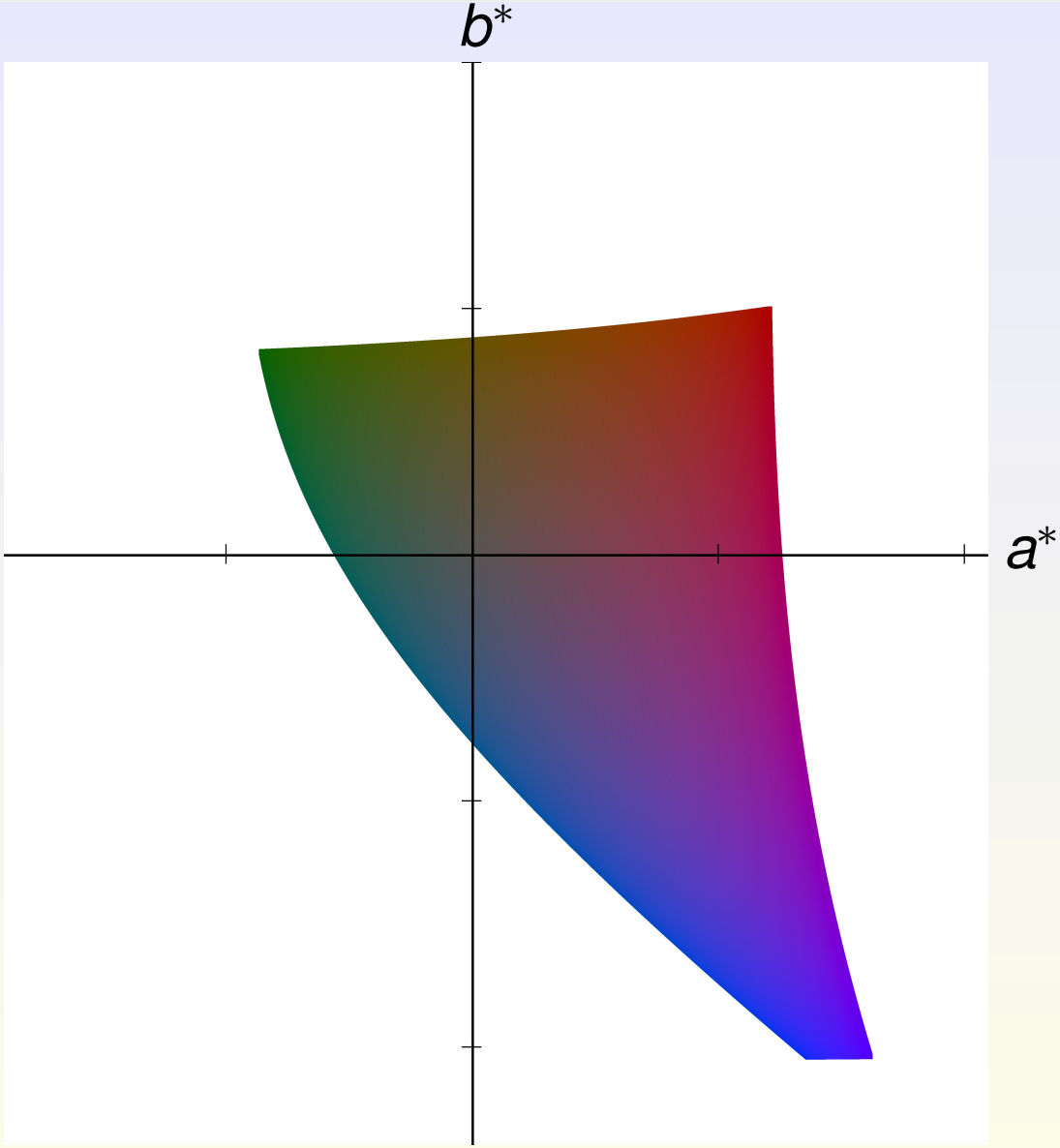
$L = 40$

CIE La*b* Color Space



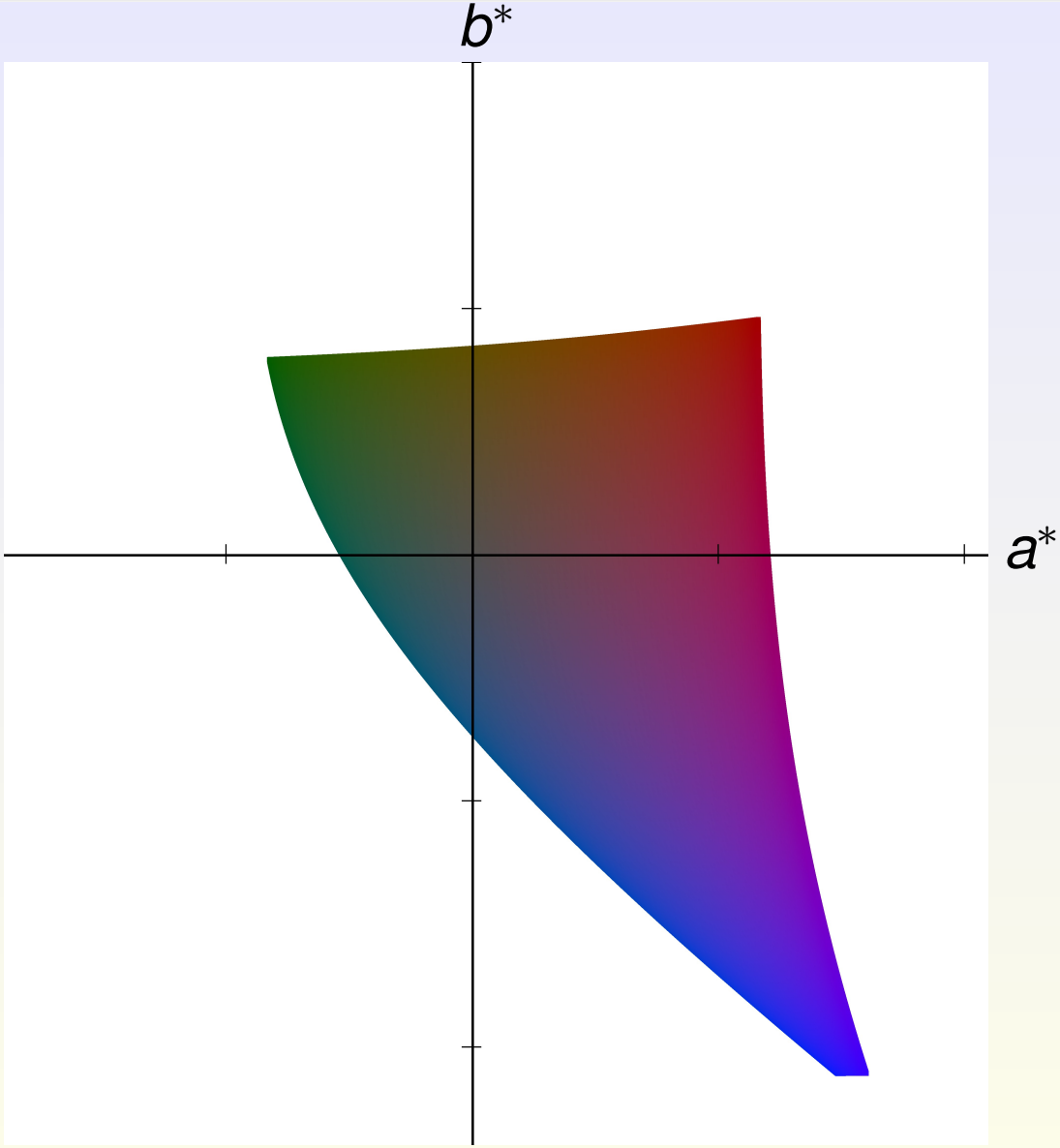
$L = 38$

CIE La*b* Color Space



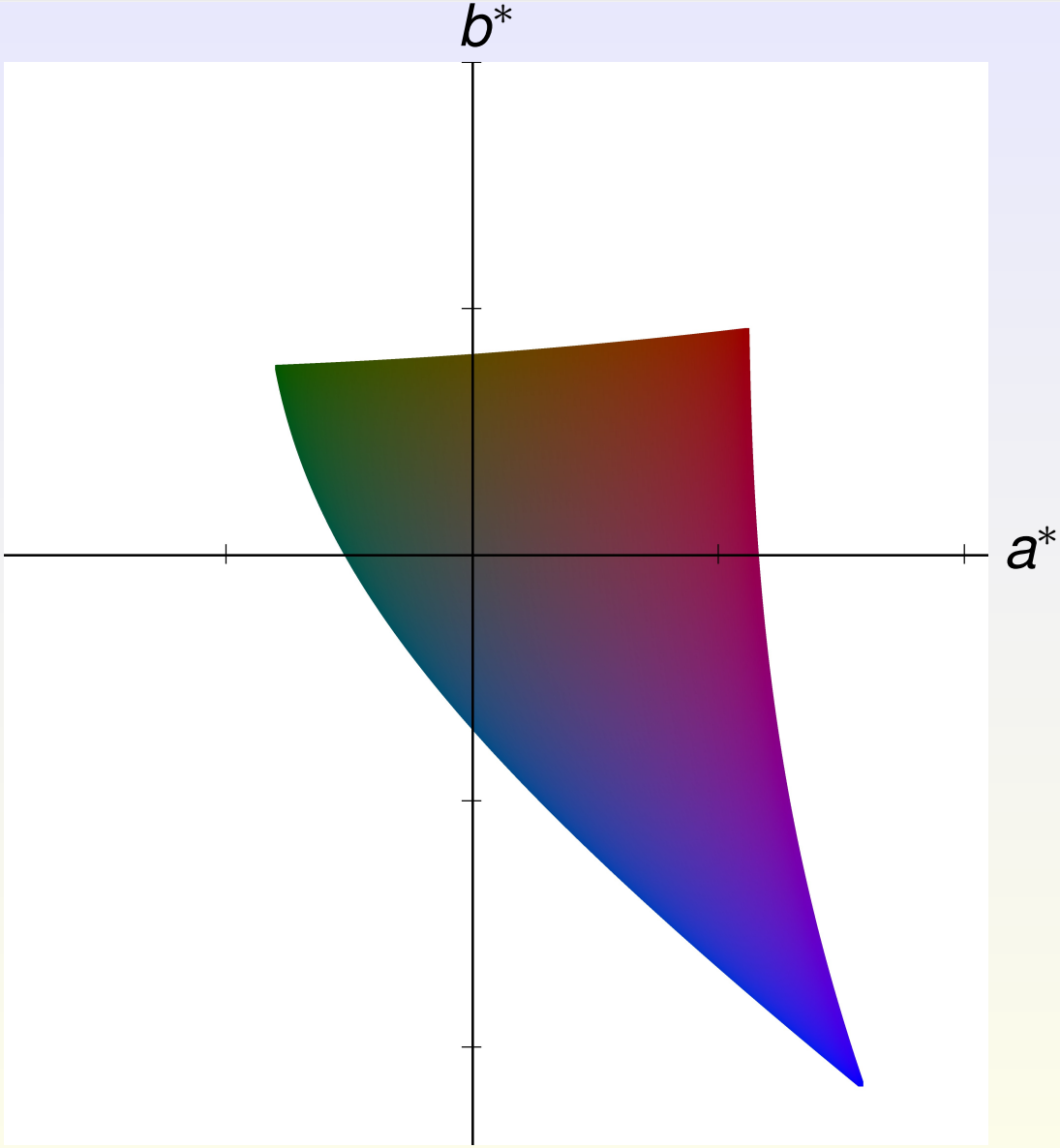
$L = 36$

CIE La*b* Color Space



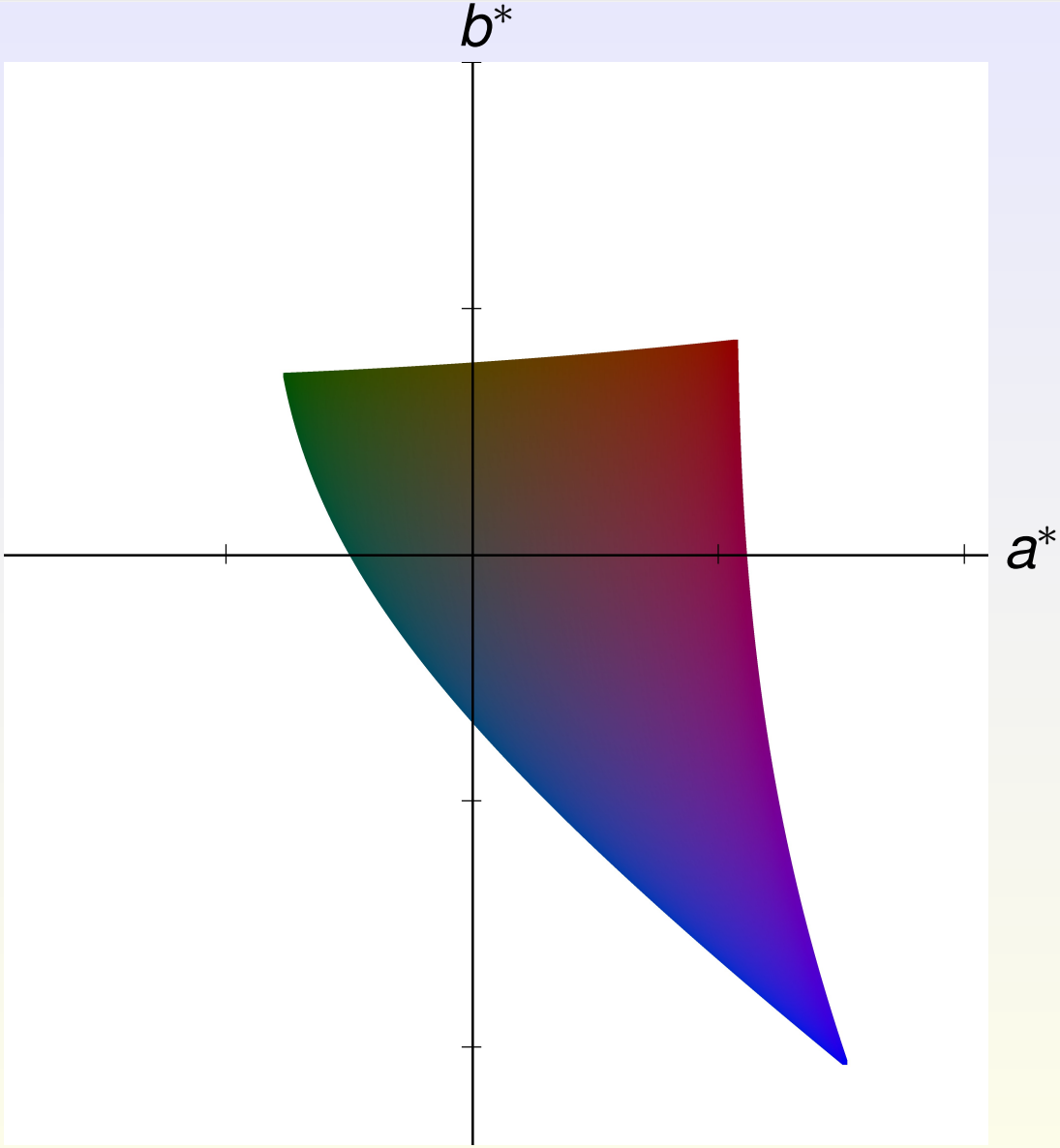
$L = 34$

CIE La*b* Color Space



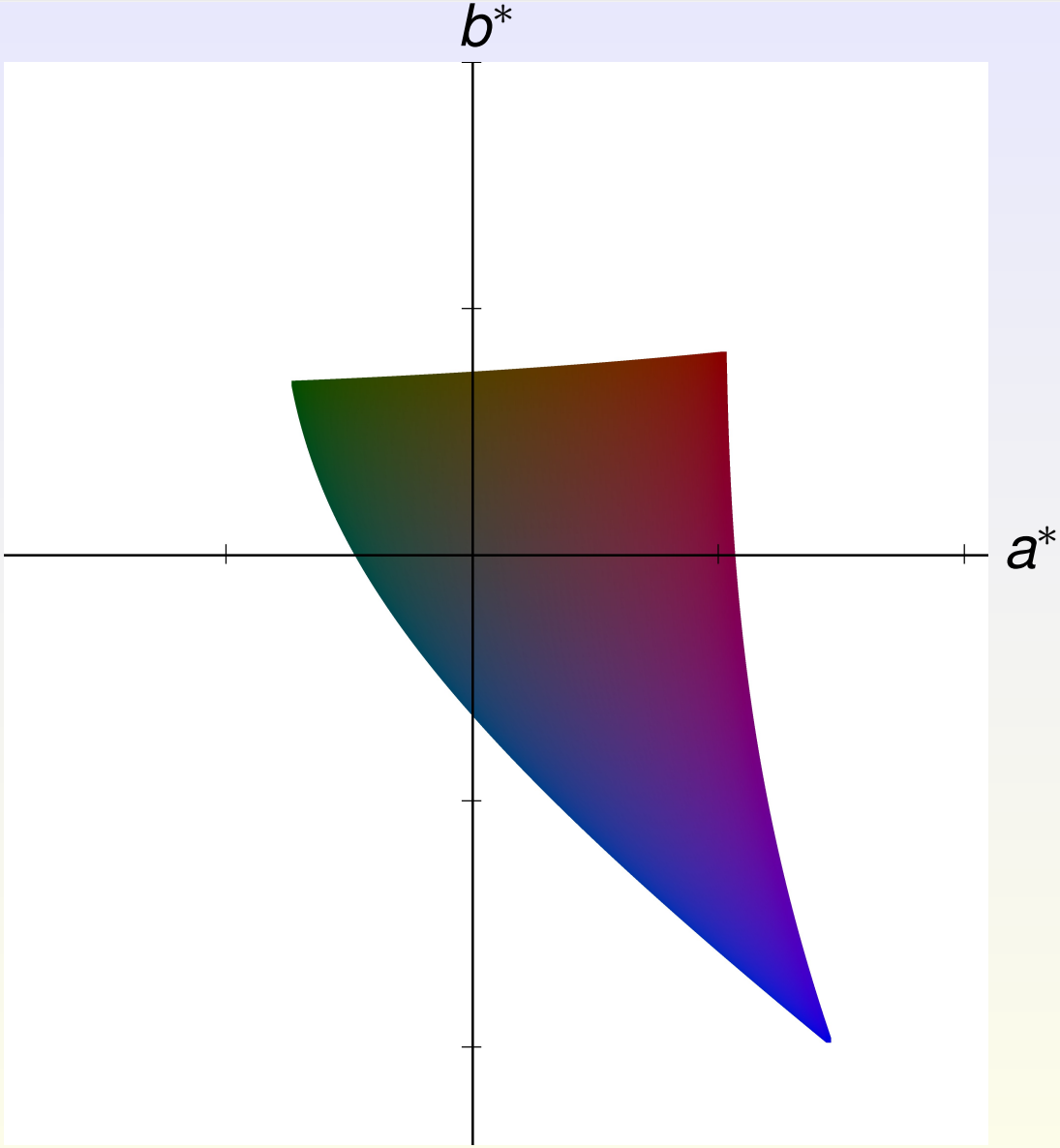
$L = 32$

CIE La*b* Color Space



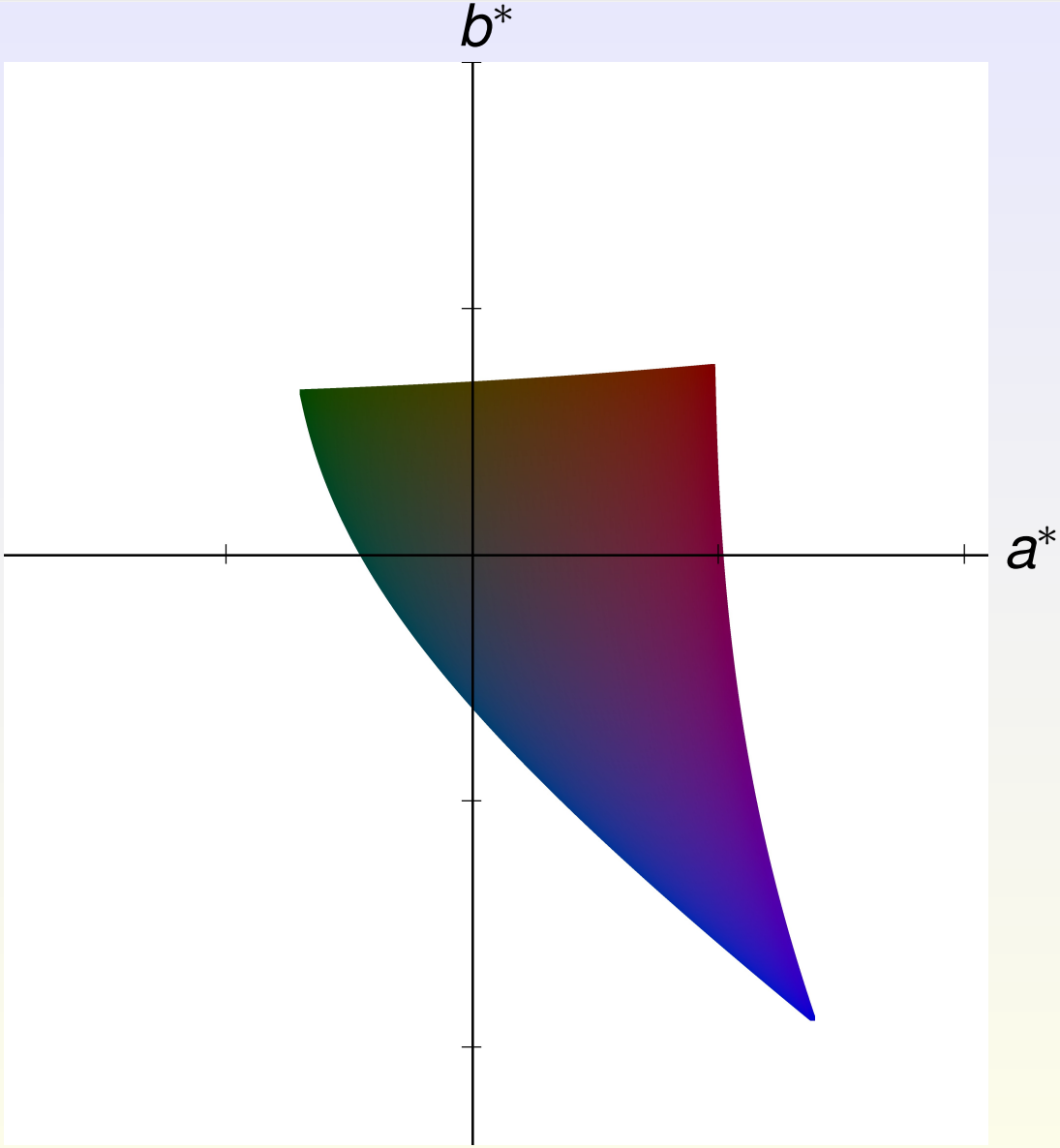
$L = 30$

CIE La*b* Color Space



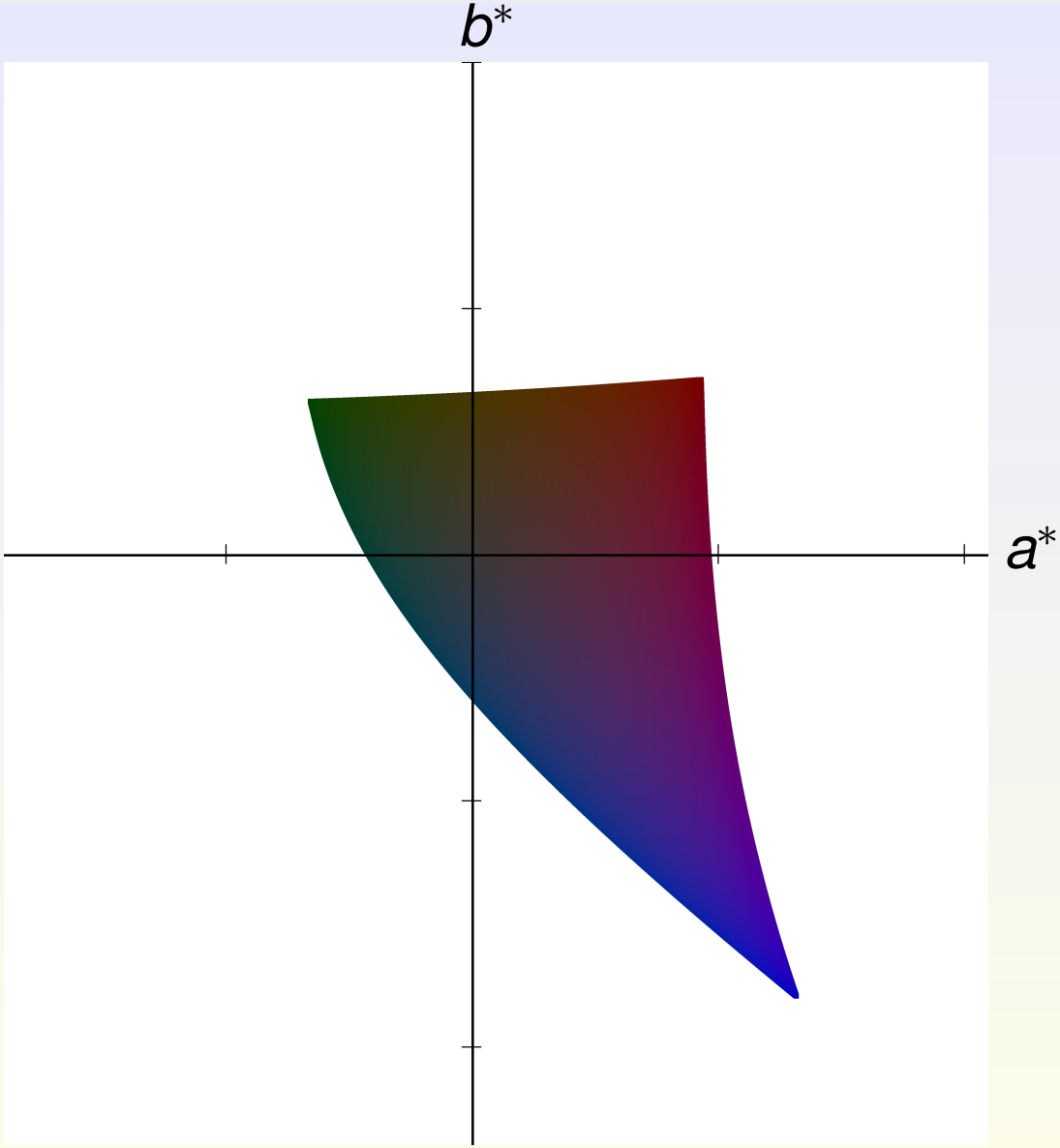
$L = 28$

CIE La*b* Color Space



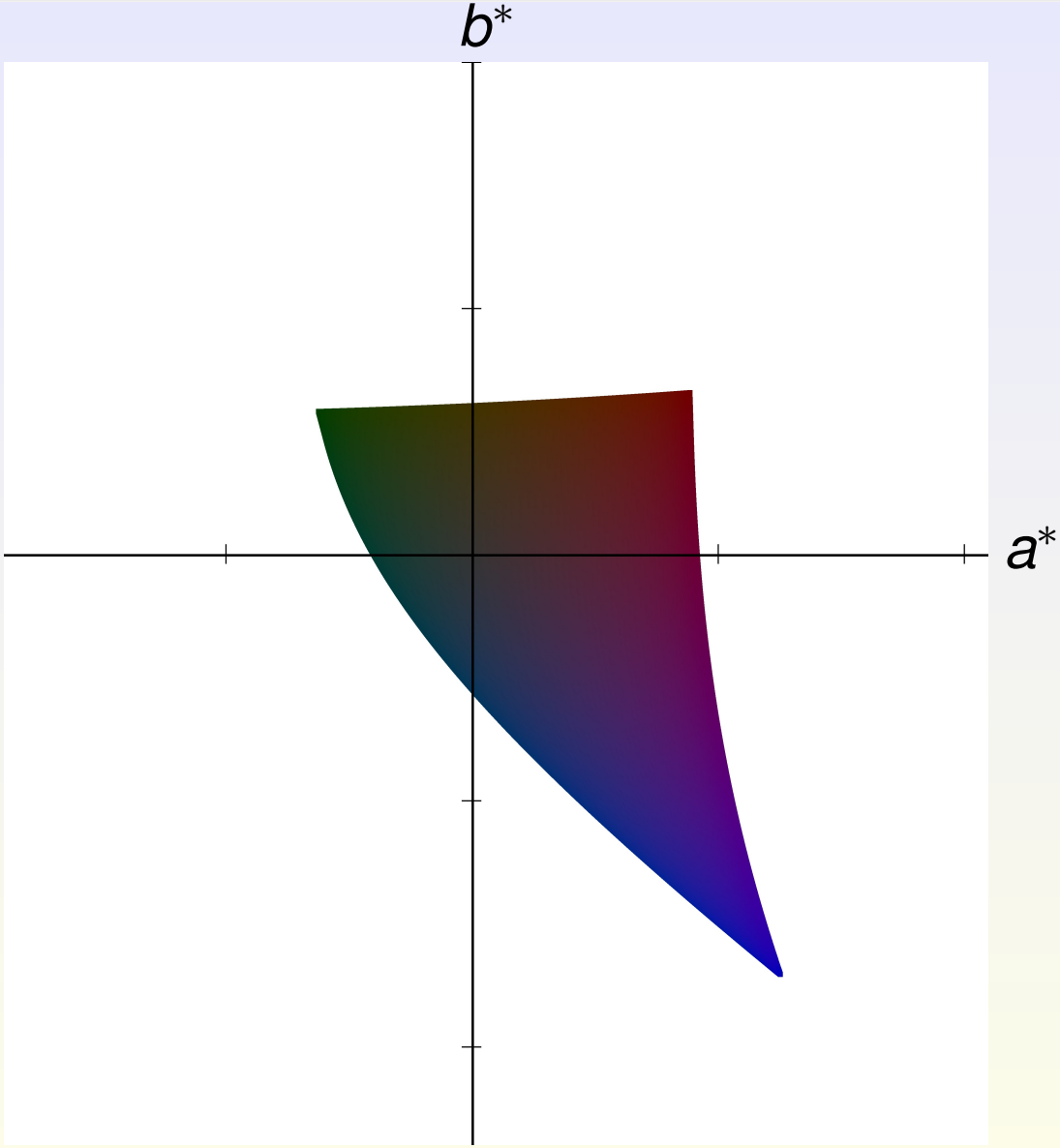
$L = 26$

CIE La*b* Color Space



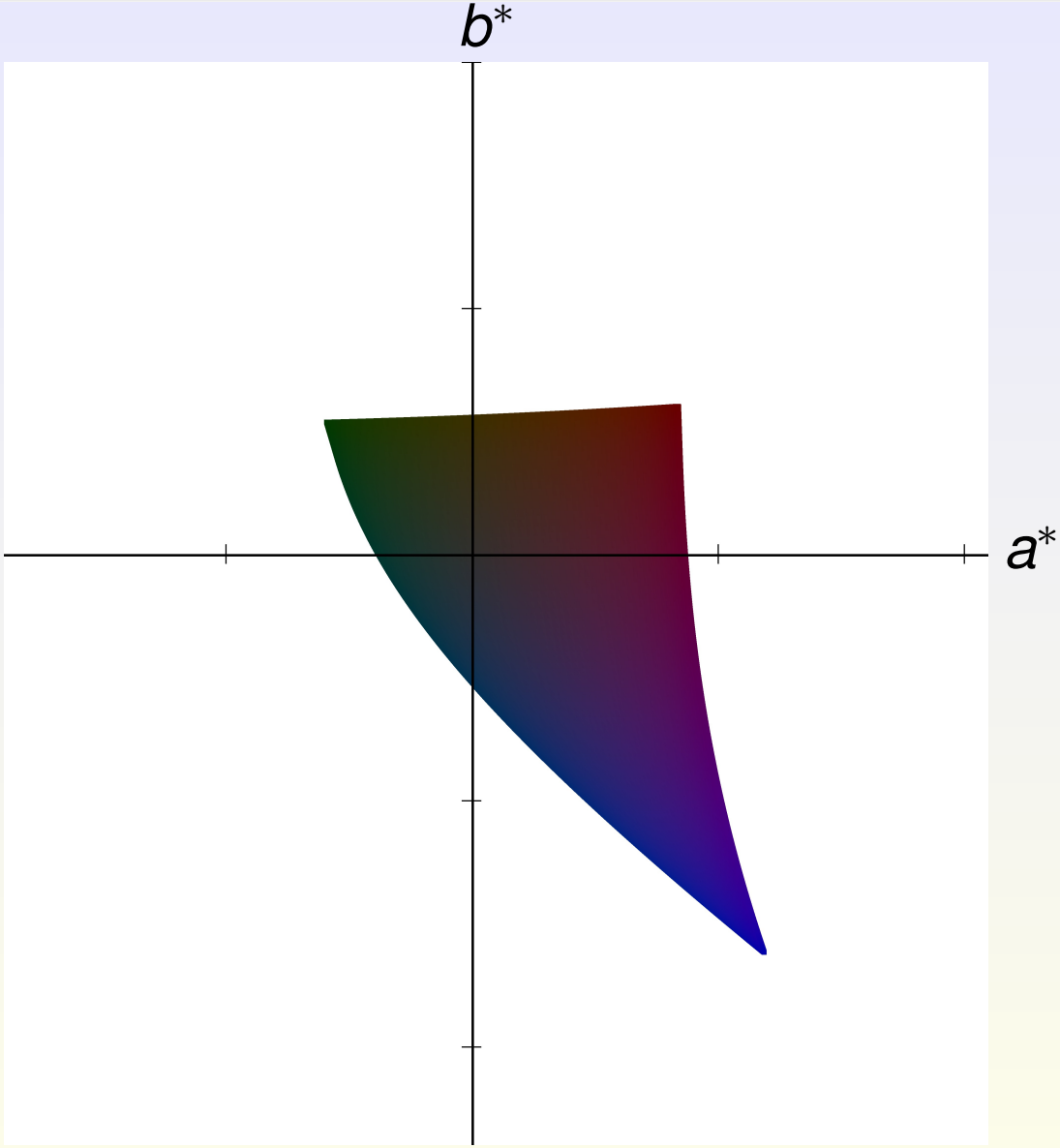
$L = 24$

CIE La*b* Color Space



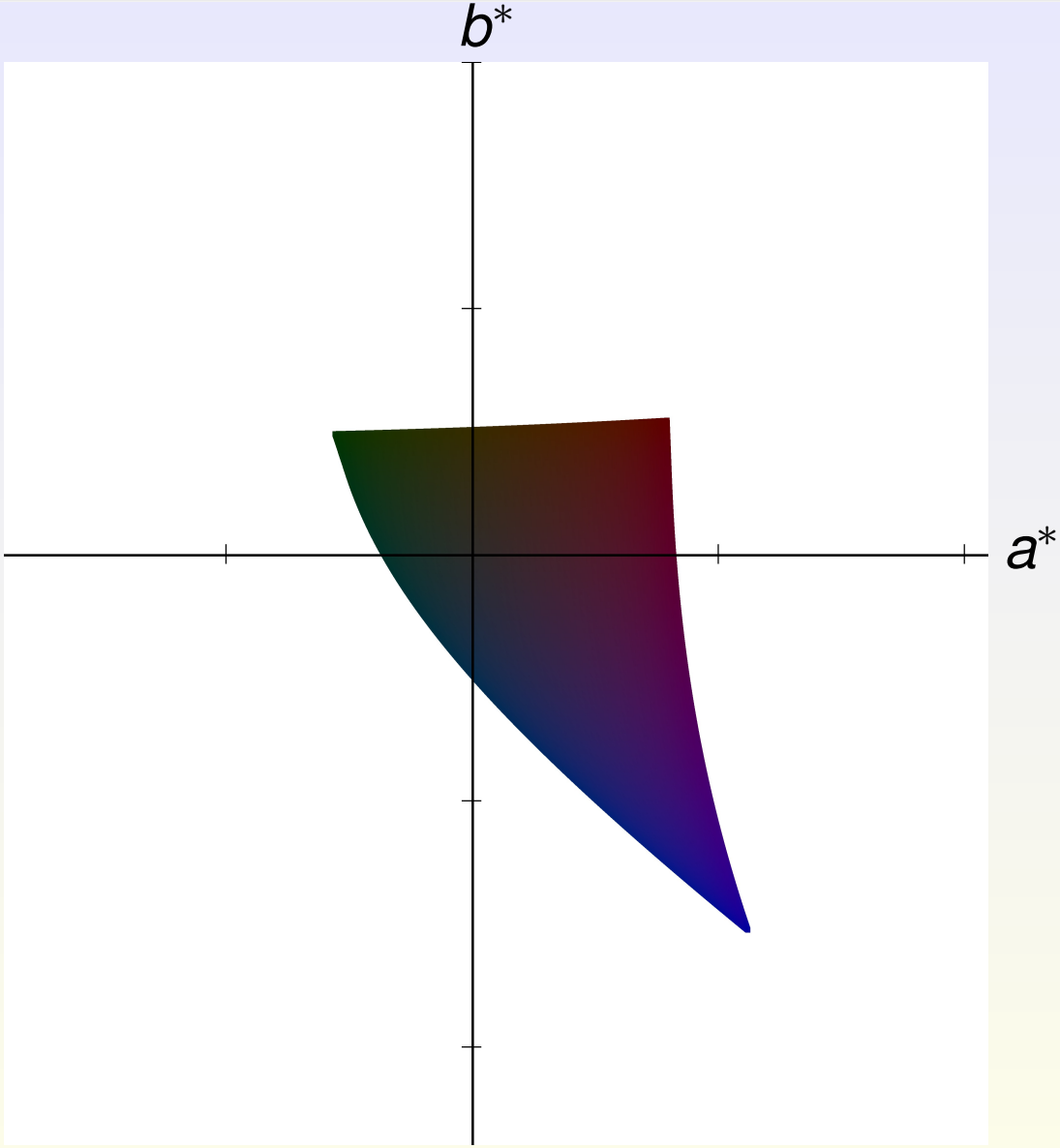
$L = 22$

CIE La*b* Color Space



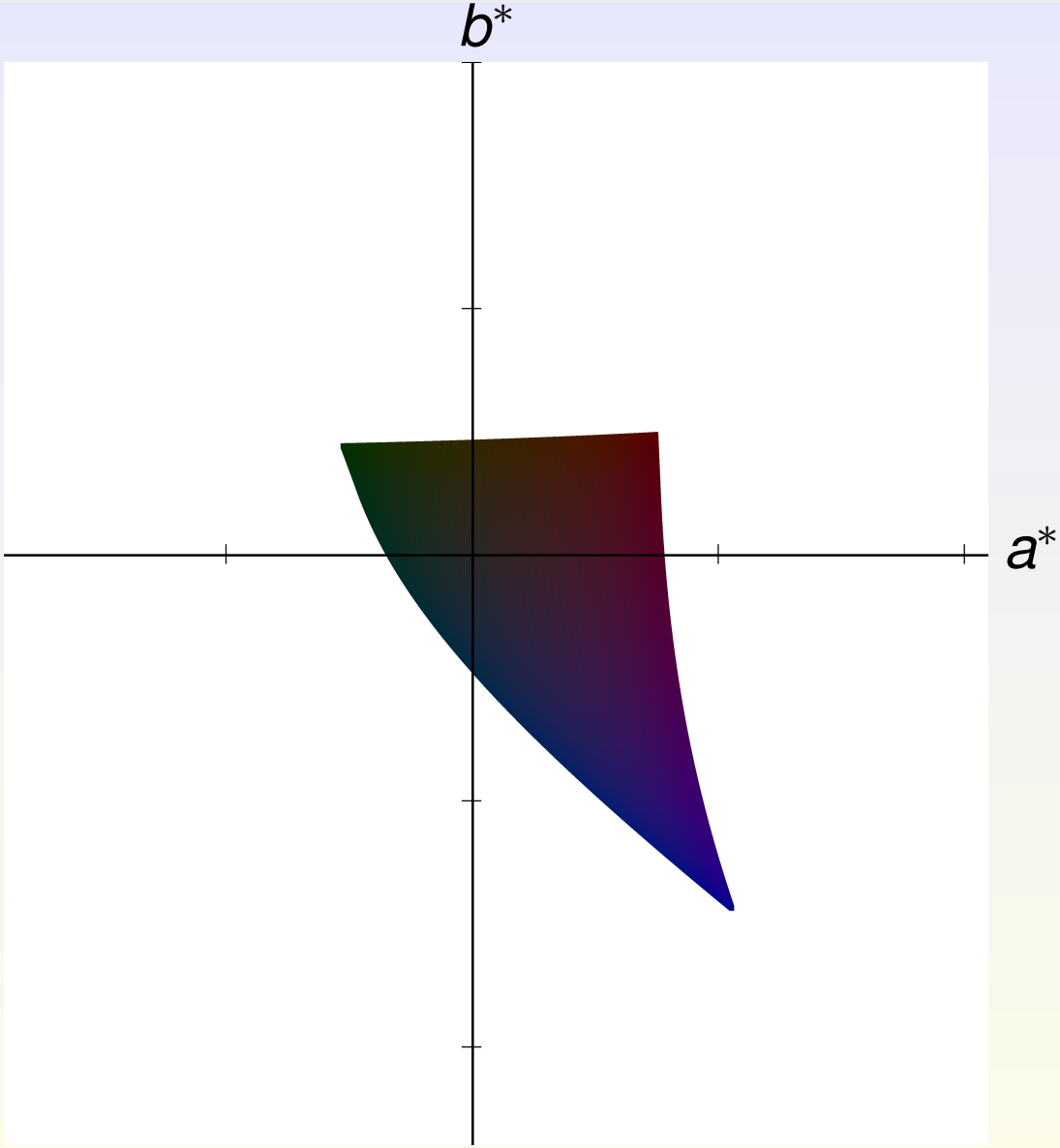
$L = 20$

CIE La*b* Color Space



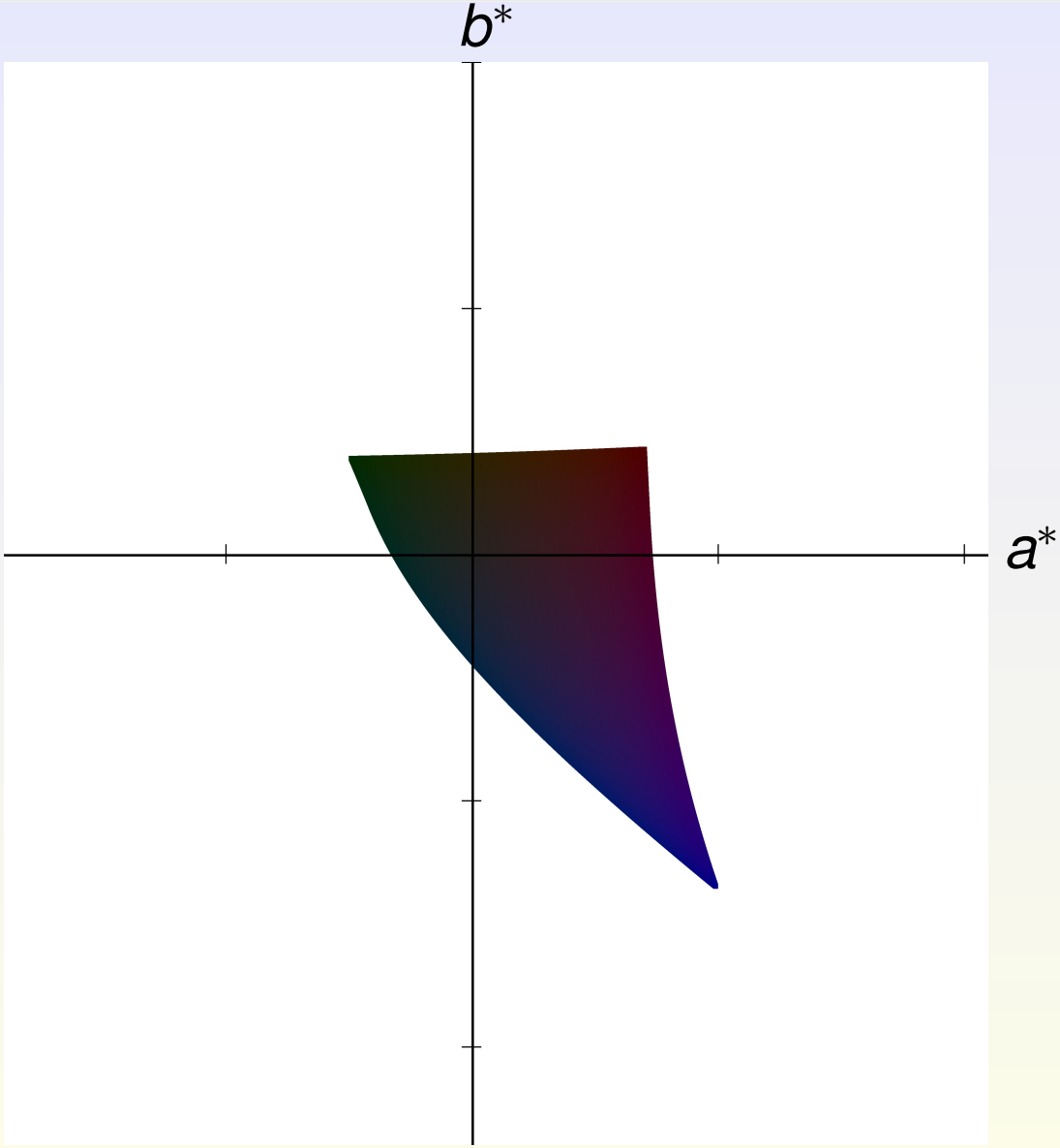
$L = 18$

CIE La*b* Color Space



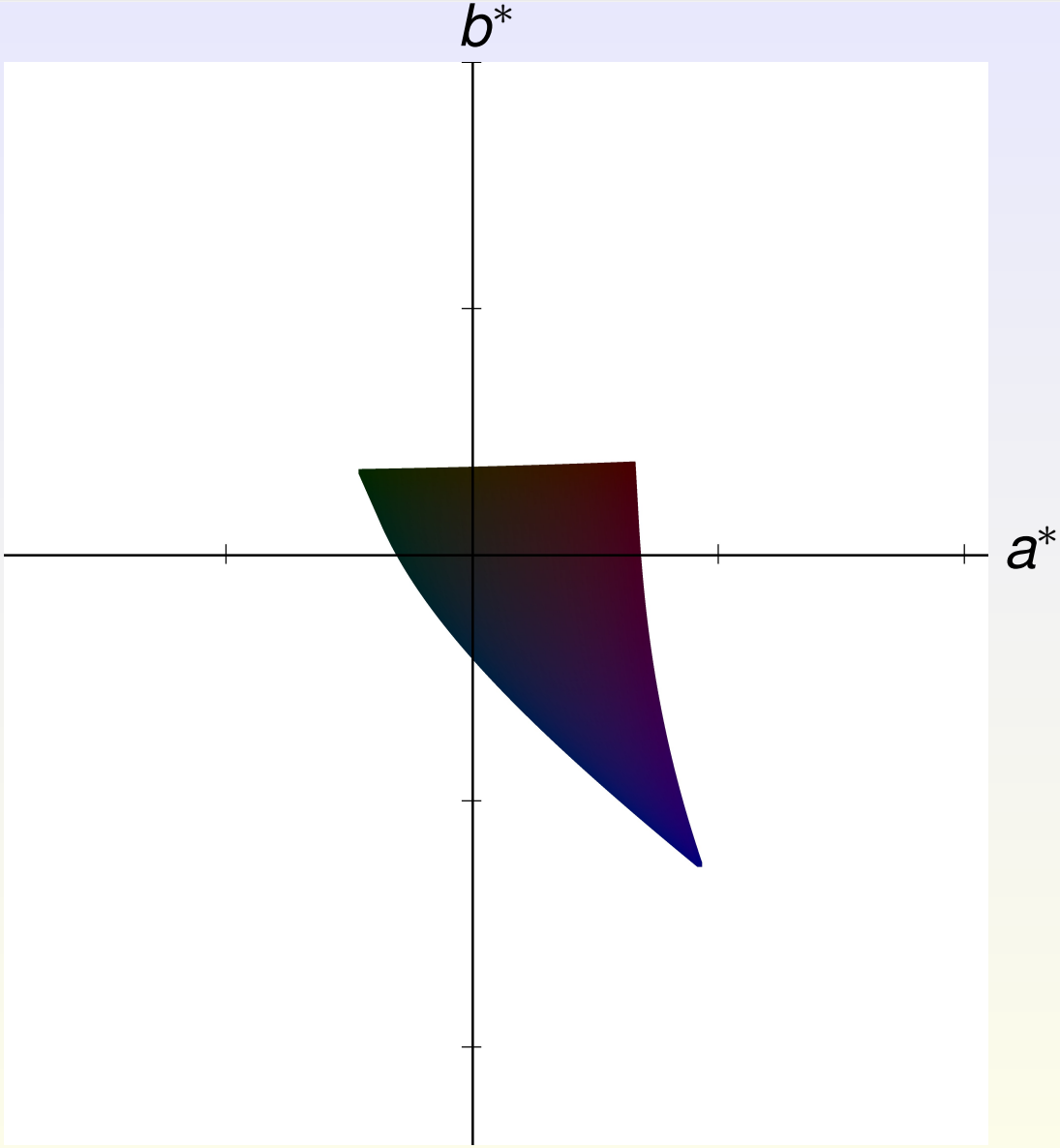
$L = 16$

CIE La*b* Color Space



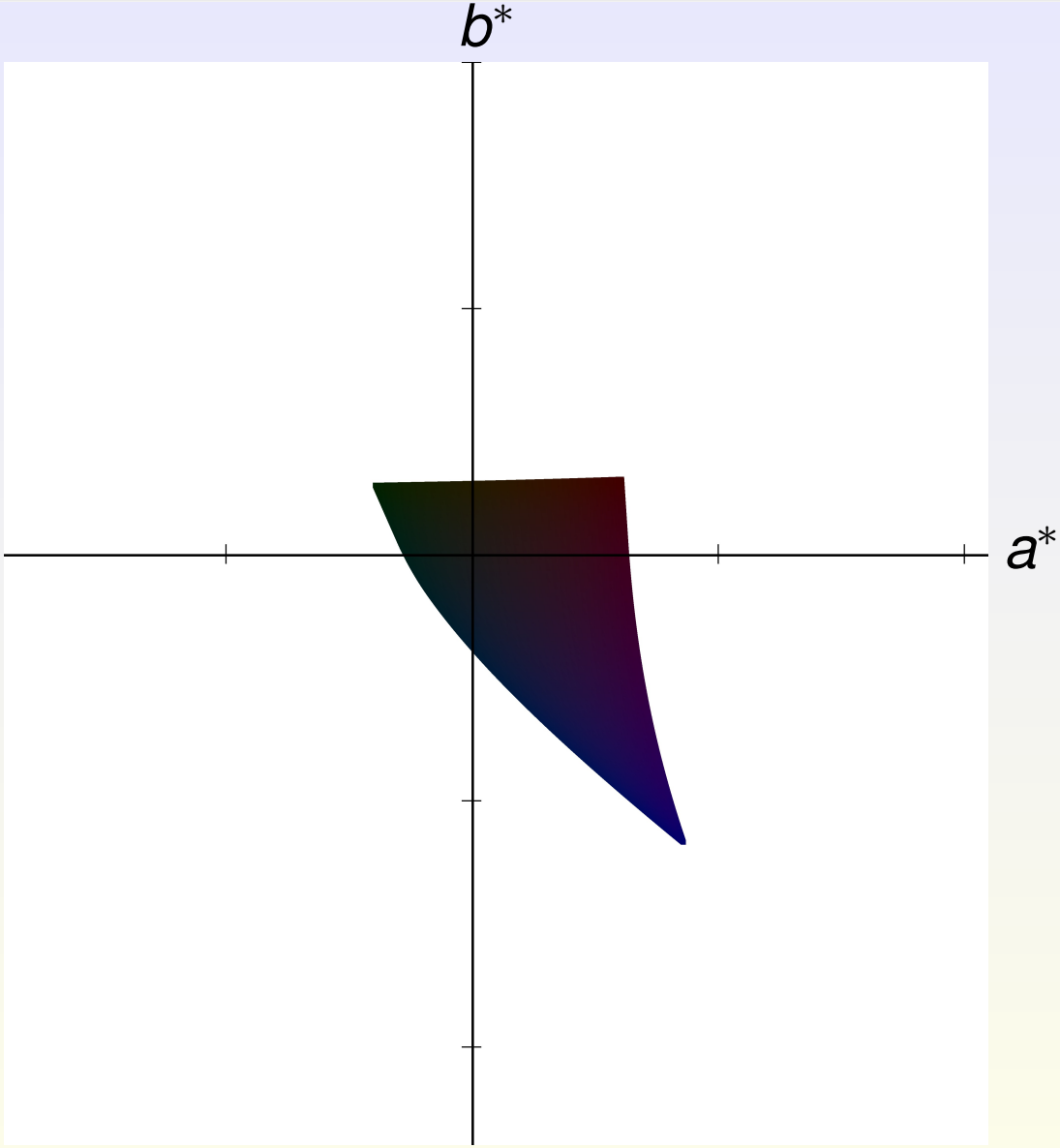
$L = 14$

CIE La*b* Color Space



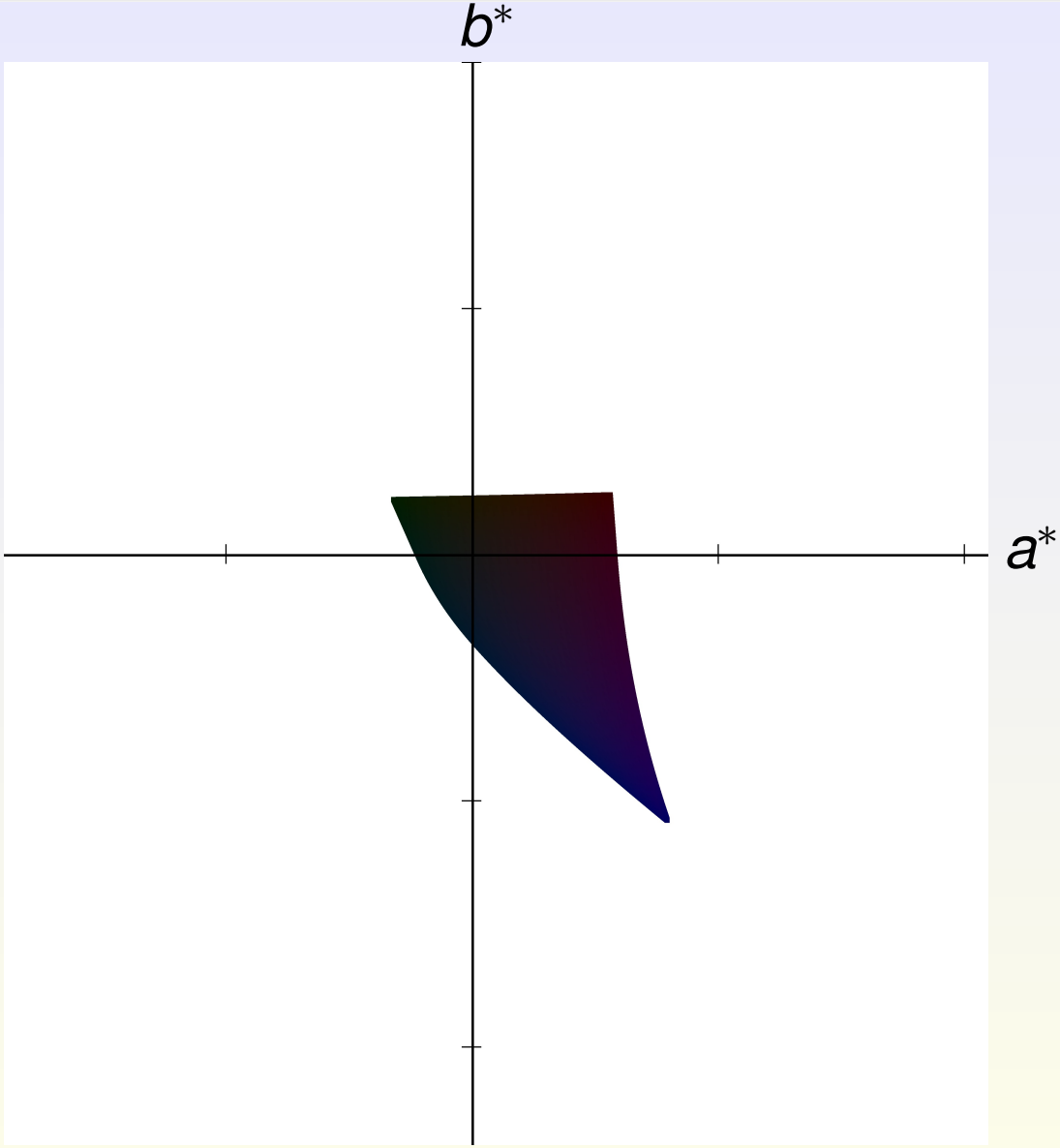
$L = 12$

CIE La*b* Color Space



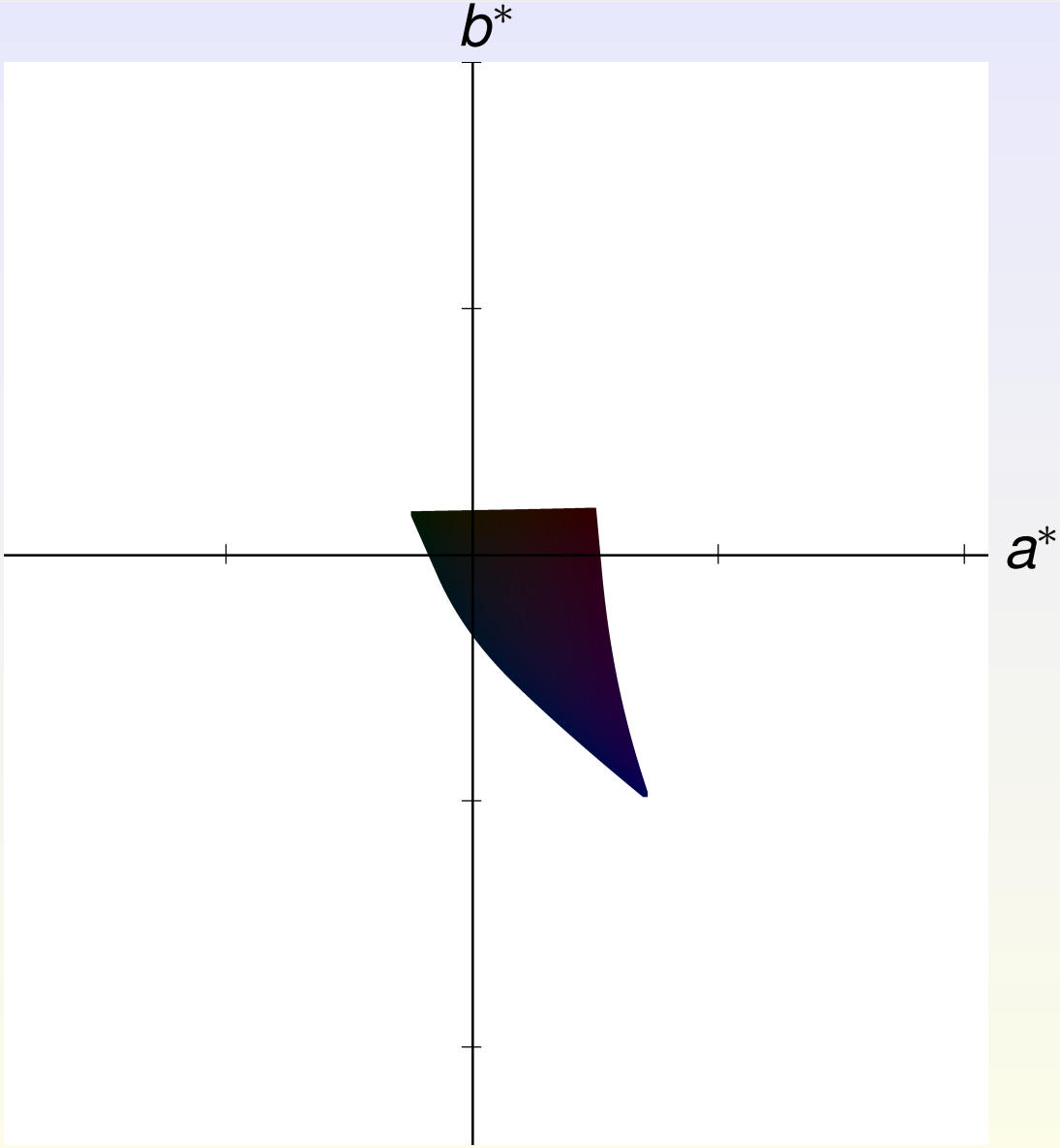
$L = 10$

CIE La*b* Color Space



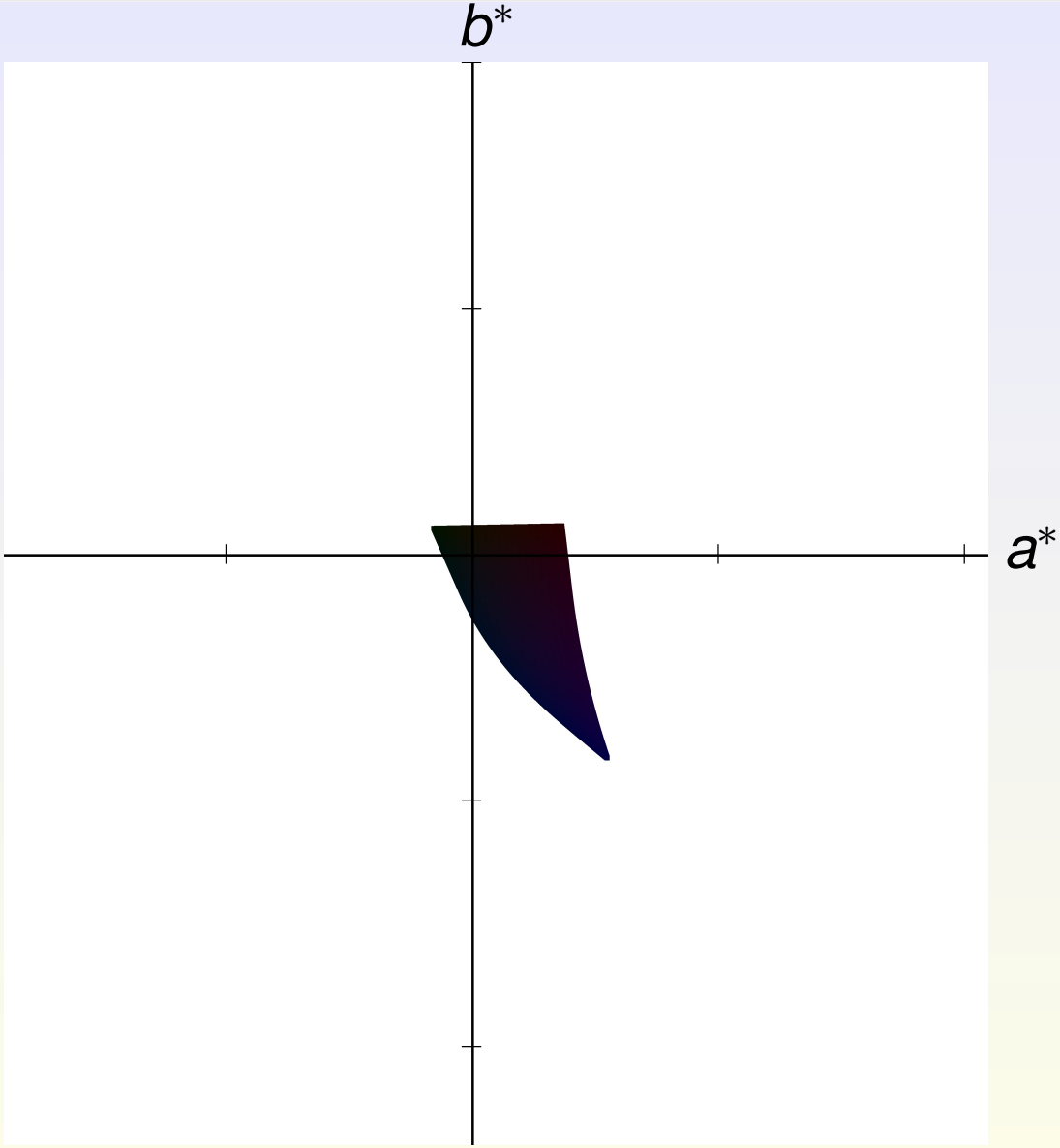
$L = 8$

CIE La*b* Color Space



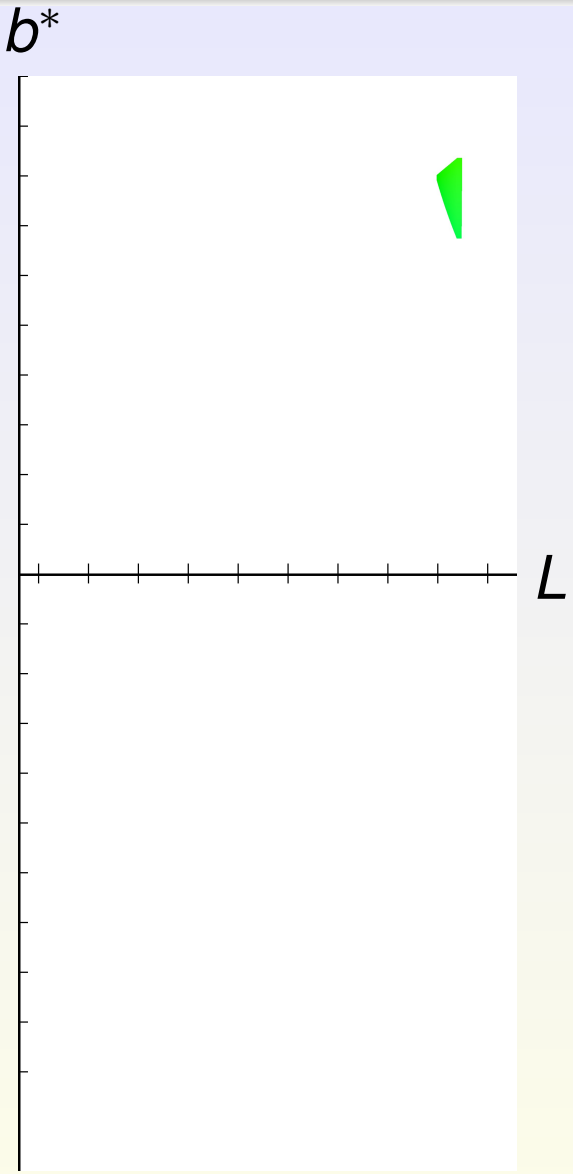
$L = 6$

CIE La*b* Color Space



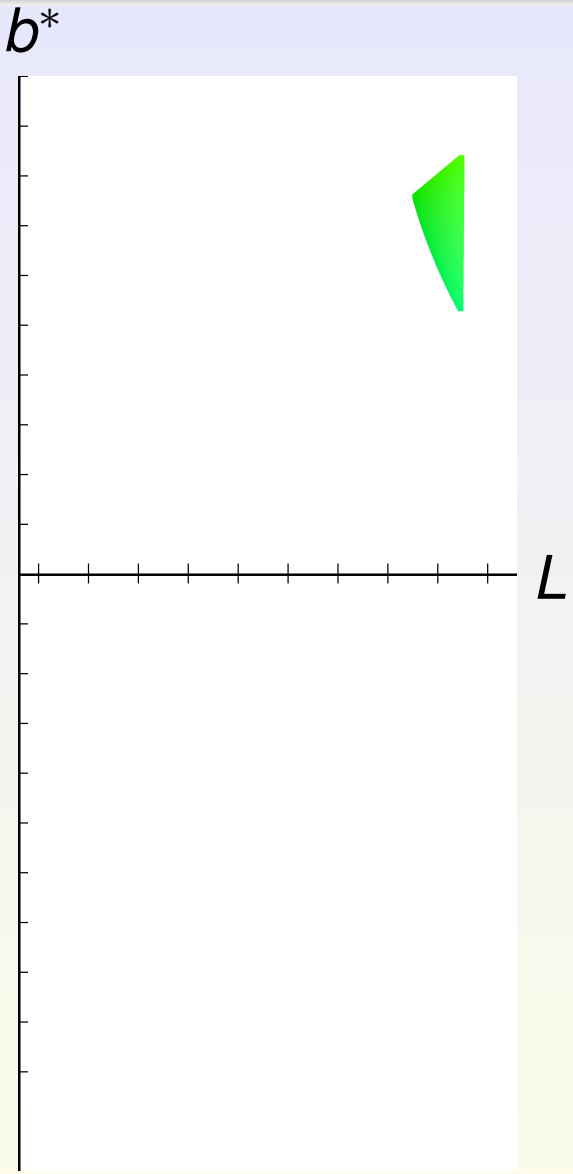
$L = 4$

CIE La*b* Color Space



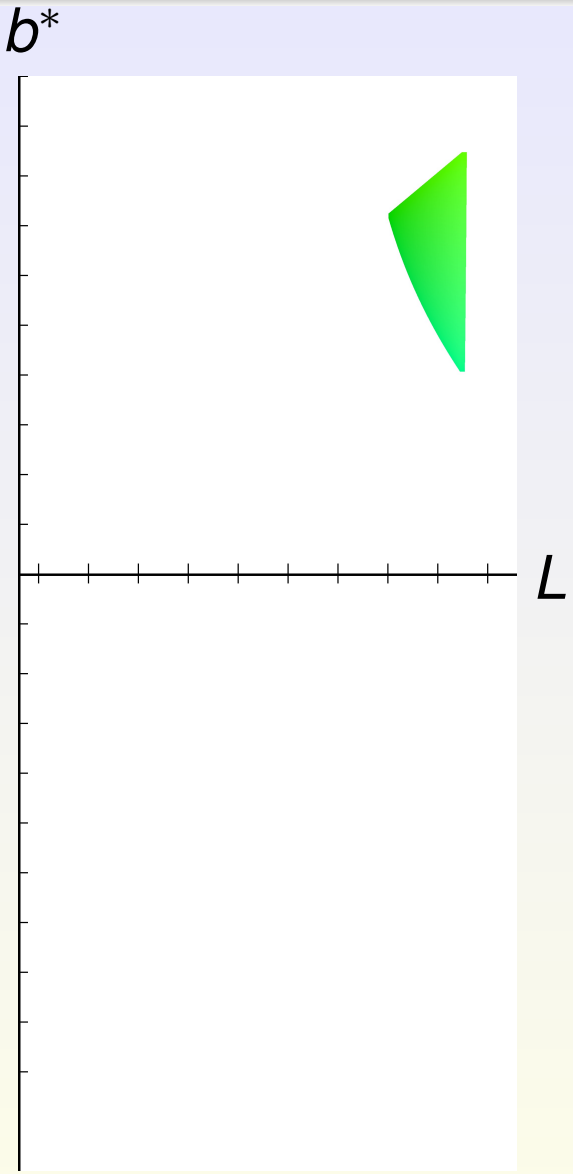
$a^* = -83$

CIE La*b* Color Space



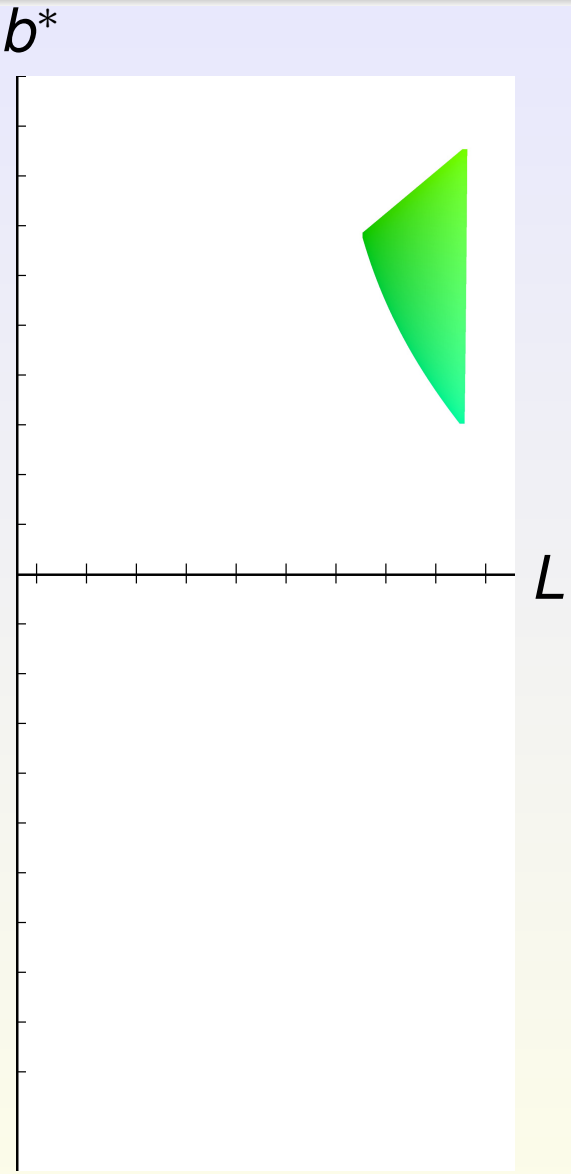
$a^* = -79$

CIE La*b* Color Space



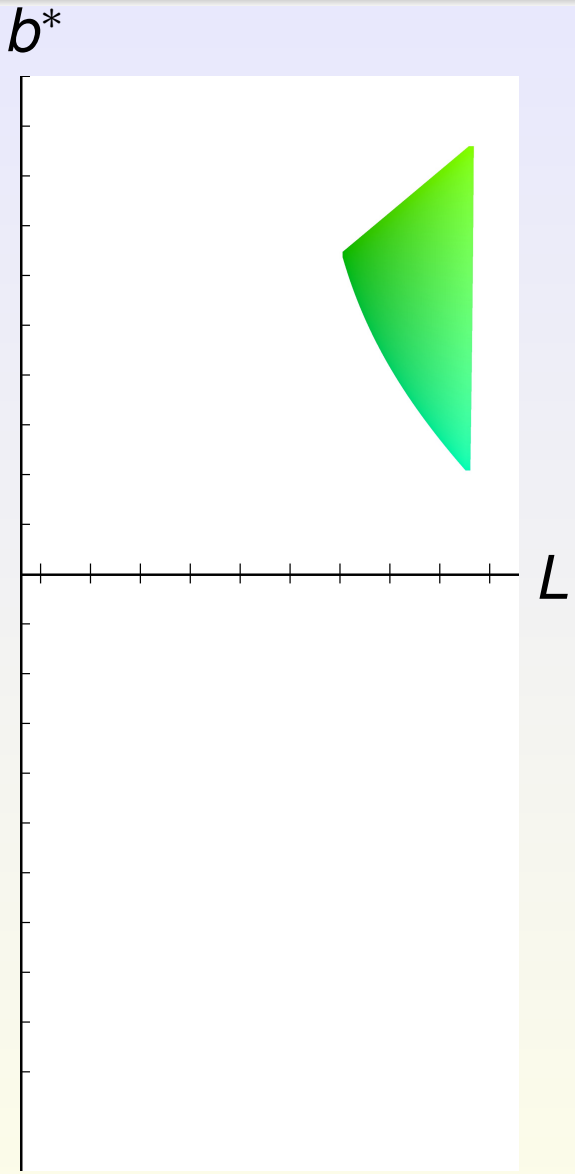
$a^* = -75$

CIE La*b* Color Space



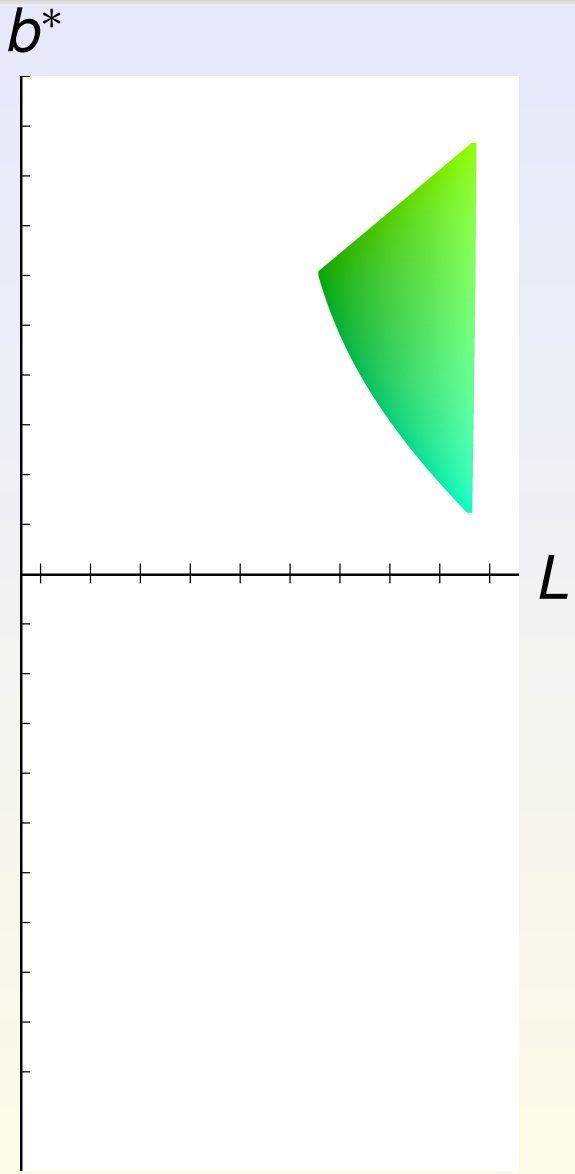
$a^* = -71$

CIE La*b* Color Space



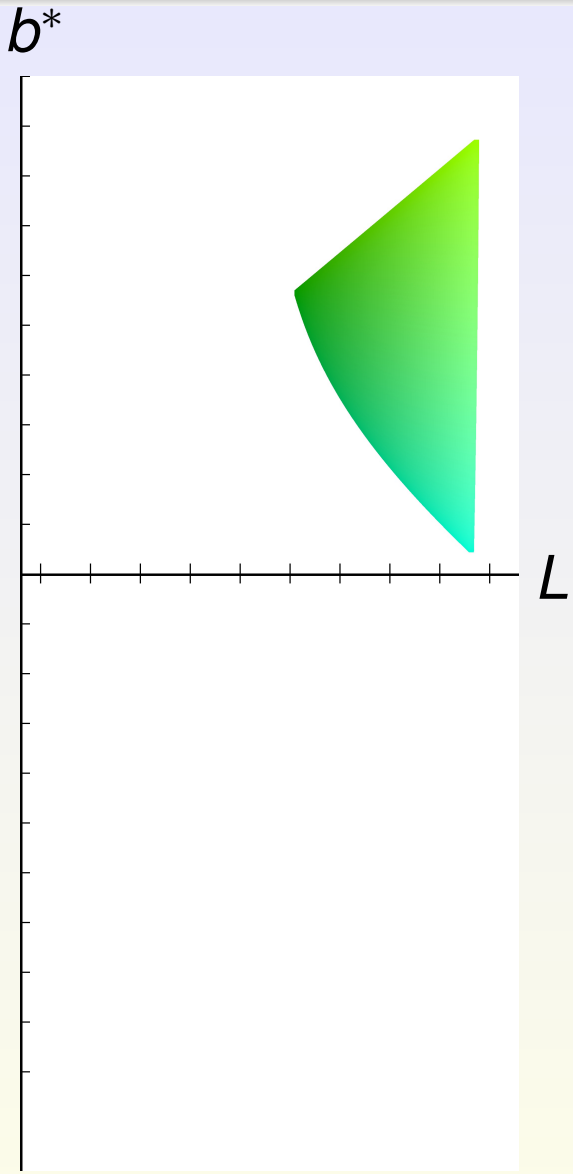
$a^* = -67$

CIE La*b* Color Space



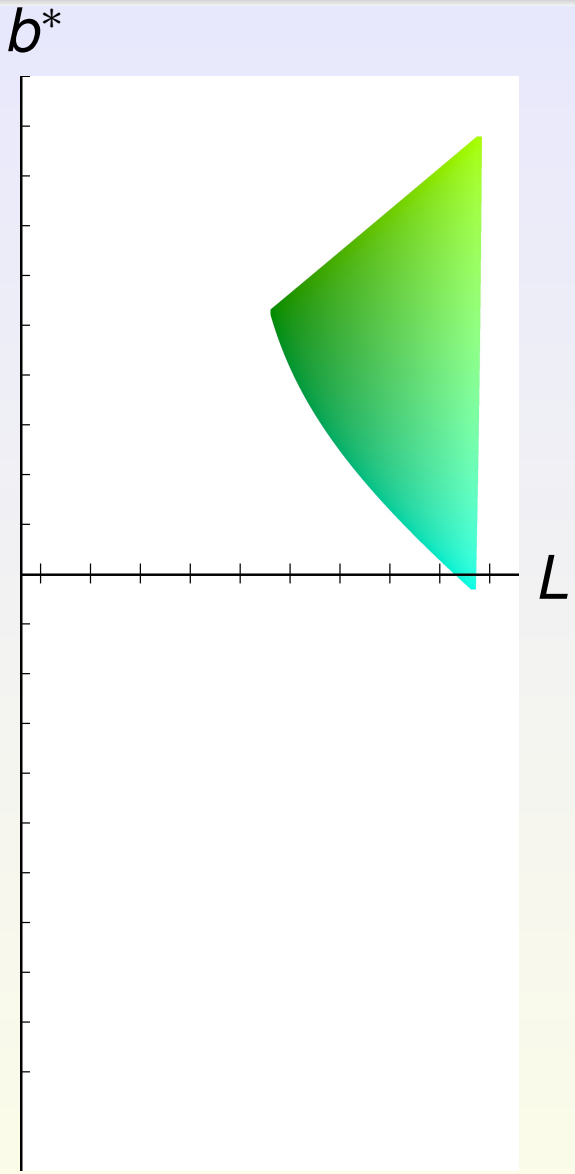
$a^* = -63$

CIE La*b* Color Space



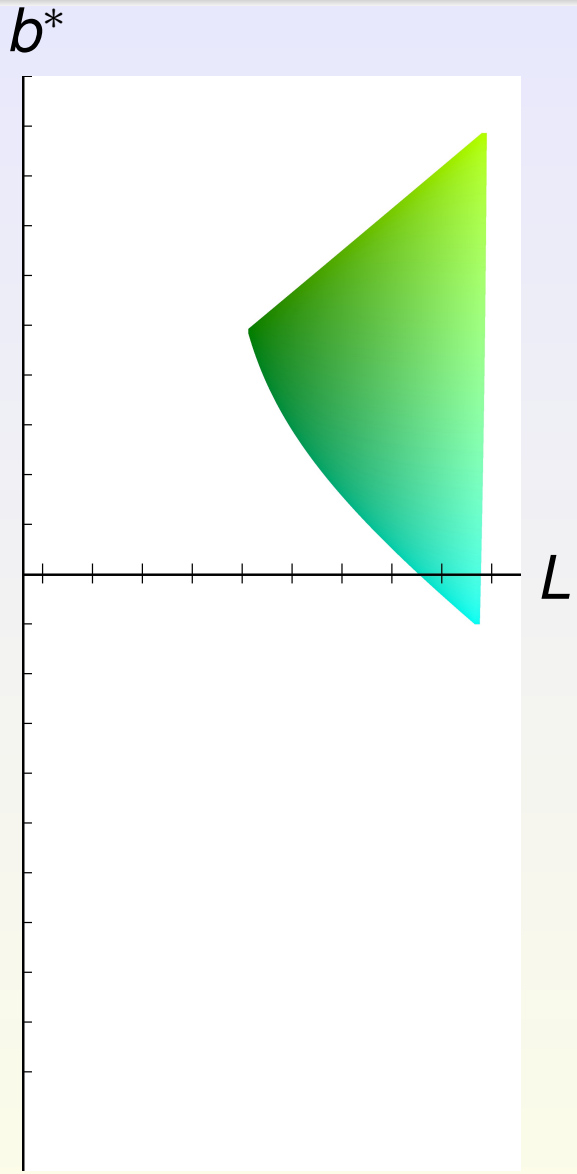
$a^* = -59$

CIE La*b* Color Space



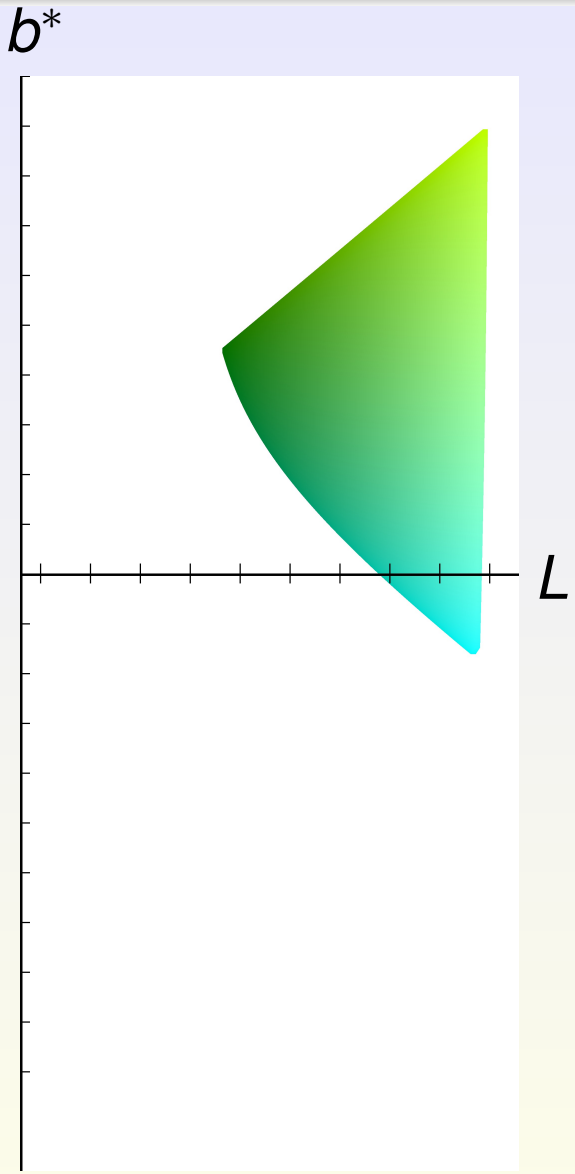
$a^* = -55$

CIE La*b* Color Space



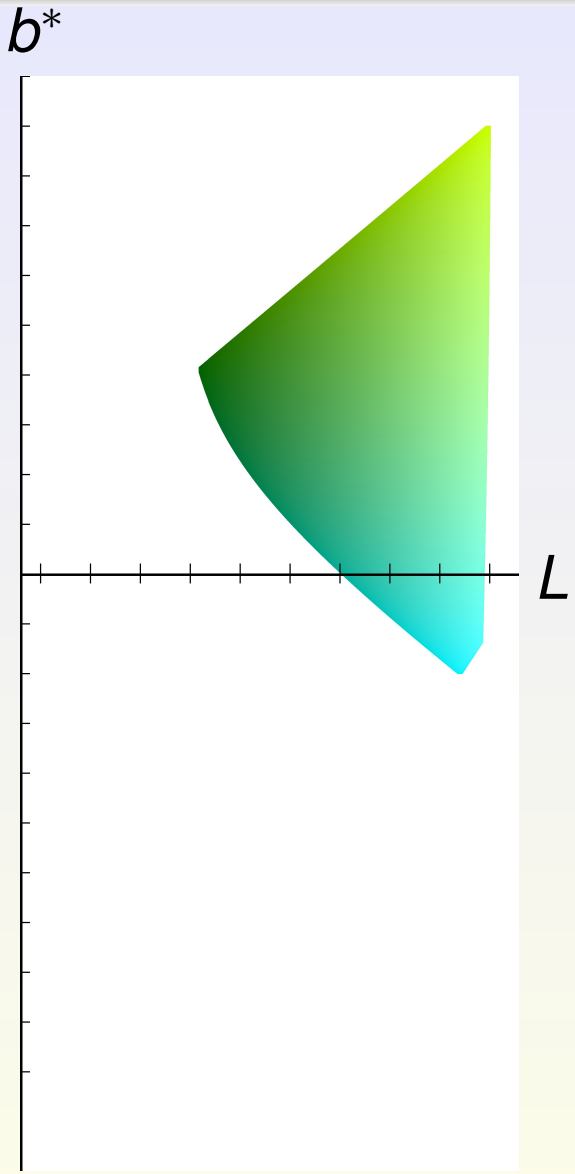
$a^* = -51$

CIE La*b* Color Space



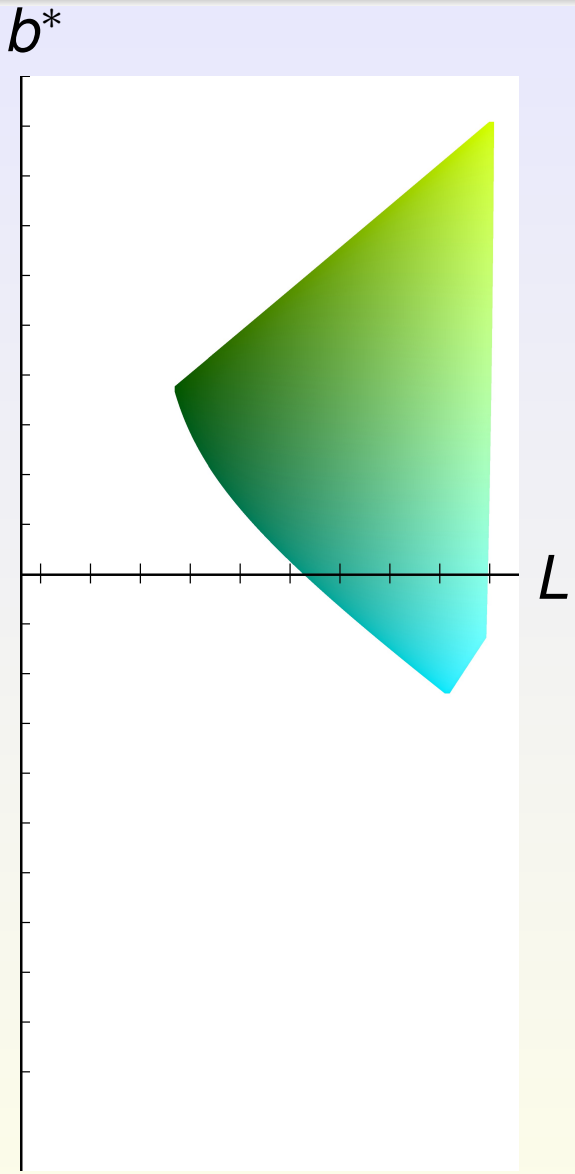
$a^* = -47$

CIE La*b* Color Space



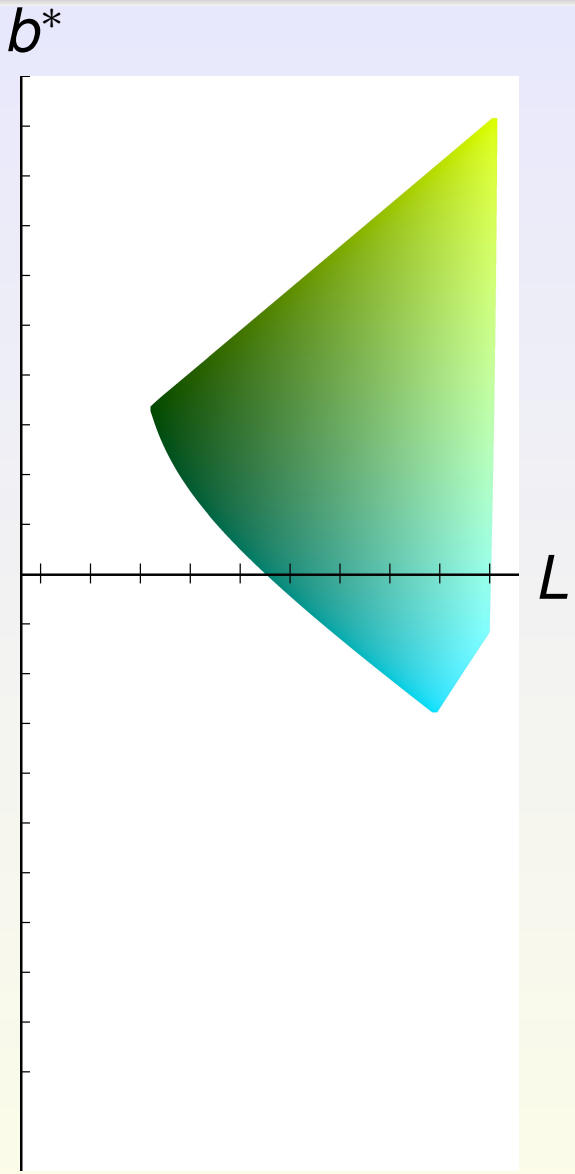
$a^* = -43$

CIE La*b* Color Space



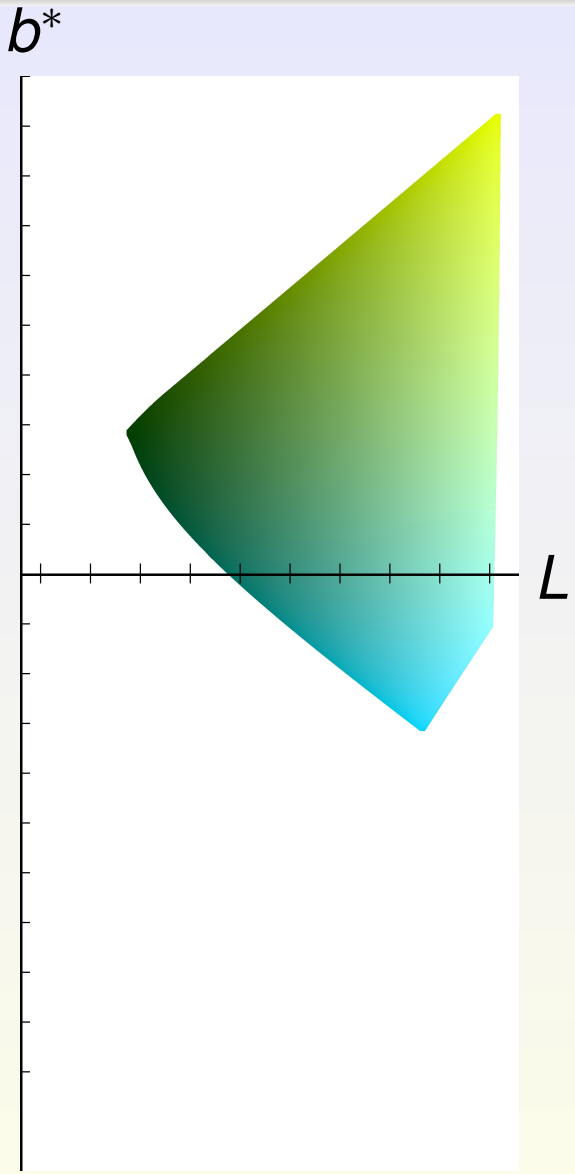
$a^* = -39$

CIE La*b* Color Space



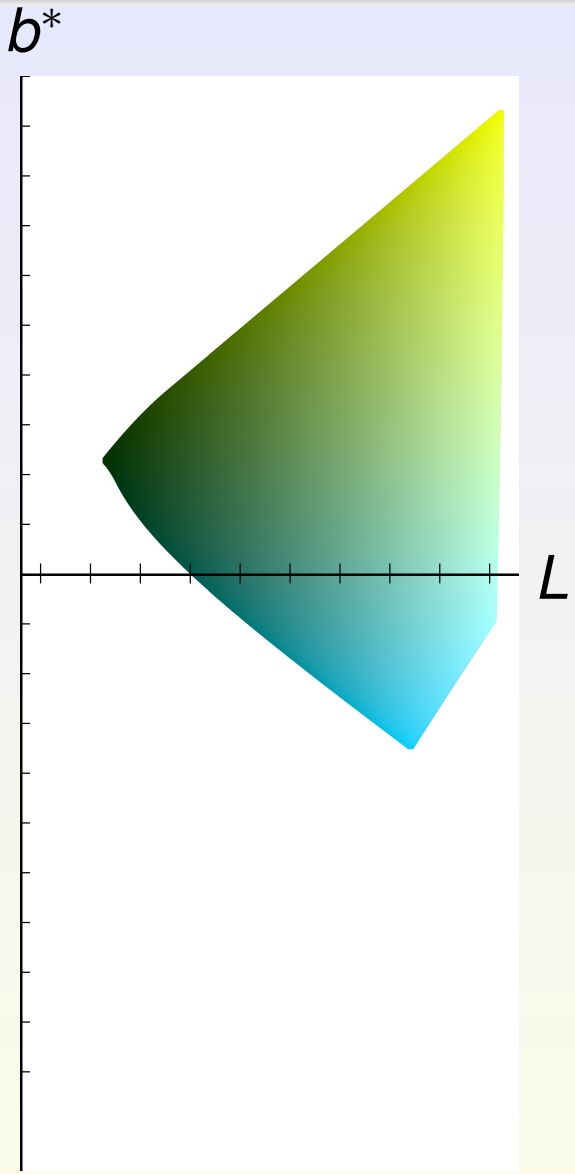
$a^* = -35$

CIE La*b* Color Space



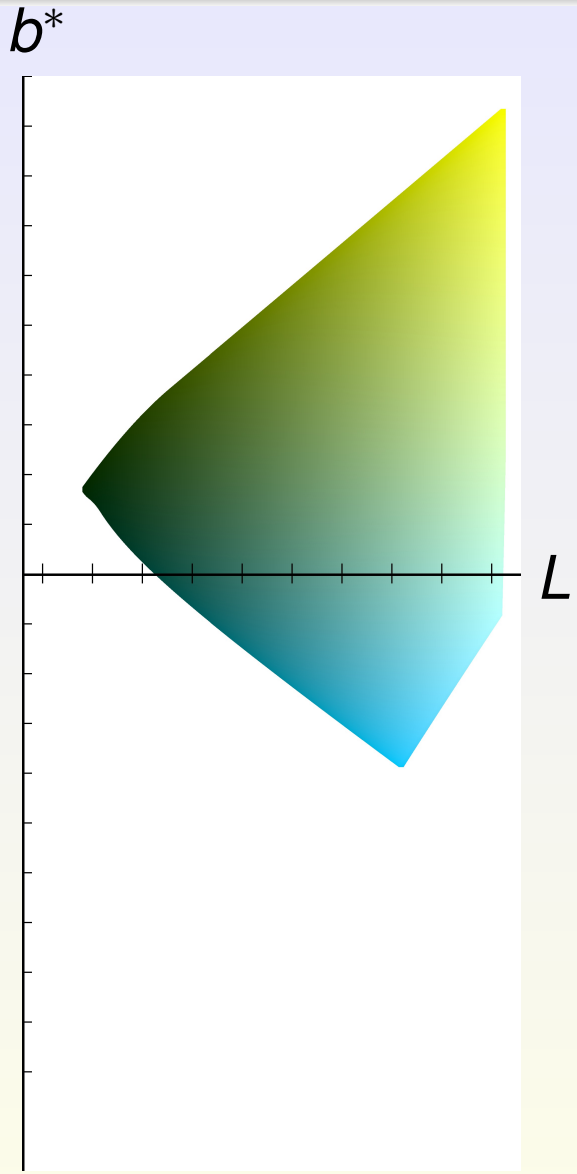
$a^* = -31$

CIE La*b* Color Space



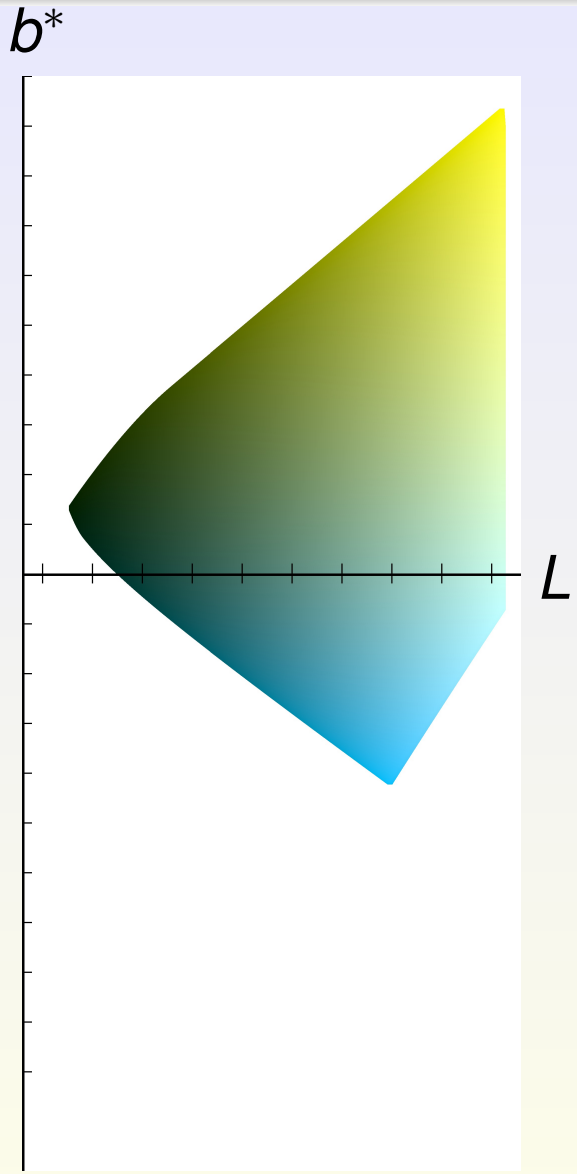
$a^* = -27$

CIE La*b* Color Space



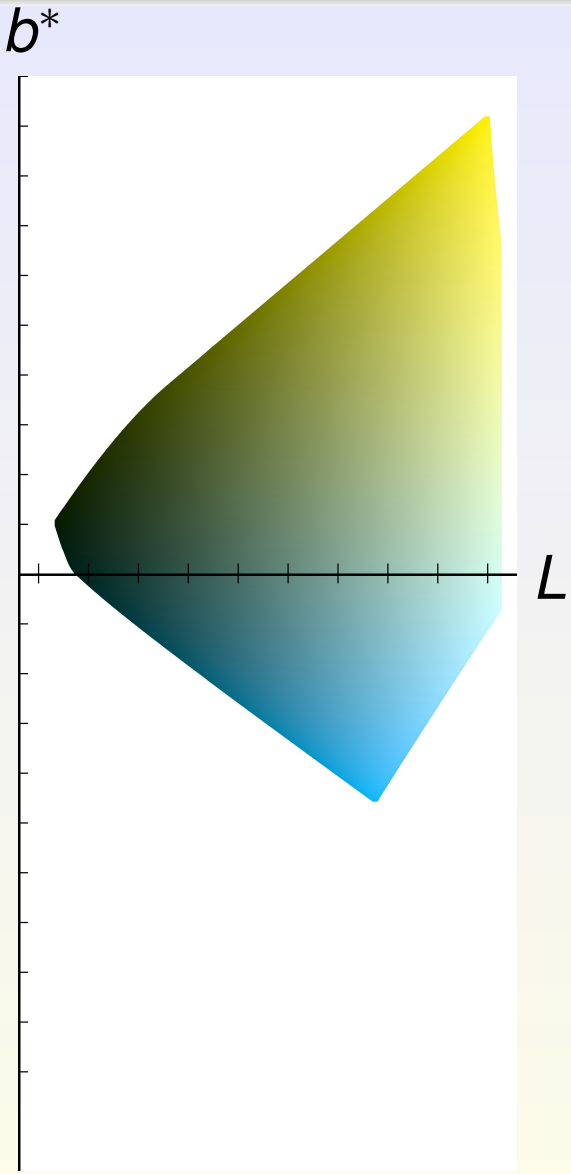
$a^* = -23$

CIE La*b* Color Space



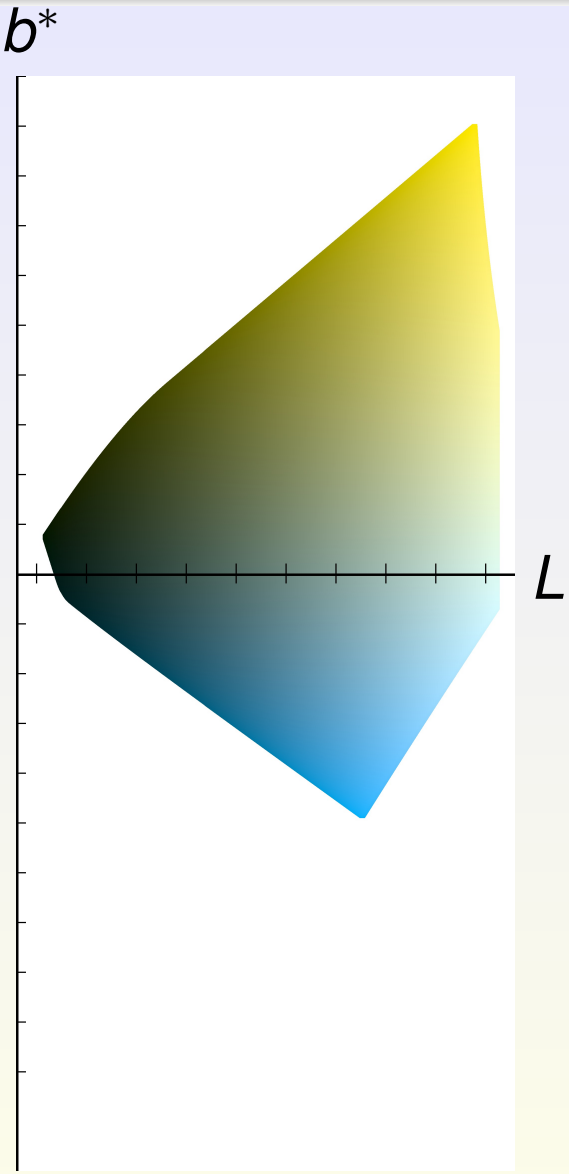
$a^* = -19$

CIE La*b* Color Space



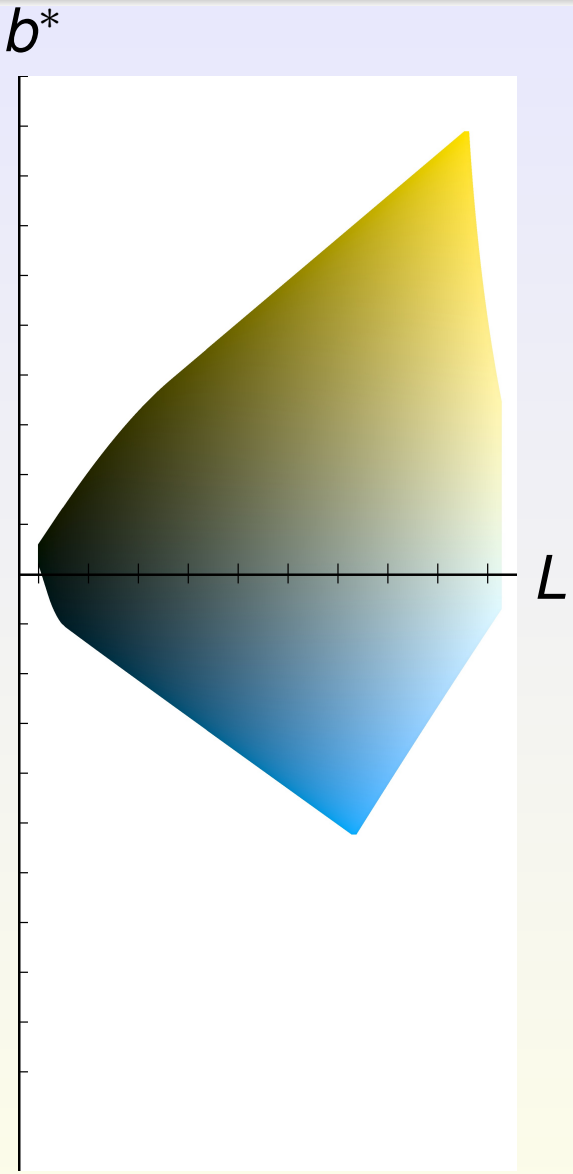
$a^* = -15$

CIE La*b* Color Space



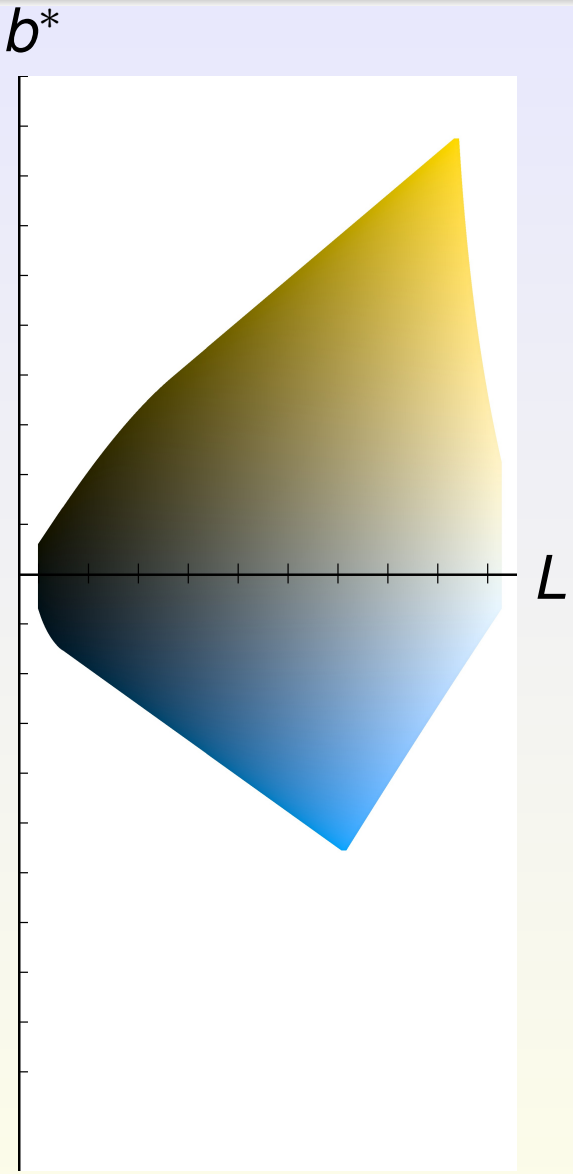
$a^* = -11$

CIE La*b* Color Space



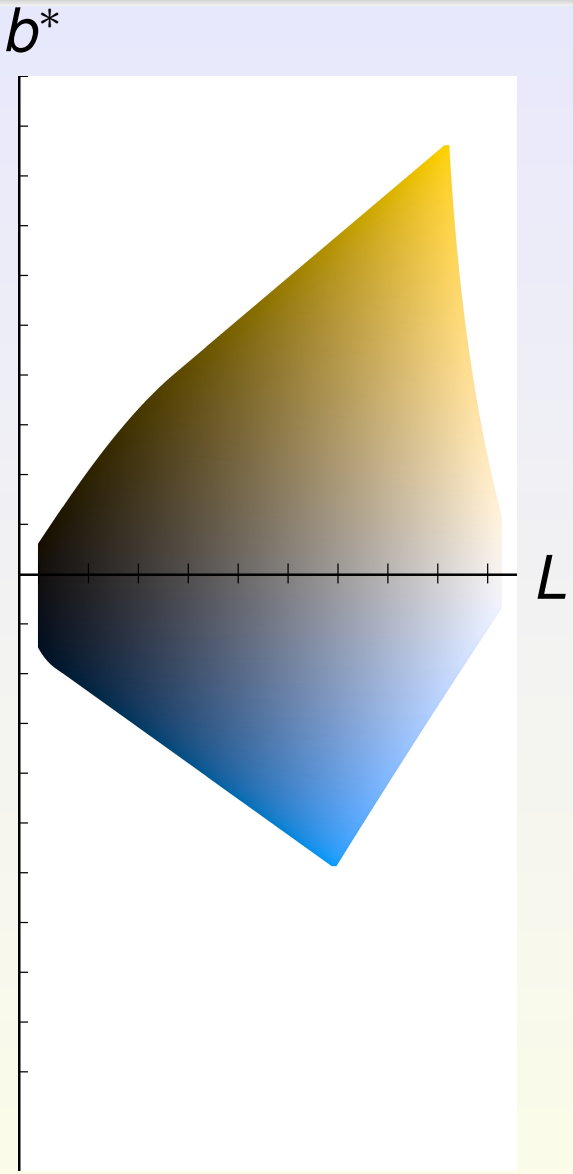
$$a^* = -7$$

CIE La*b* Color Space



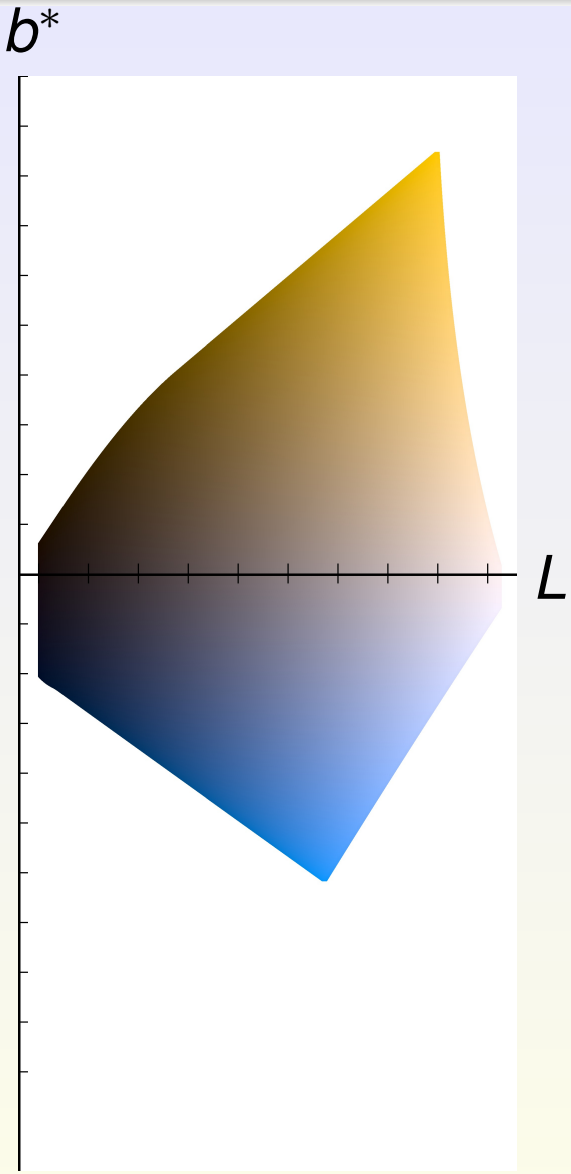
$a^* = -3$

CIE La*b* Color Space



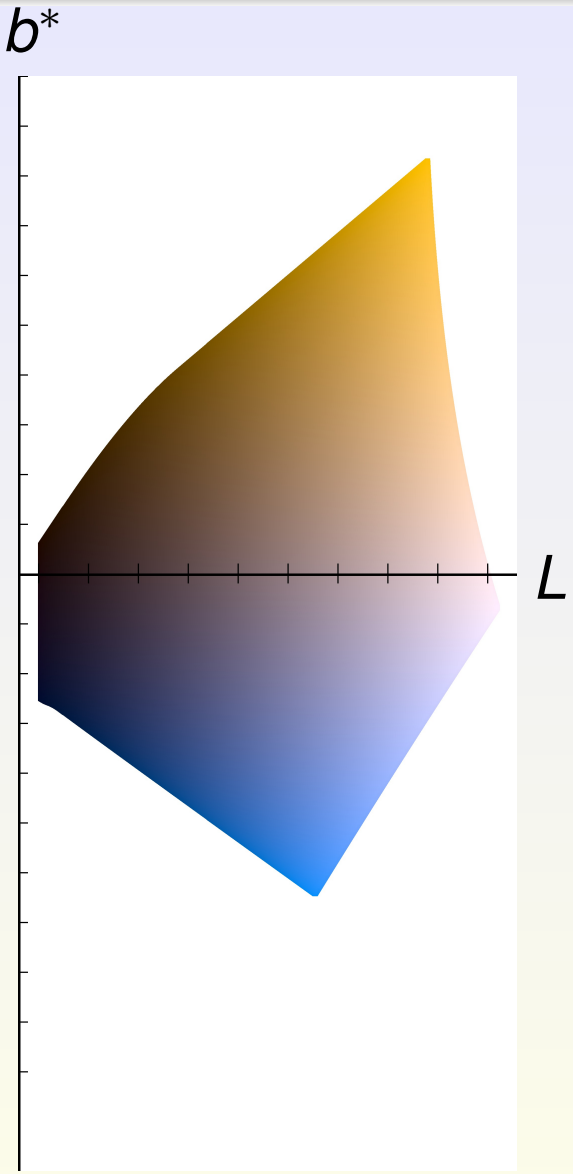
$a^* = 1$

CIE La*b* Color Space



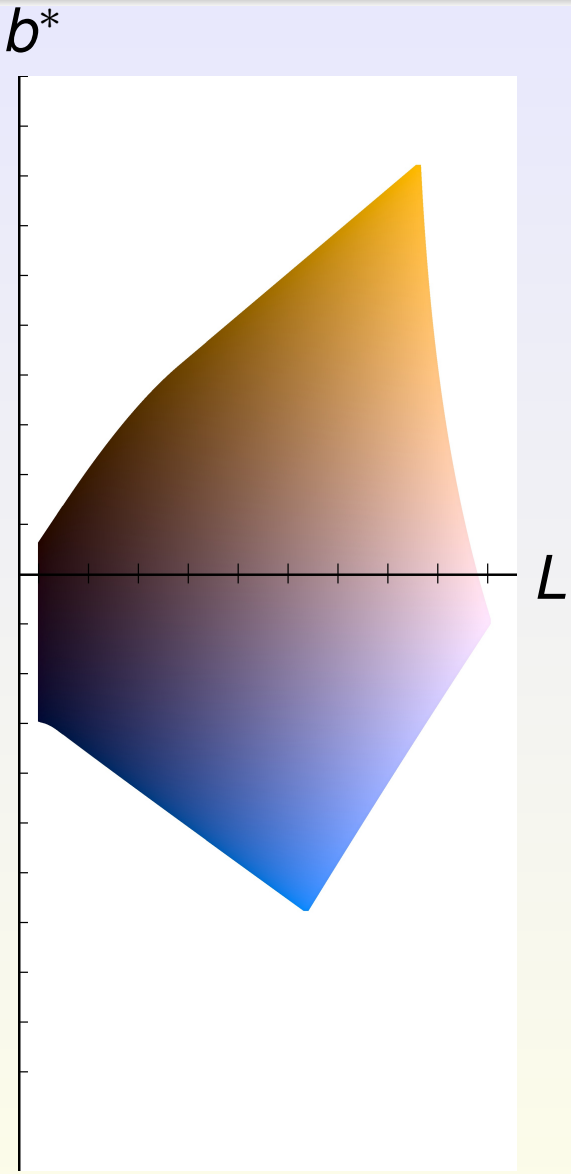
$a^* = 5$

CIE La*b* Color Space



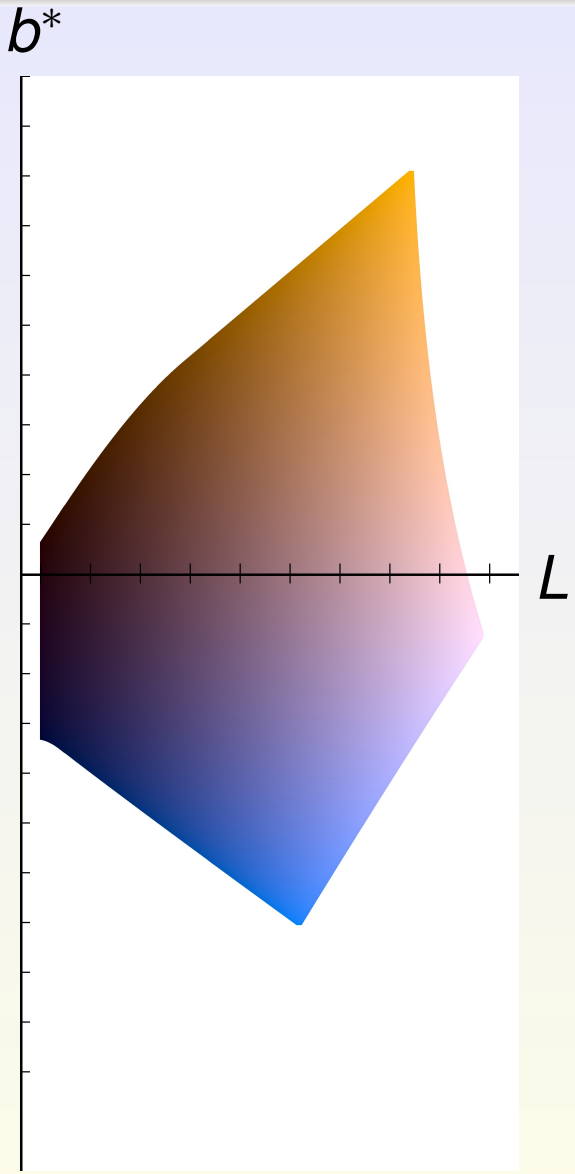
$a^* = 9$

CIE La*b* Color Space



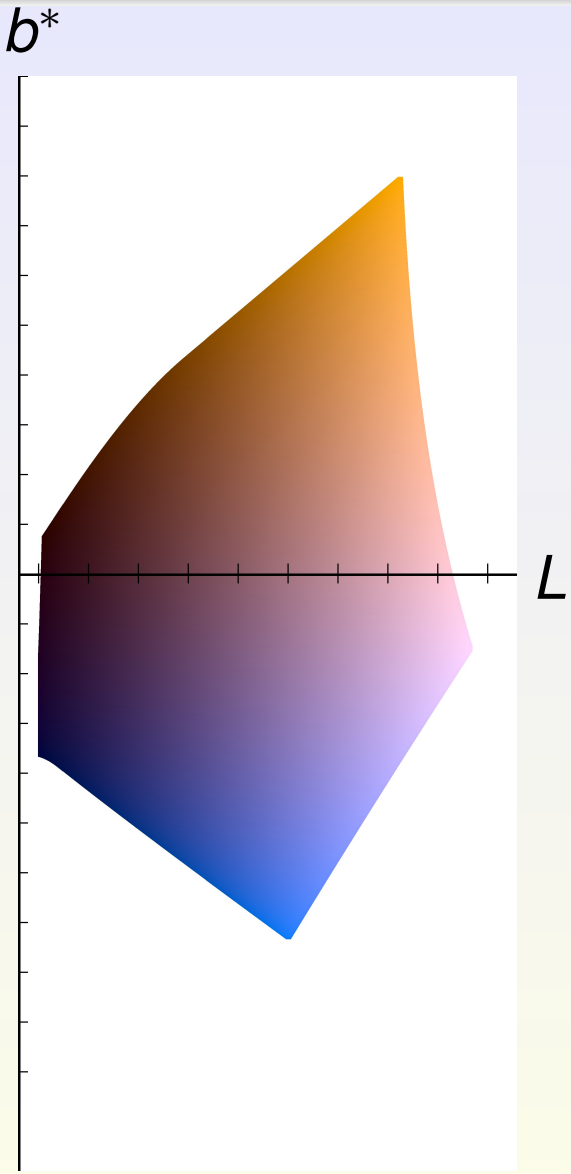
$a^* = 13$

CIE La*b* Color Space



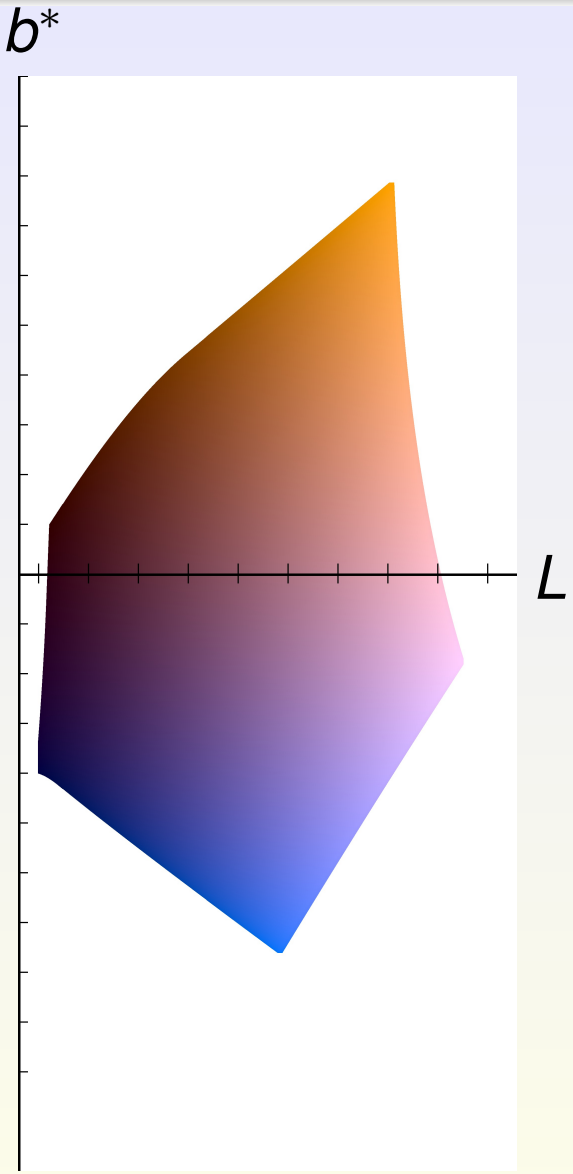
$a^* = 17$

CIE La*b* Color Space



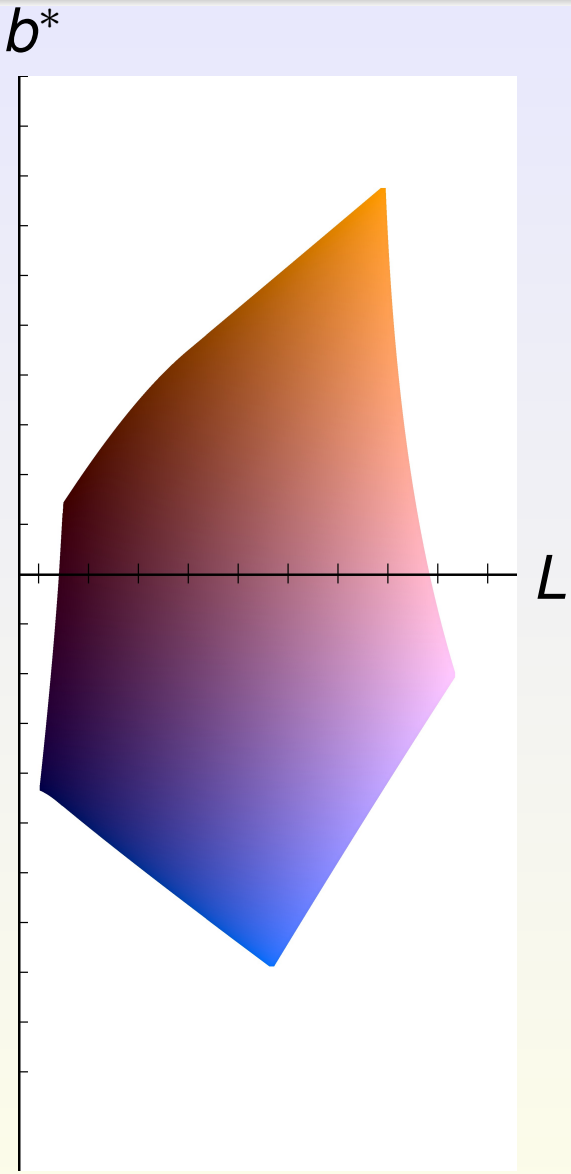
$a^* = 21$

CIE La*b* Color Space



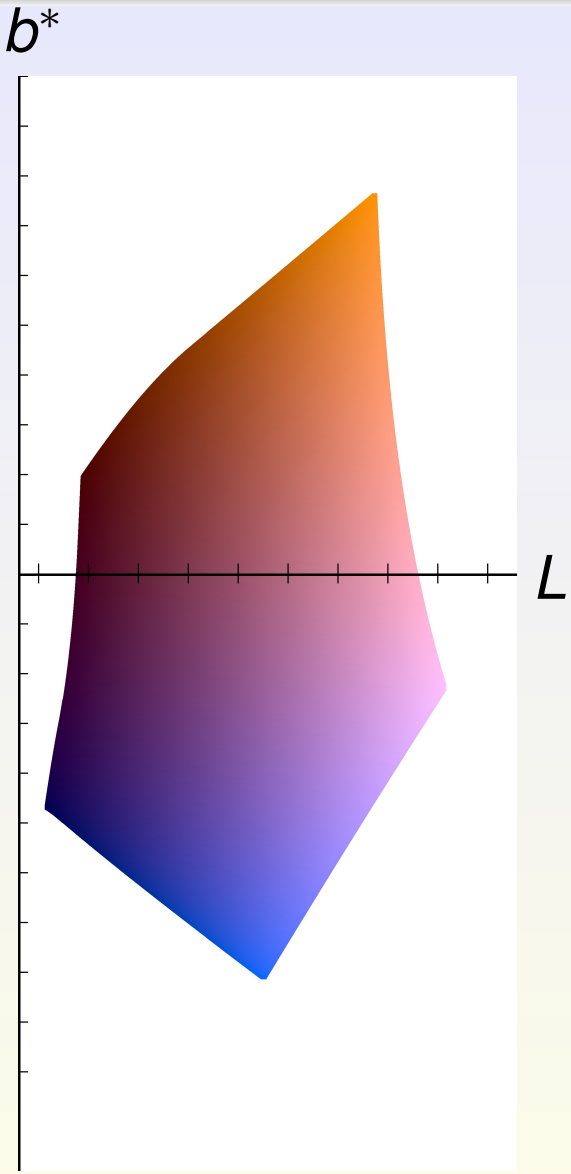
$a^* = 25$

CIE La*b* Color Space



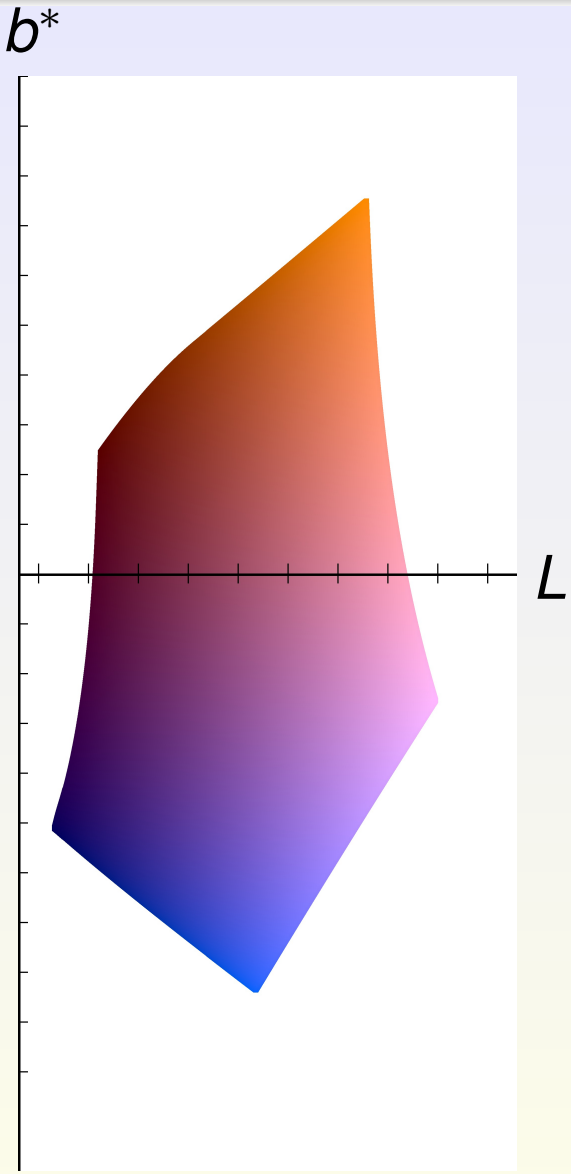
$a^* = 29$

CIE La*b* Color Space



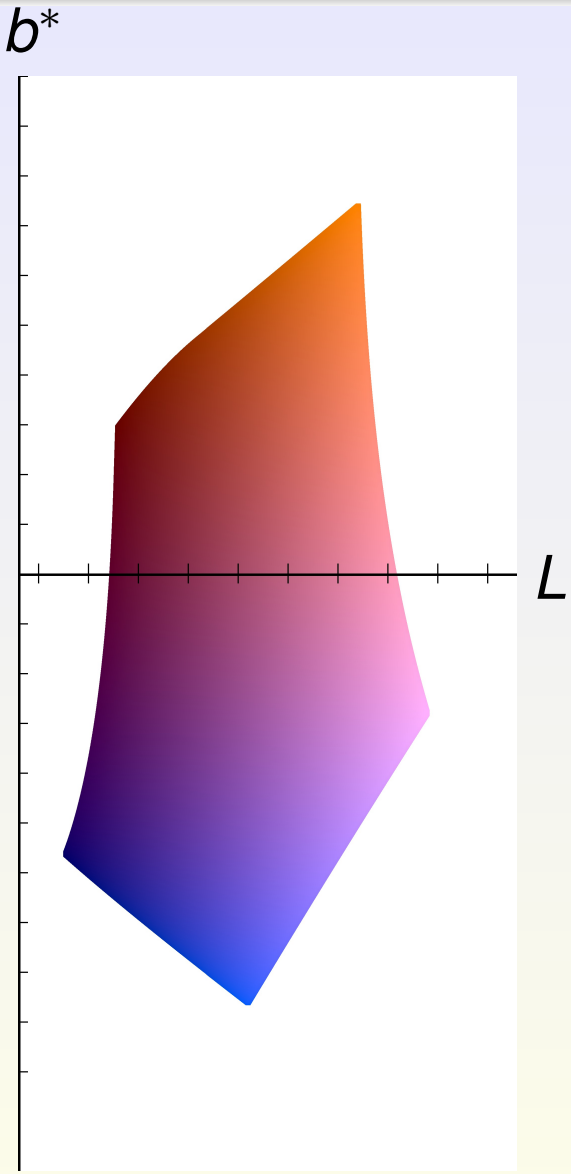
$a^* = 33$

CIE La*b* Color Space



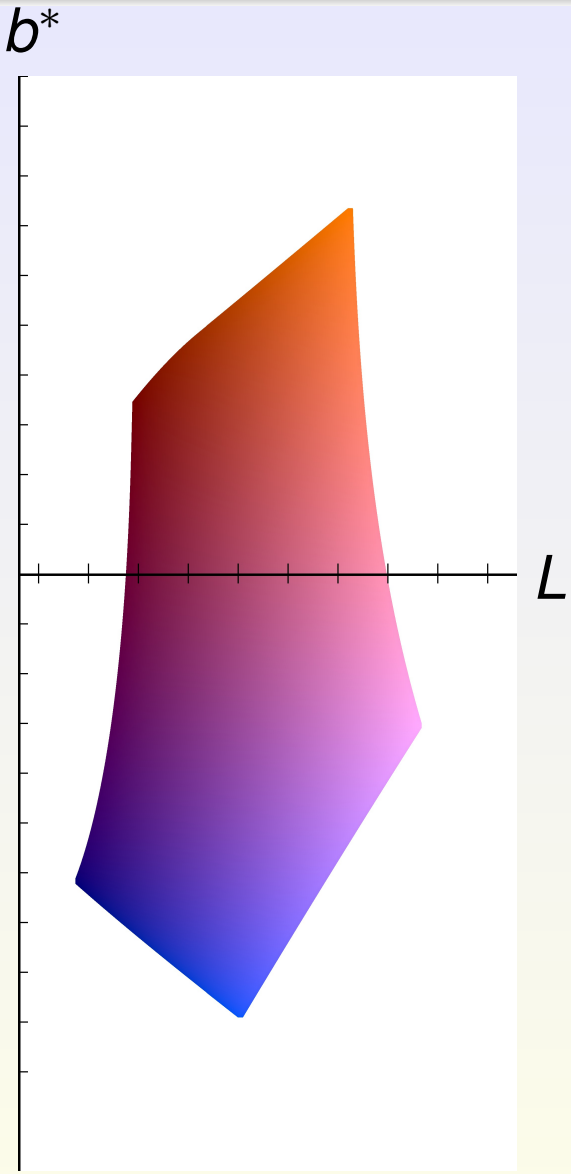
$a^* = 37$

CIE La*b* Color Space



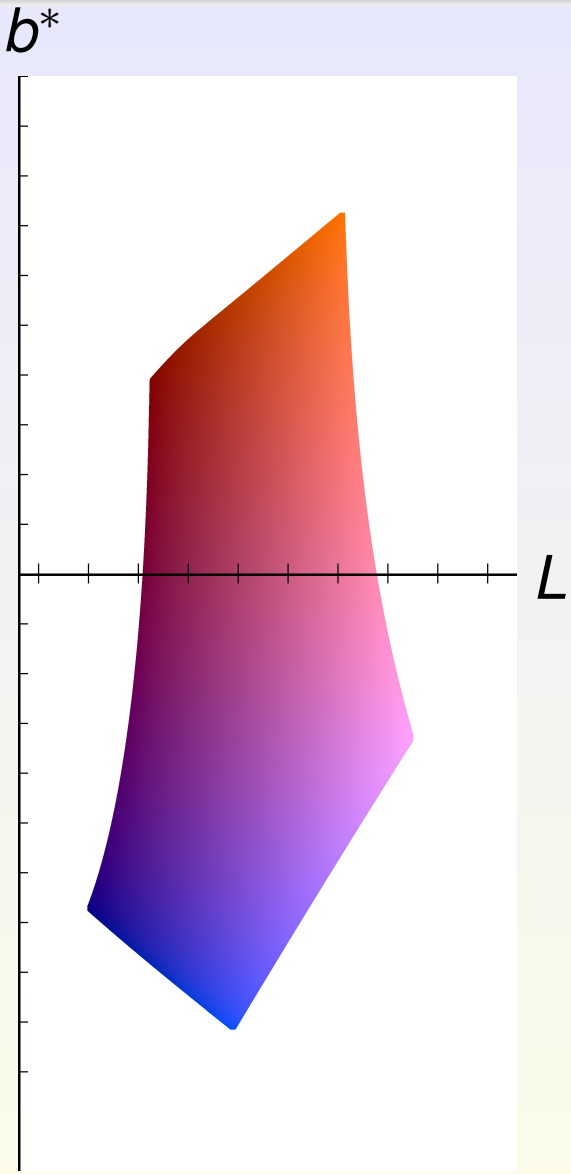
$a^* = 41$

CIE La*b* Color Space



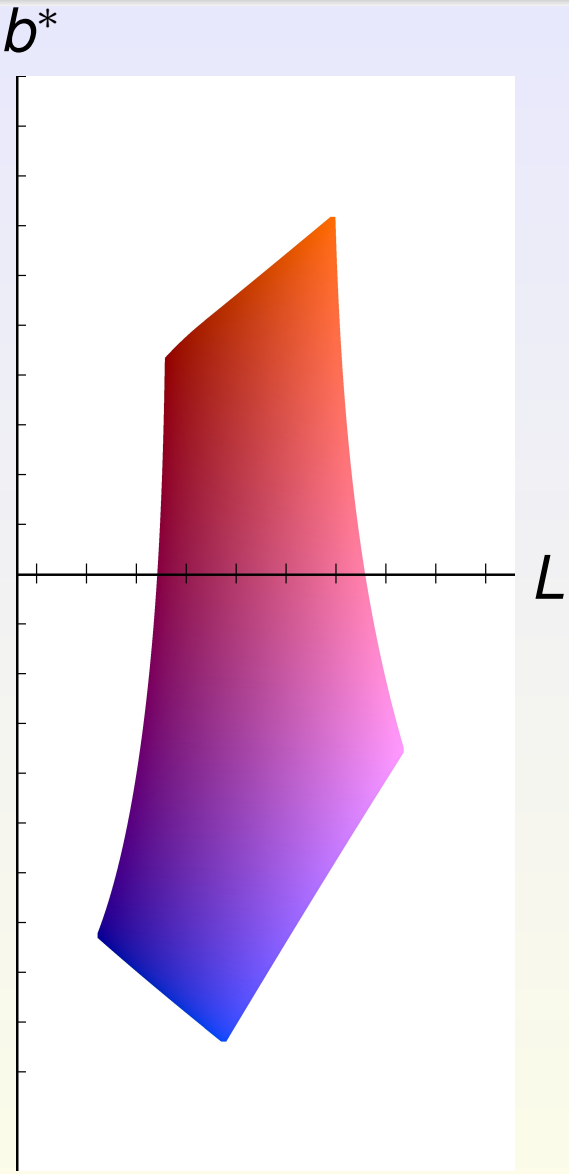
$a^* = 45$

CIE La*b* Color Space



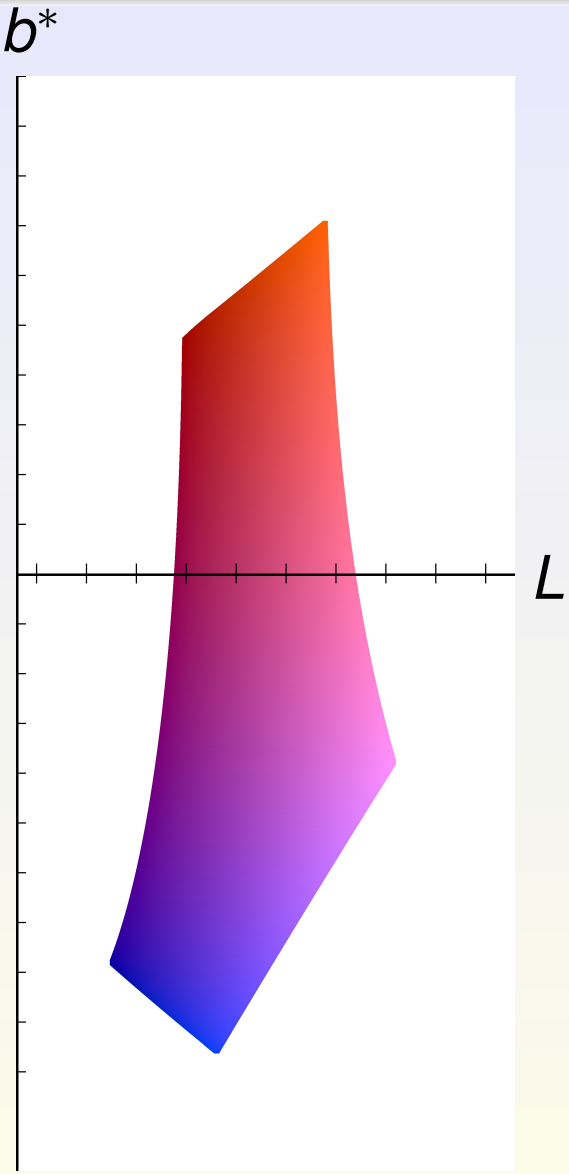
$a^* = 49$

CIE La*b* Color Space



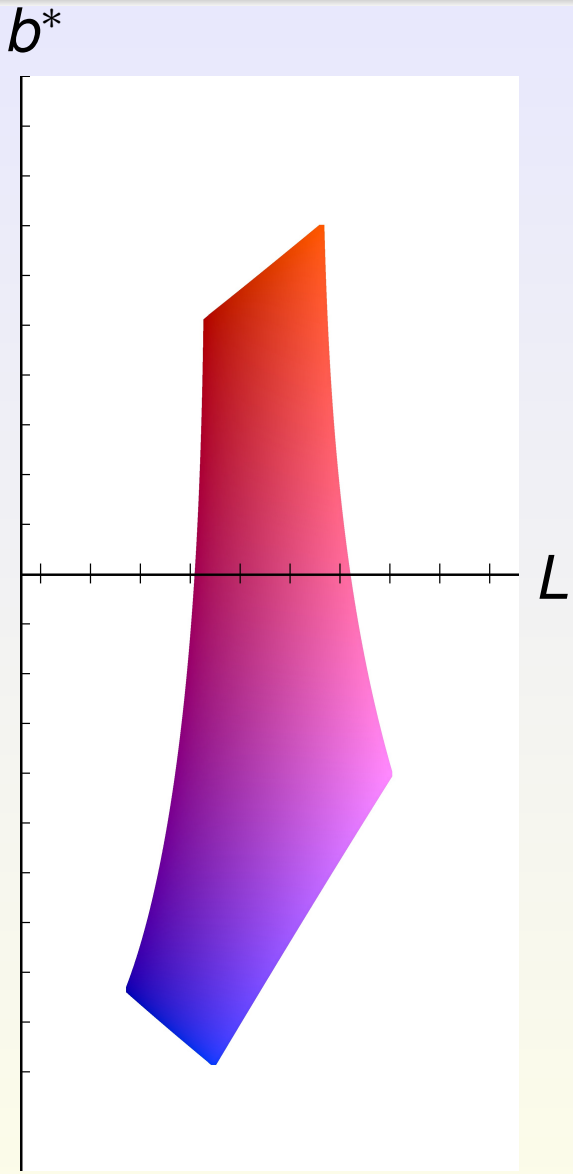
$a^* = 53$

CIE La*b* Color Space



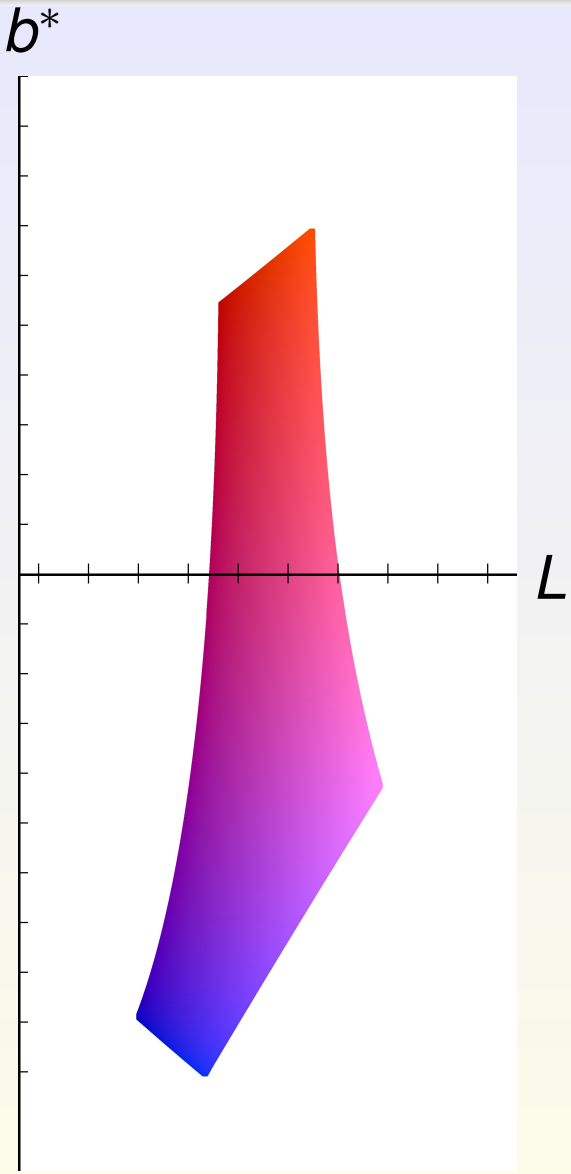
$a^* = 57$

CIE La*b* Color Space



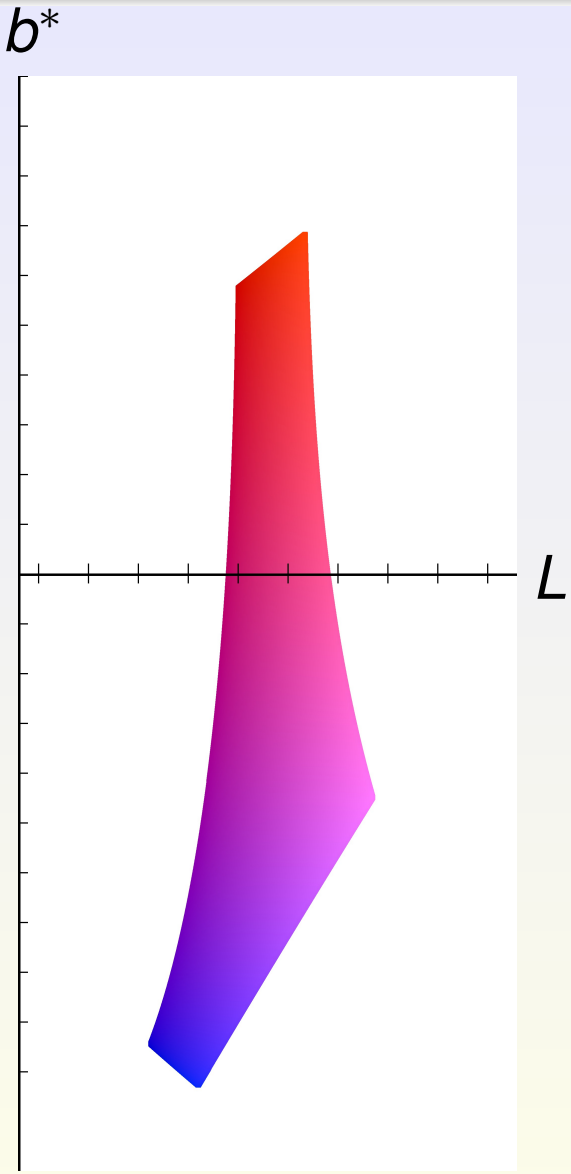
$a^* = 61$

CIE La*b* Color Space



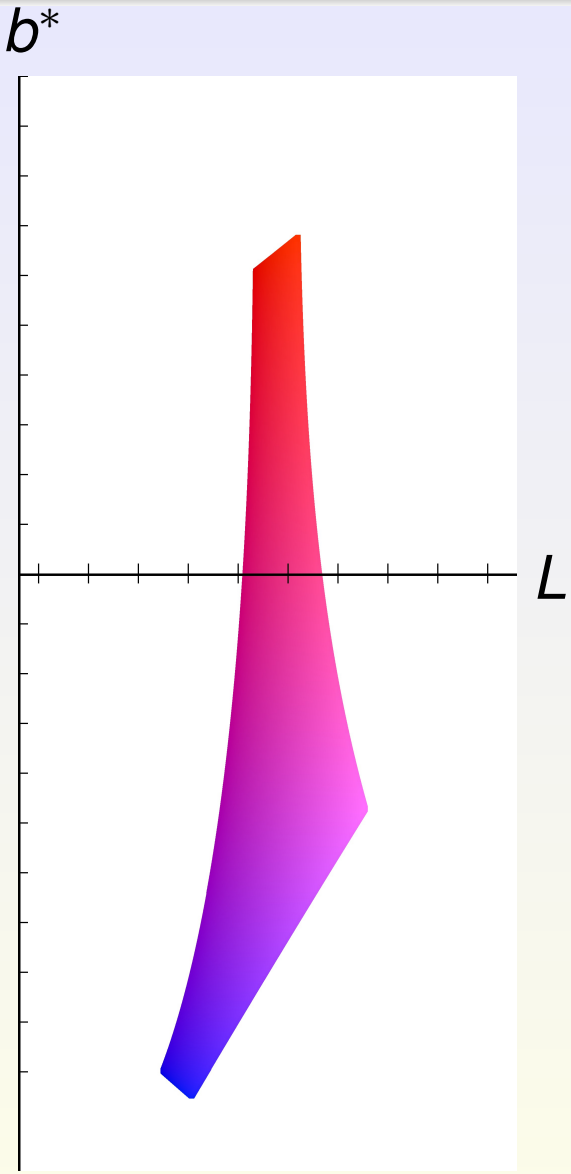
$a^* = 65$

CIE La*b* Color Space



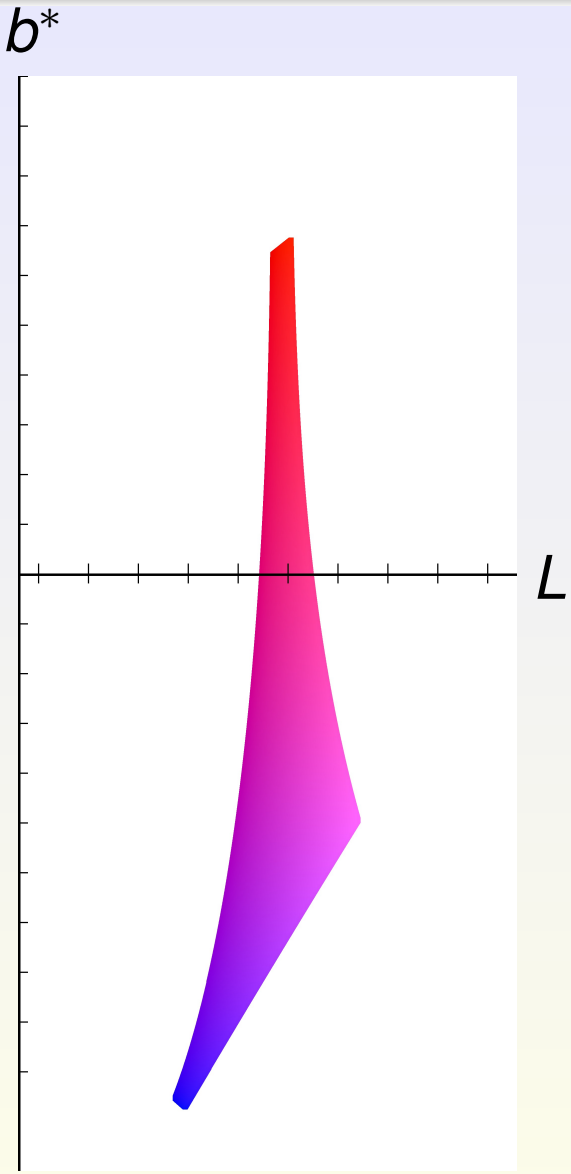
$a^* = 69$

CIE La*b* Color Space



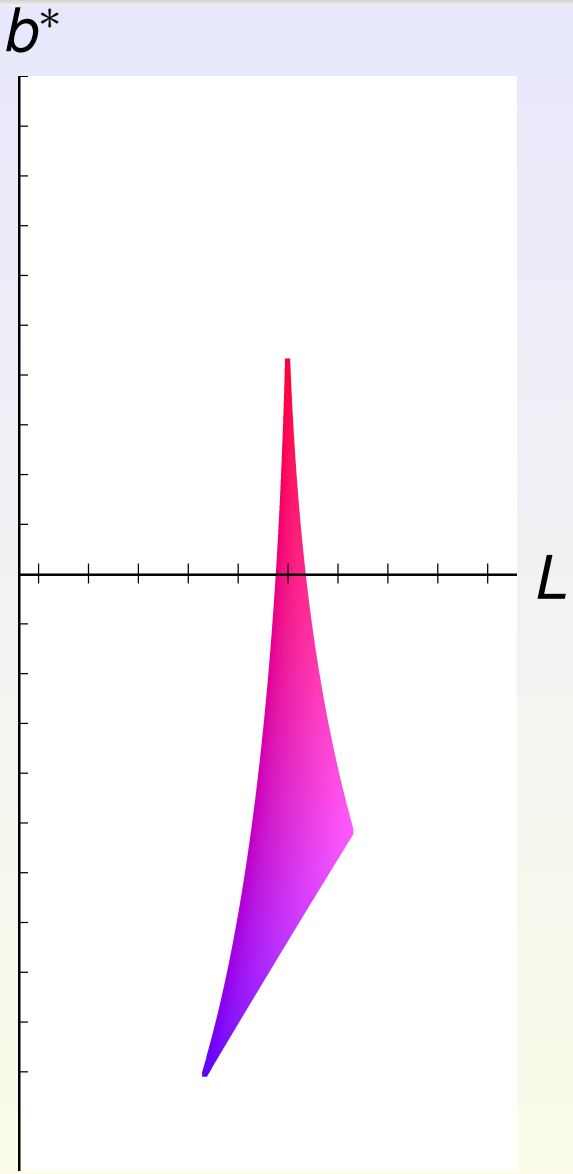
$a^* = 73$

CIE La*b* Color Space



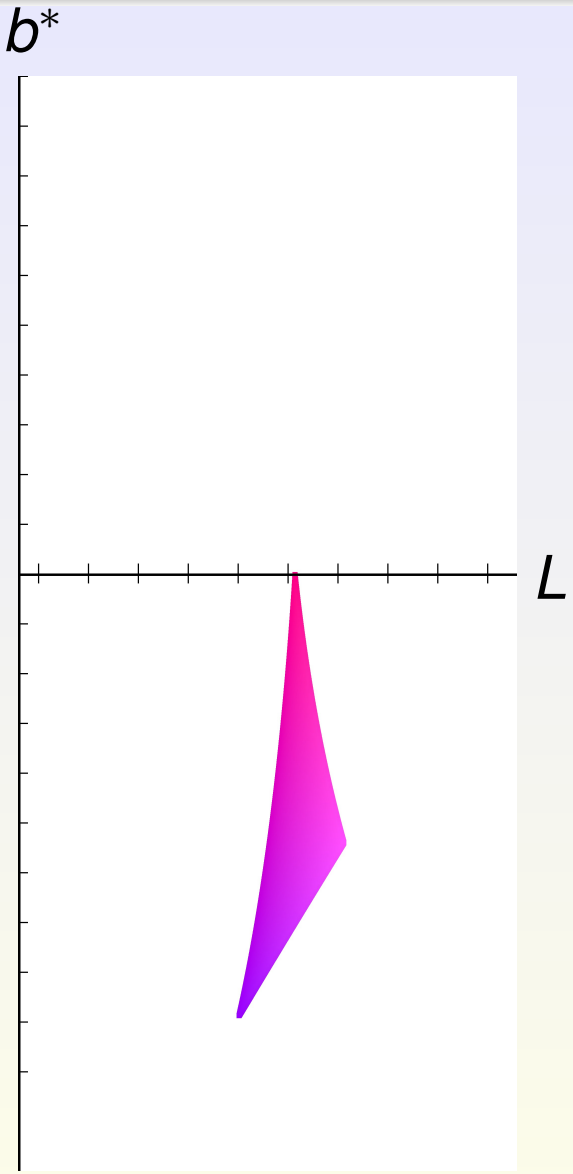
$a^* = 77$

CIE La*b* Color Space



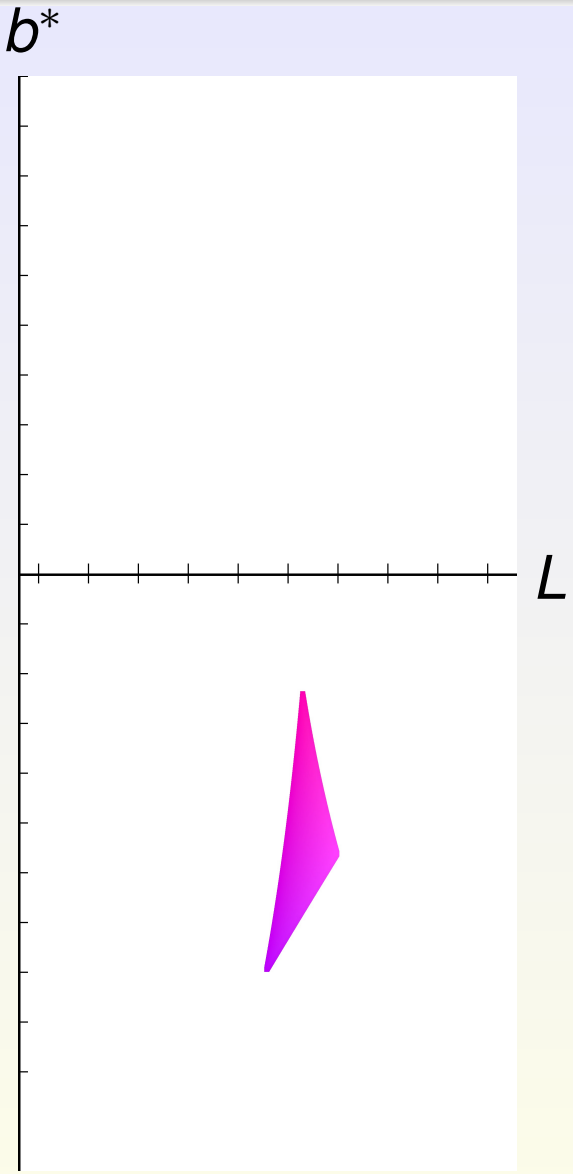
$a^* = 81$

CIE La*b* Color Space



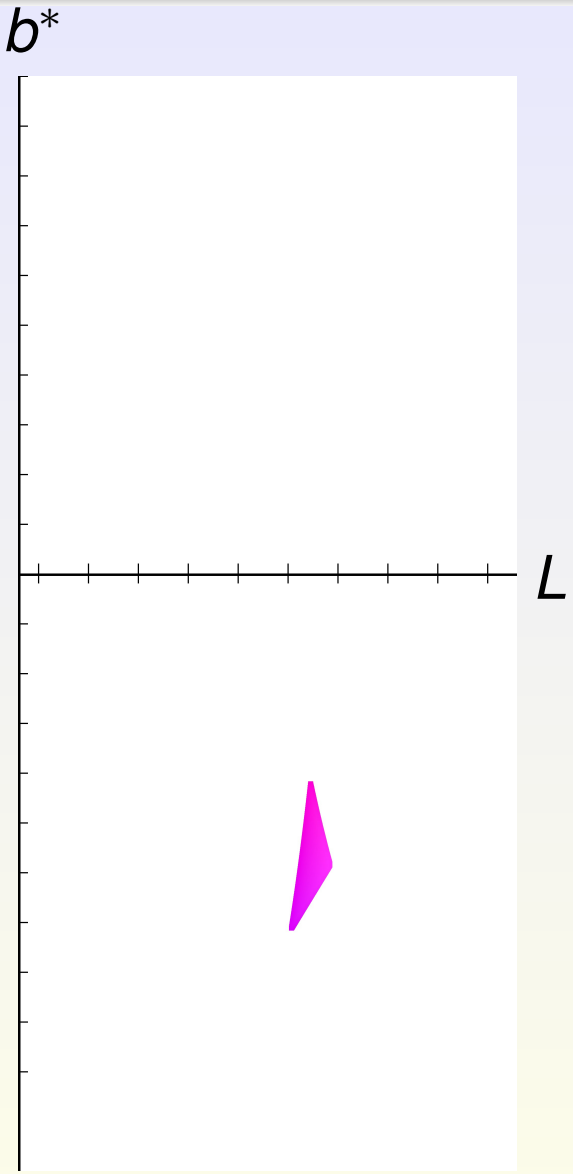
$a^* = 85$

CIE La*b* Color Space



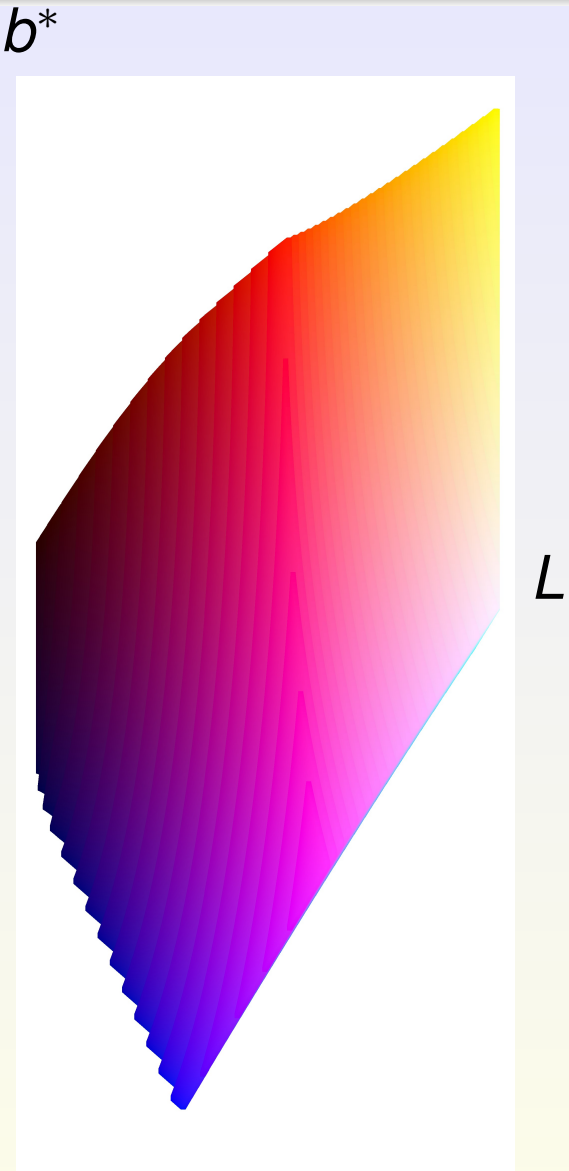
$a^* = 89$

CIE La*b* Color Space



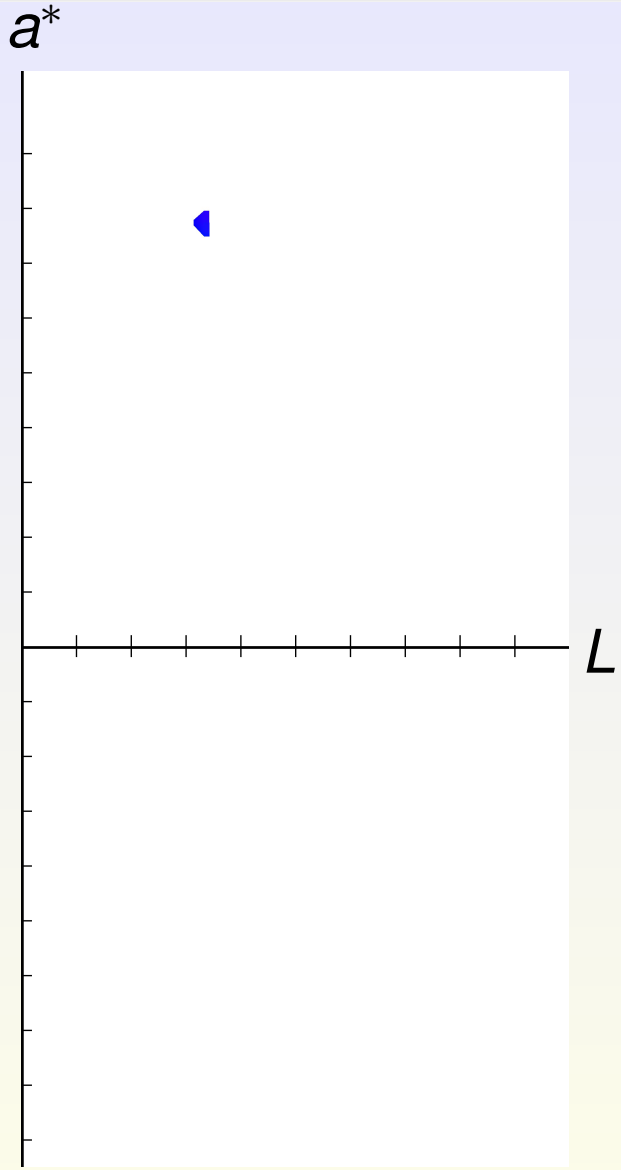
$a^* = 93$

CIE La*b* Color Space



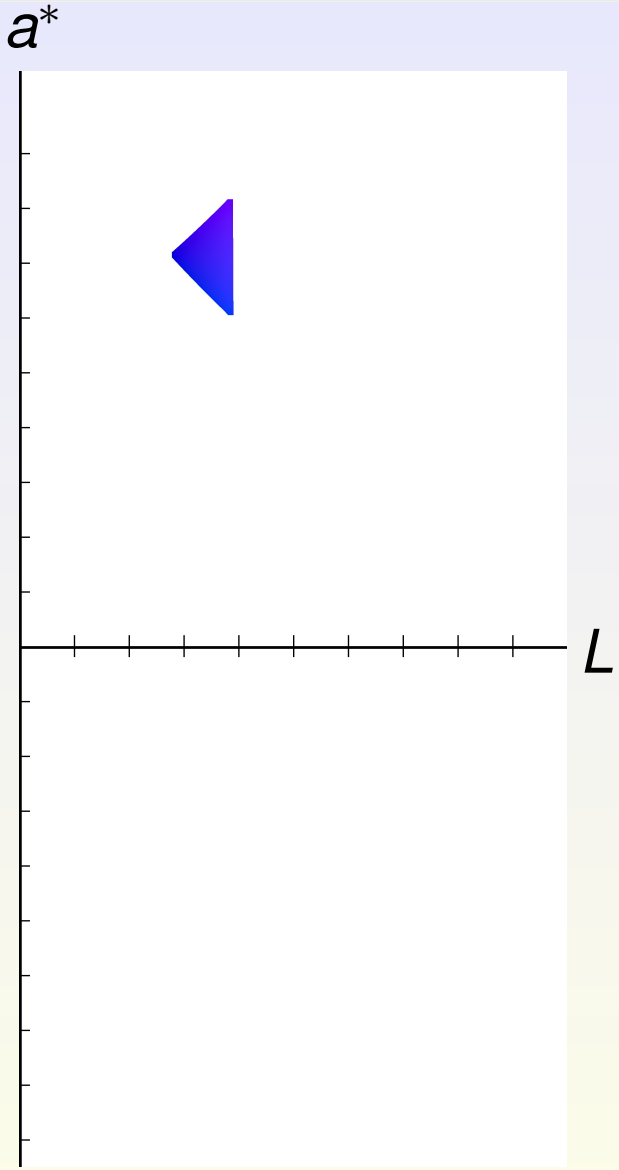
For a fixed (L, b^*), each point has the largest a^* that maps to that location.

CIE La*b* Color Space



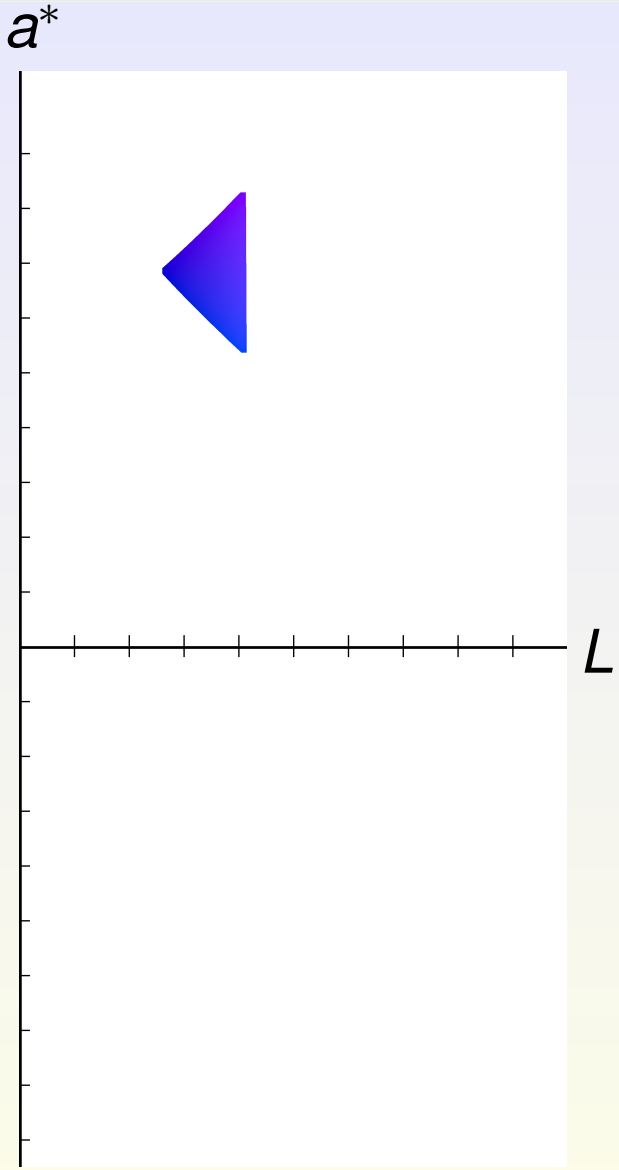
$b^* = -106$

CIE La*b* Color Space



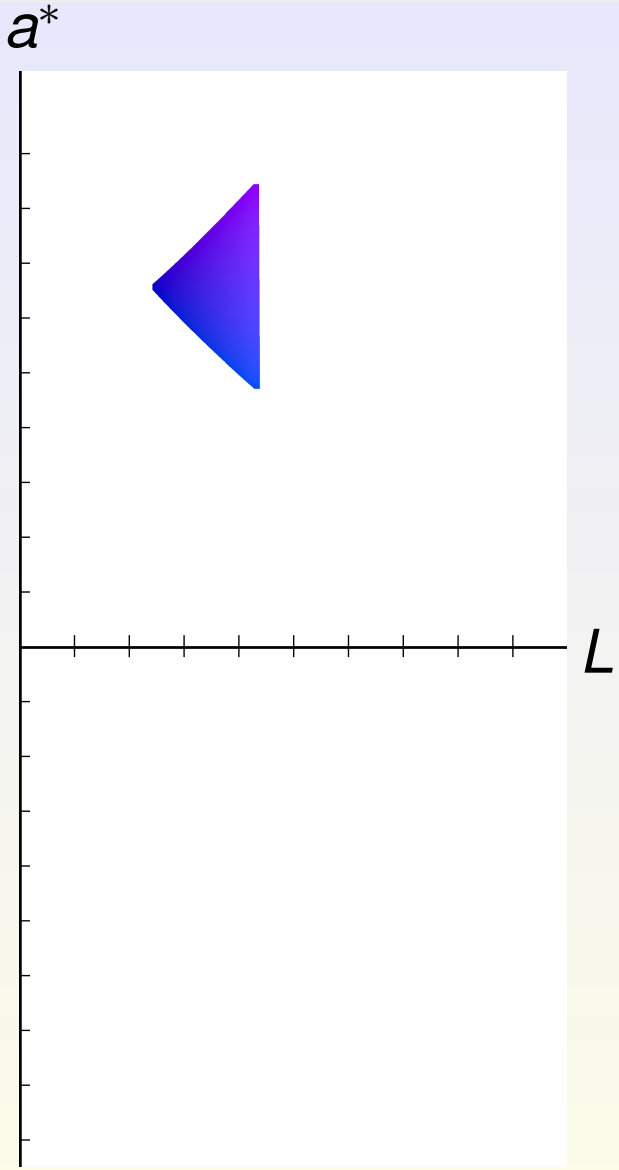
$b^* = -98$

CIE La*b* Color Space



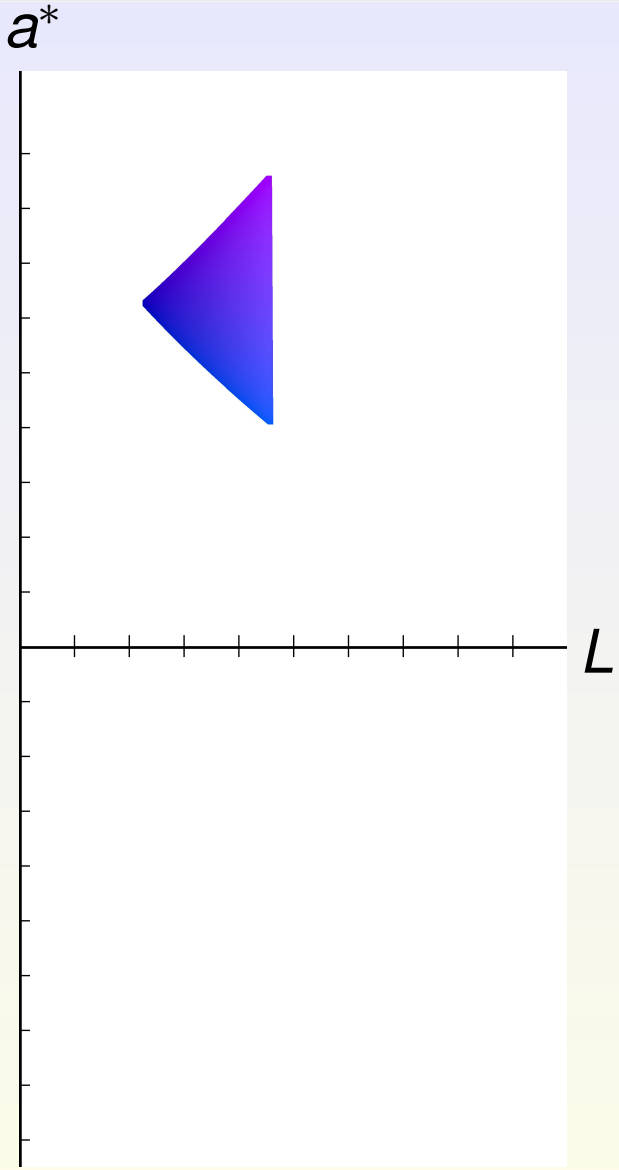
$b^* = -94$

CIE La*b* Color Space



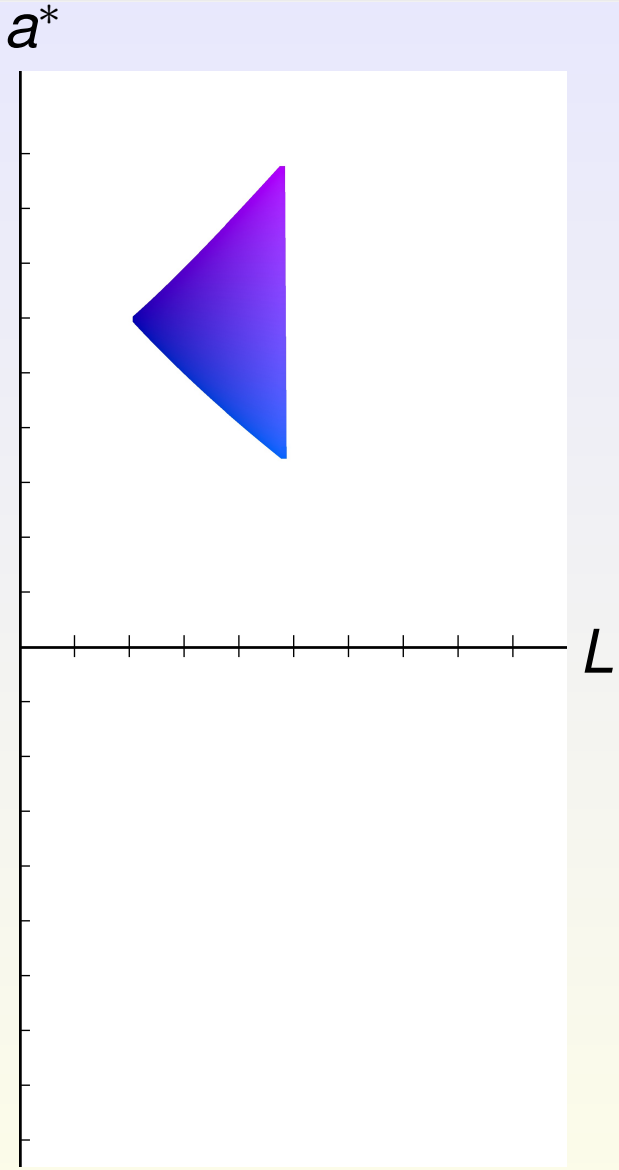
$b^* = -90$

CIE La*b* Color Space



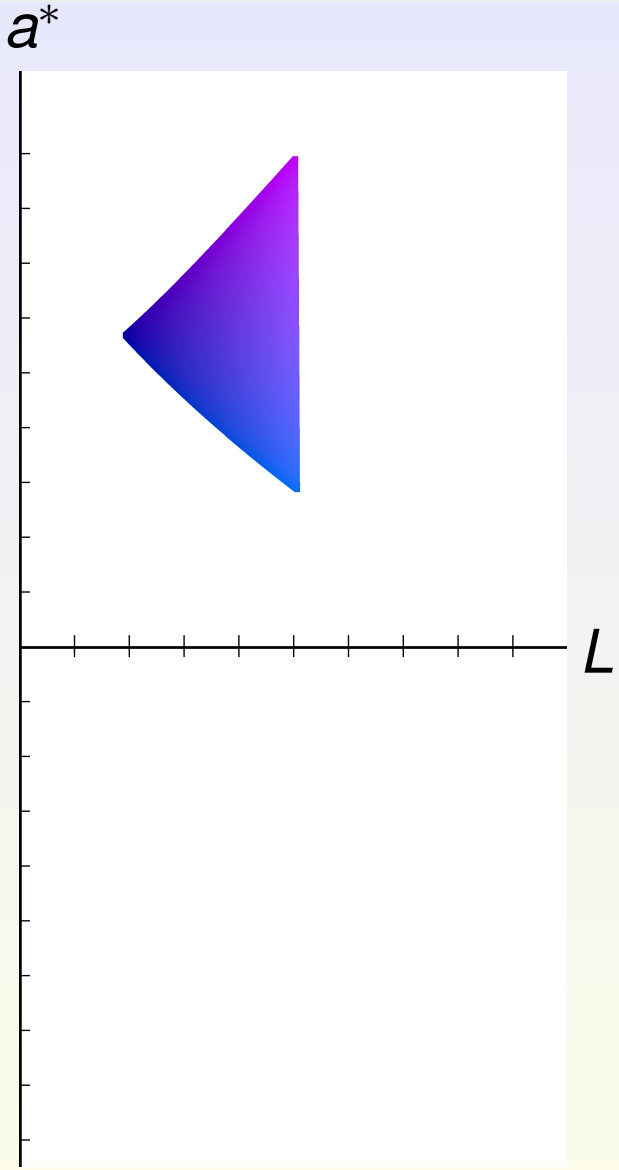
$b^* = -86$

CIE La*b* Color Space



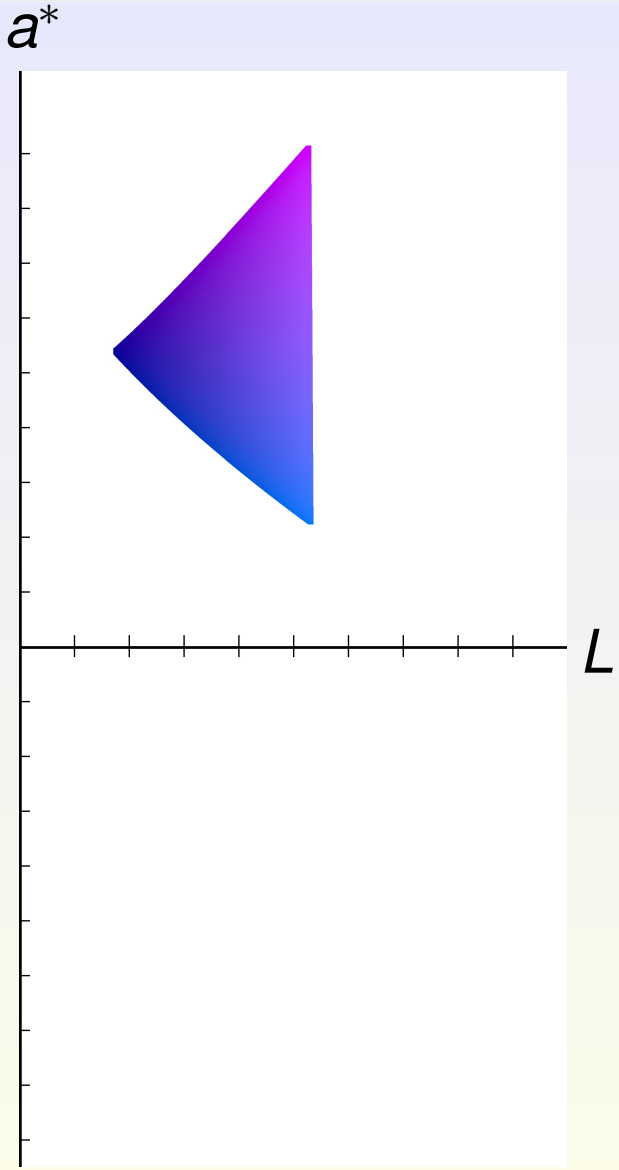
$b^* = -82$

CIE La*b* Color Space



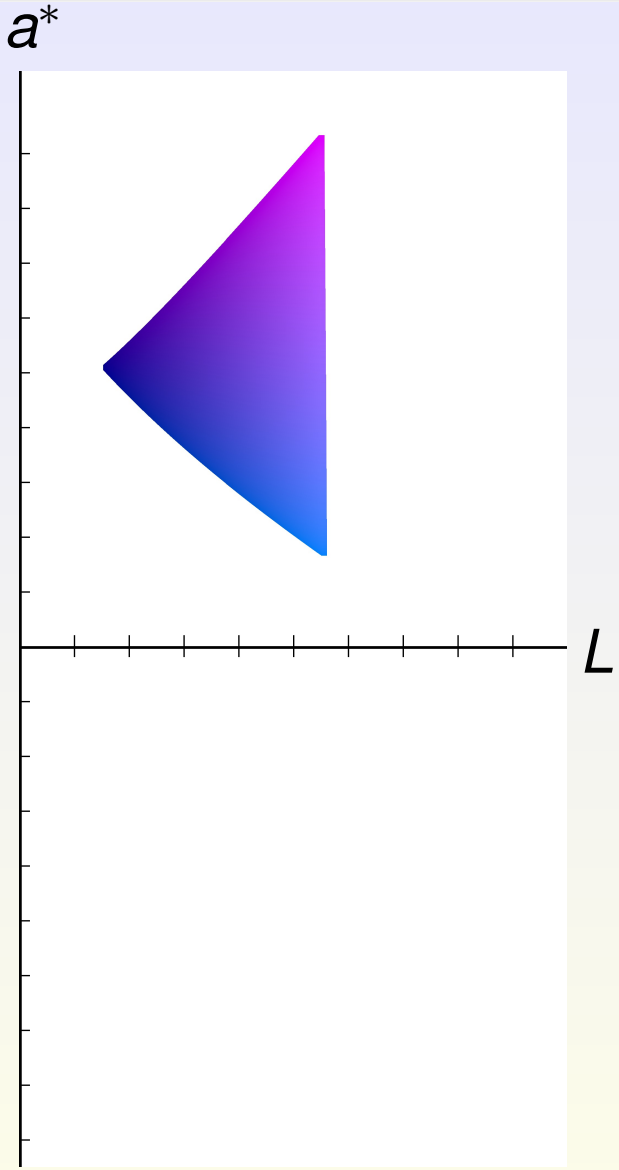
$b^* = -78$

CIE La*b* Color Space



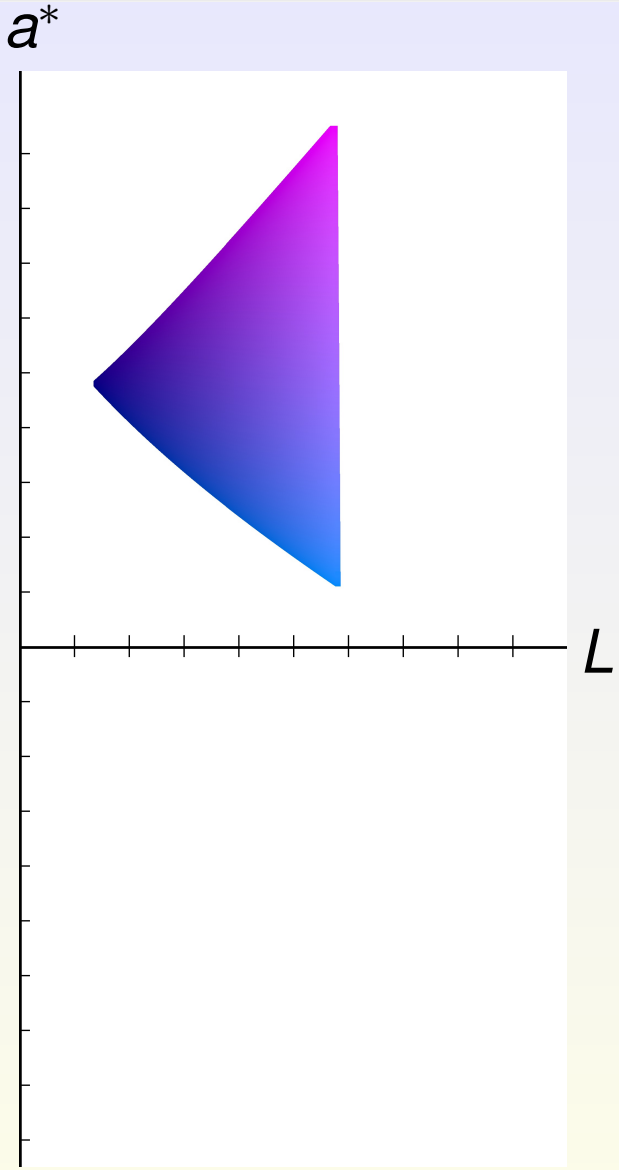
$b^* = -74$

CIE La*b* Color Space



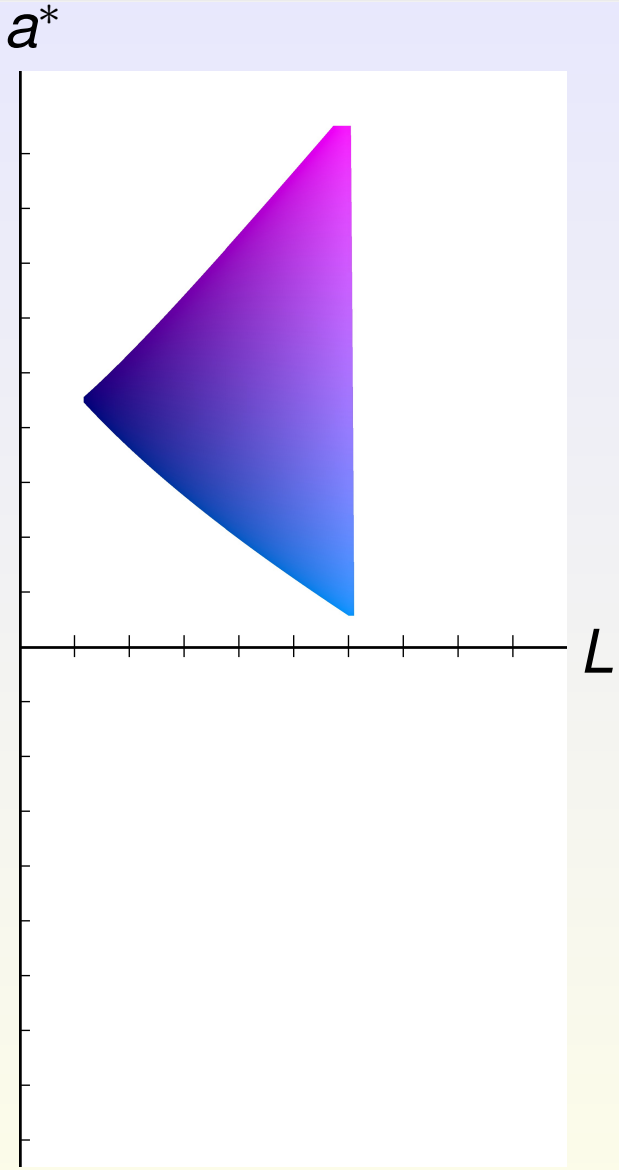
$b^* = -70$

CIE La*b* Color Space



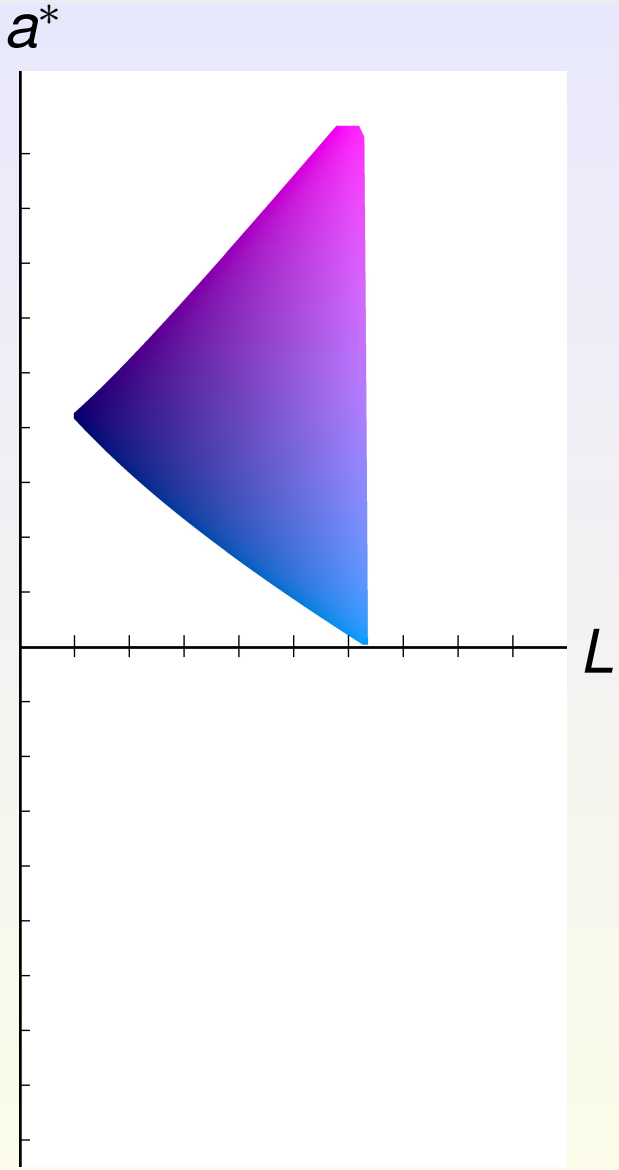
$b^* = -66$

CIE La*b* Color Space



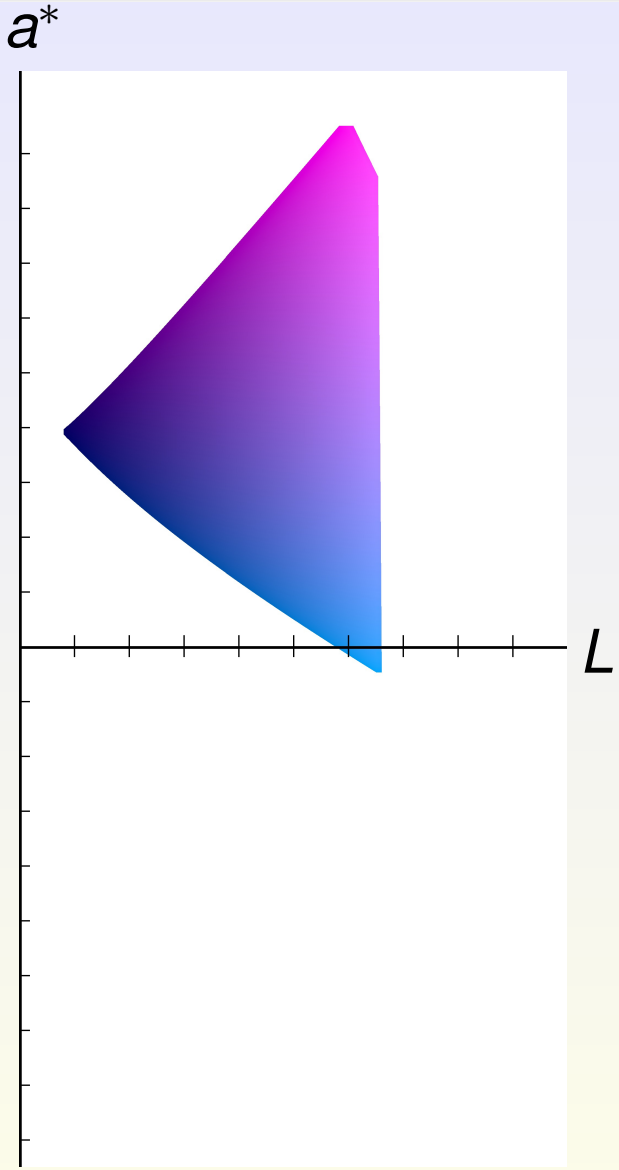
$b^* = -62$

CIE La*b* Color Space



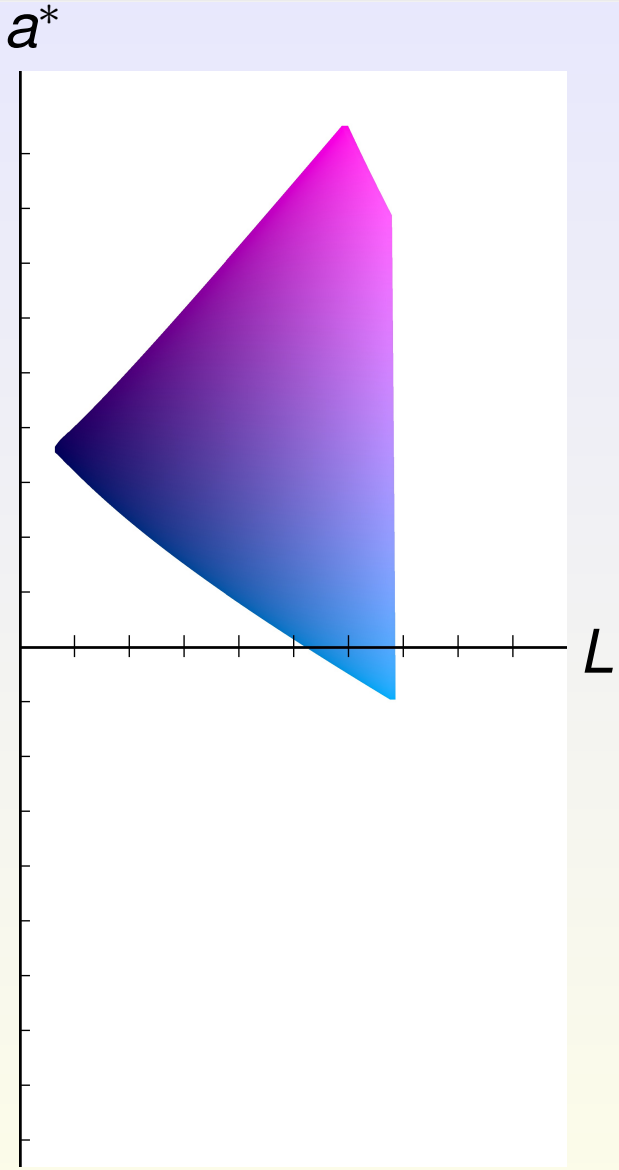
$b^* = -58$

CIE La*b* Color Space



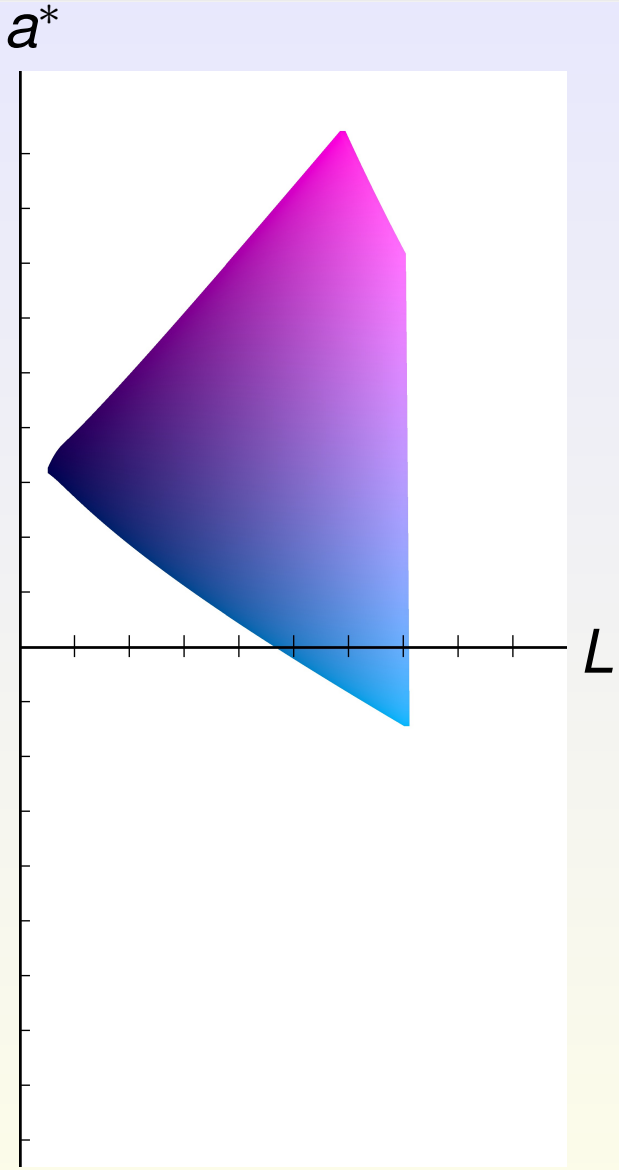
$b^* = -54$

CIE La*b* Color Space



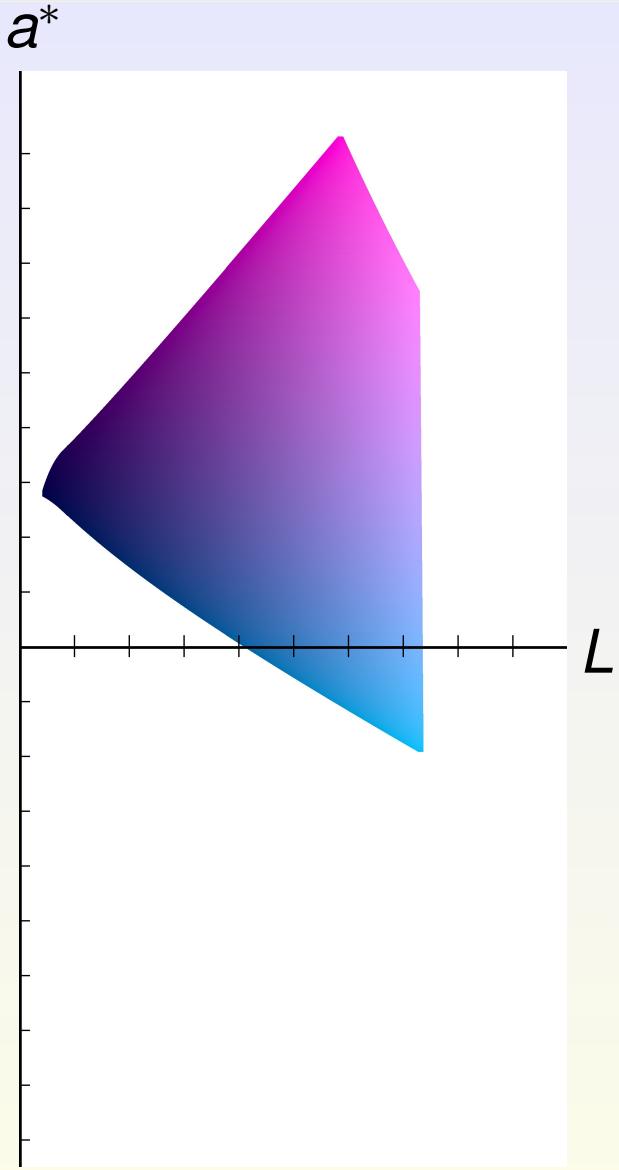
$b^* = -50$

CIE La*b* Color Space



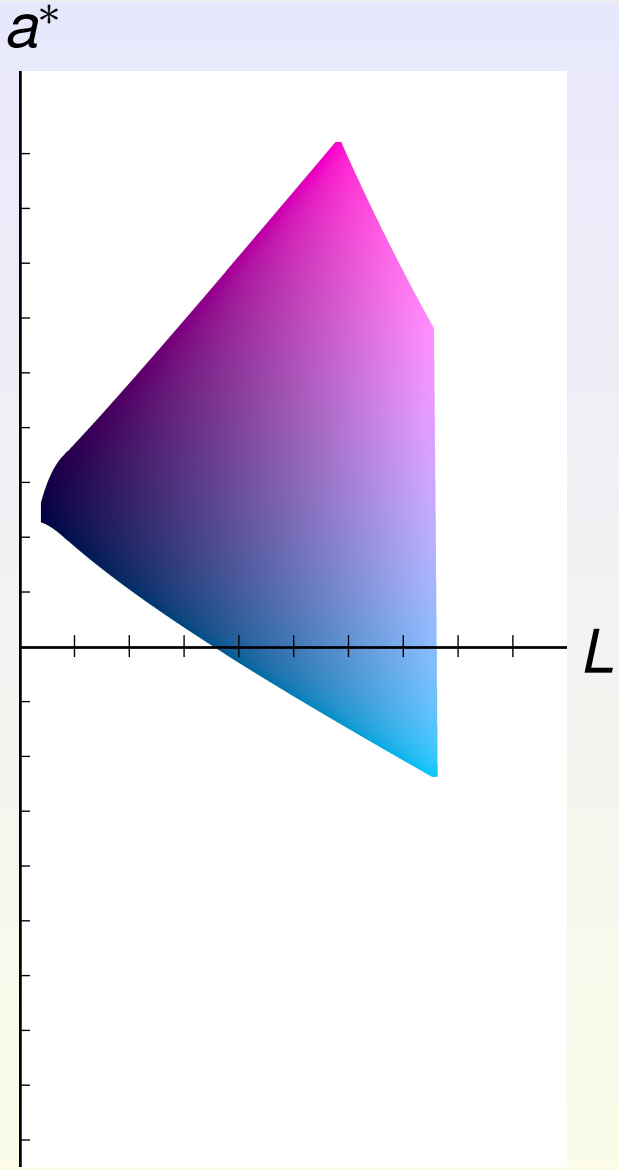
$b^* = -46$

CIE La*b* Color Space



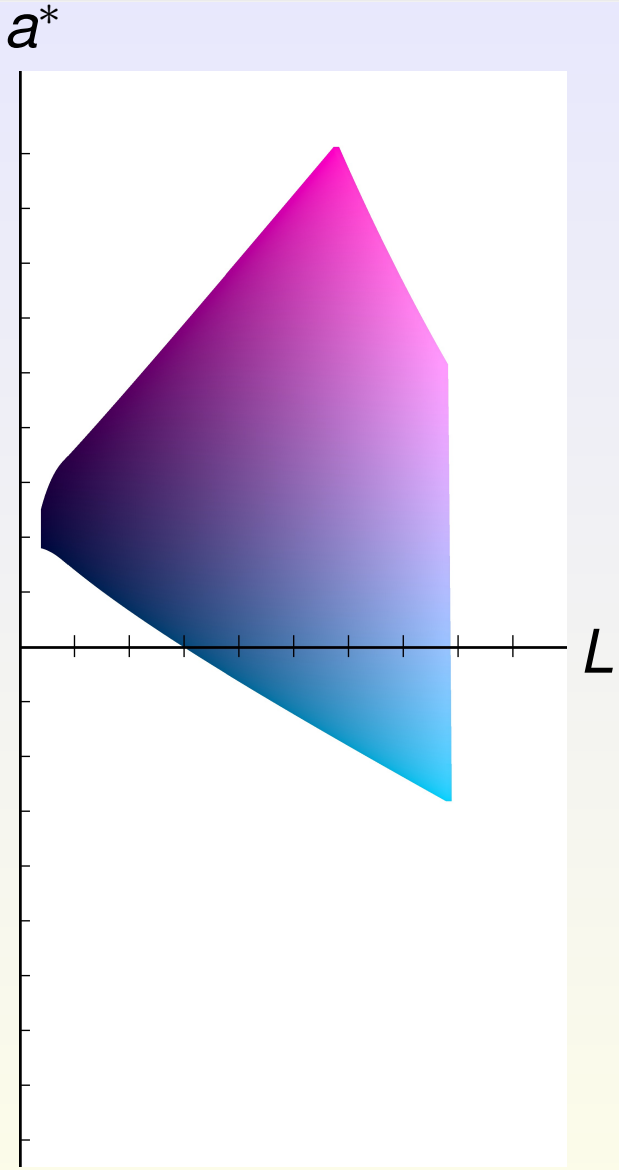
$b^* = -42$

CIE La*b* Color Space



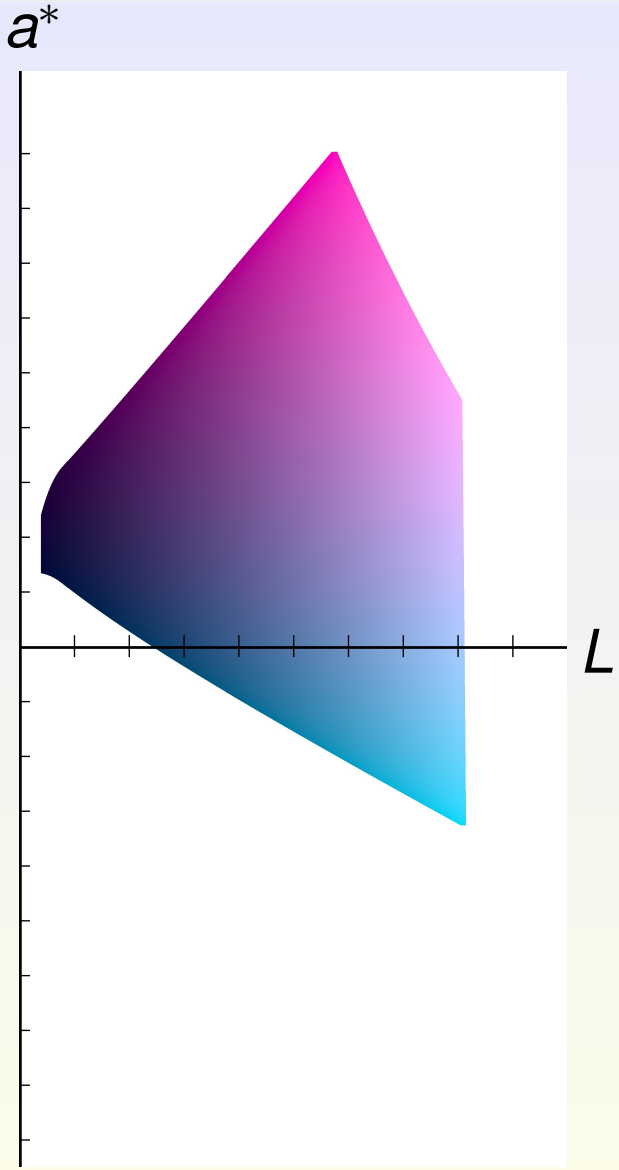
$b^* = -38$

CIE La*b* Color Space



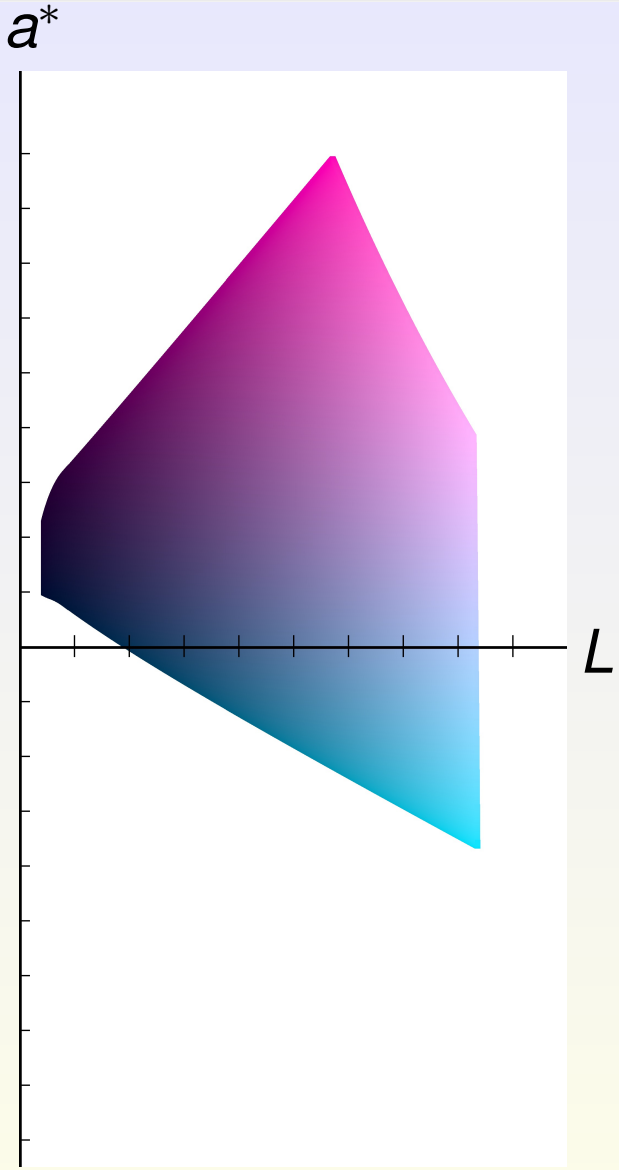
$b^* = -34$

CIE La*b* Color Space



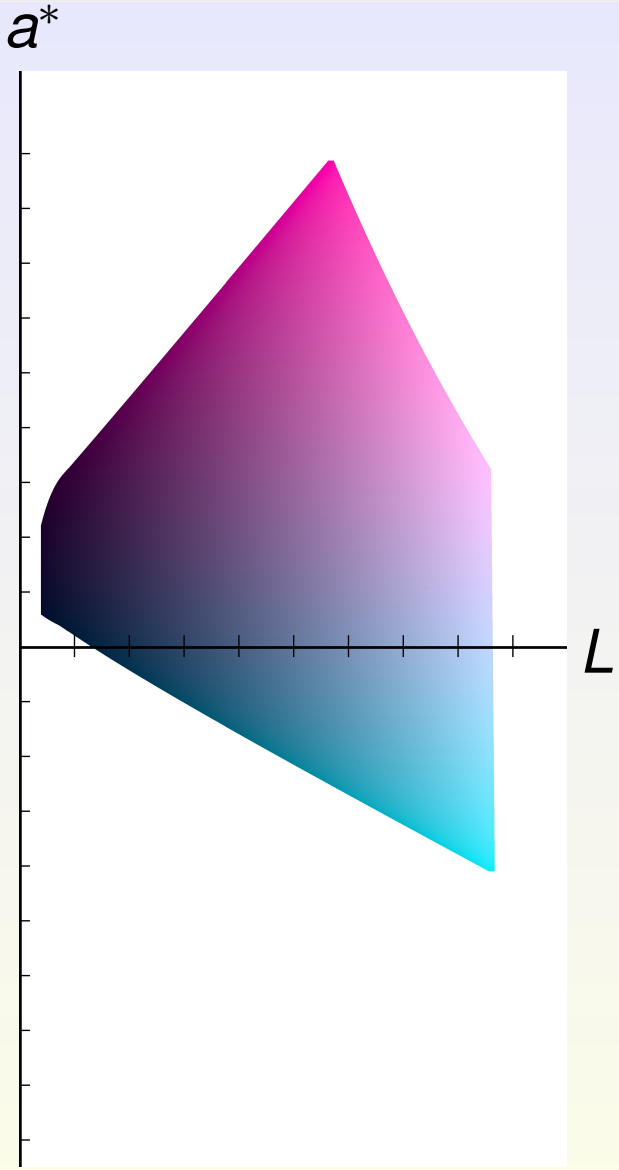
$b^* = -30$

CIE La*b* Color Space



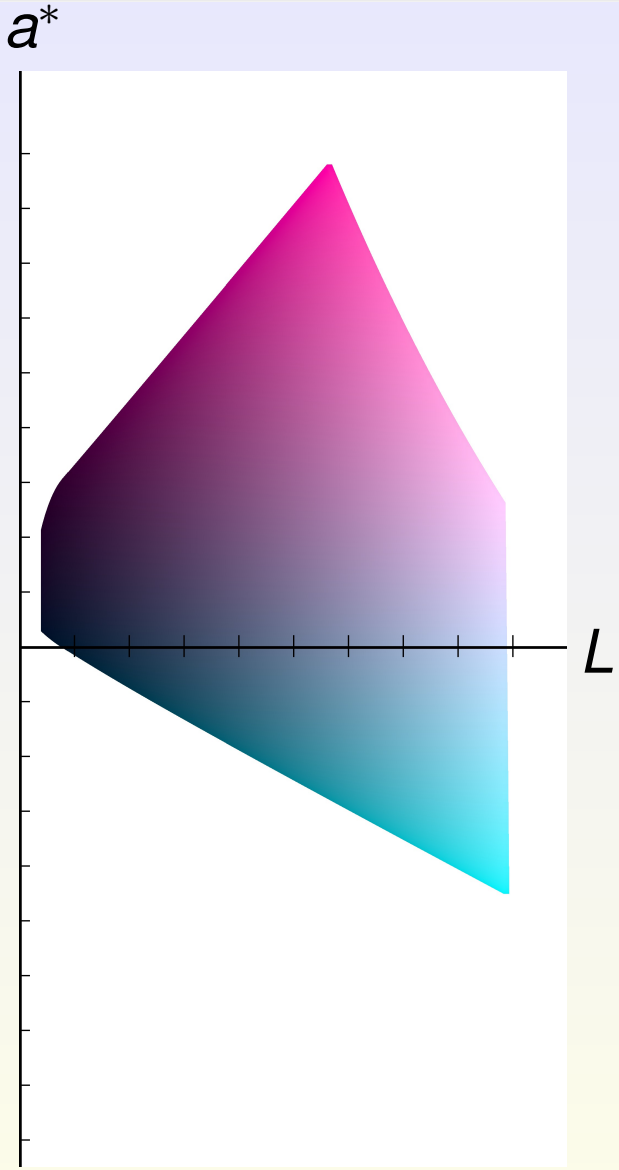
$b^* = -26$

CIE La*b* Color Space



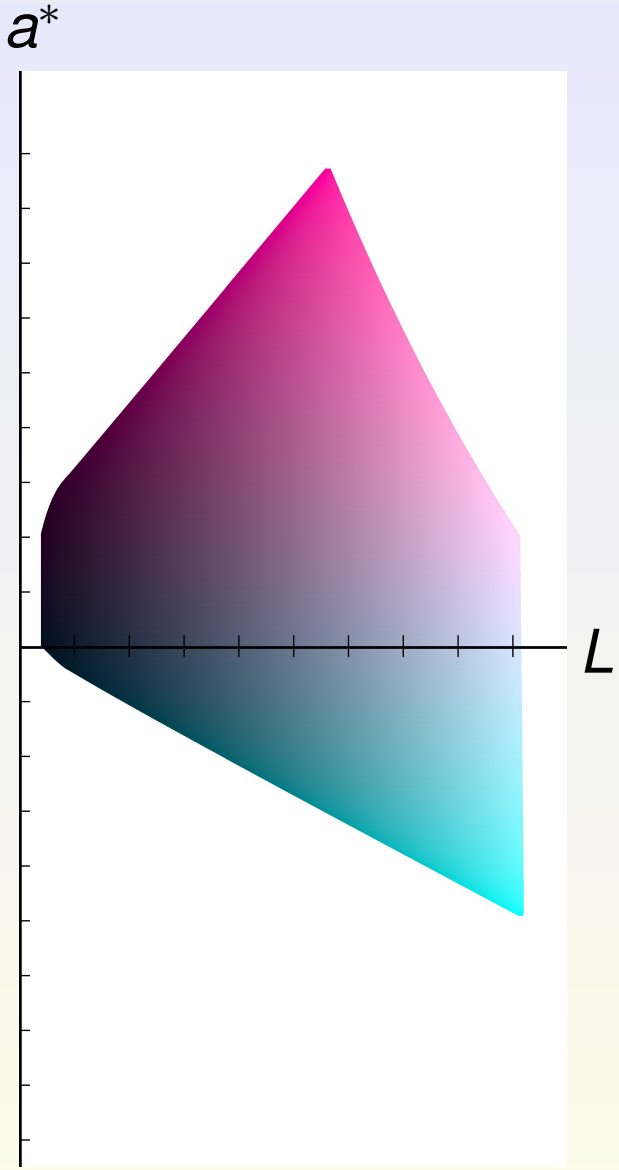
$b^* = -22$

CIE La*b* Color Space



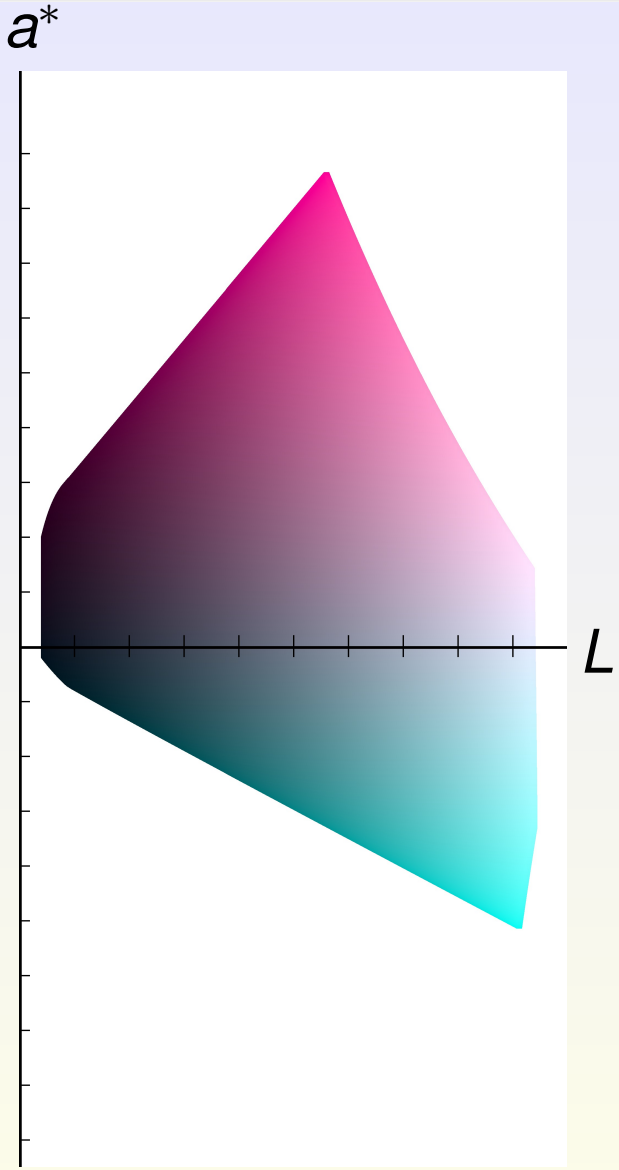
$b^* = -18$

CIE La*b* Color Space



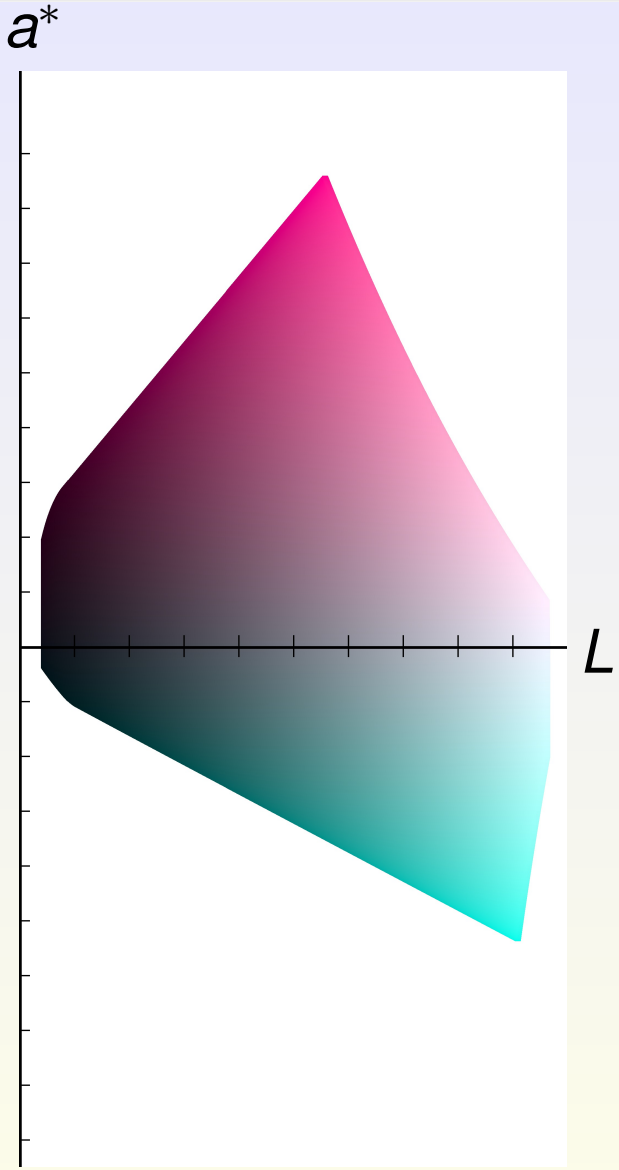
$b^* = -14$

CIE La*b* Color Space



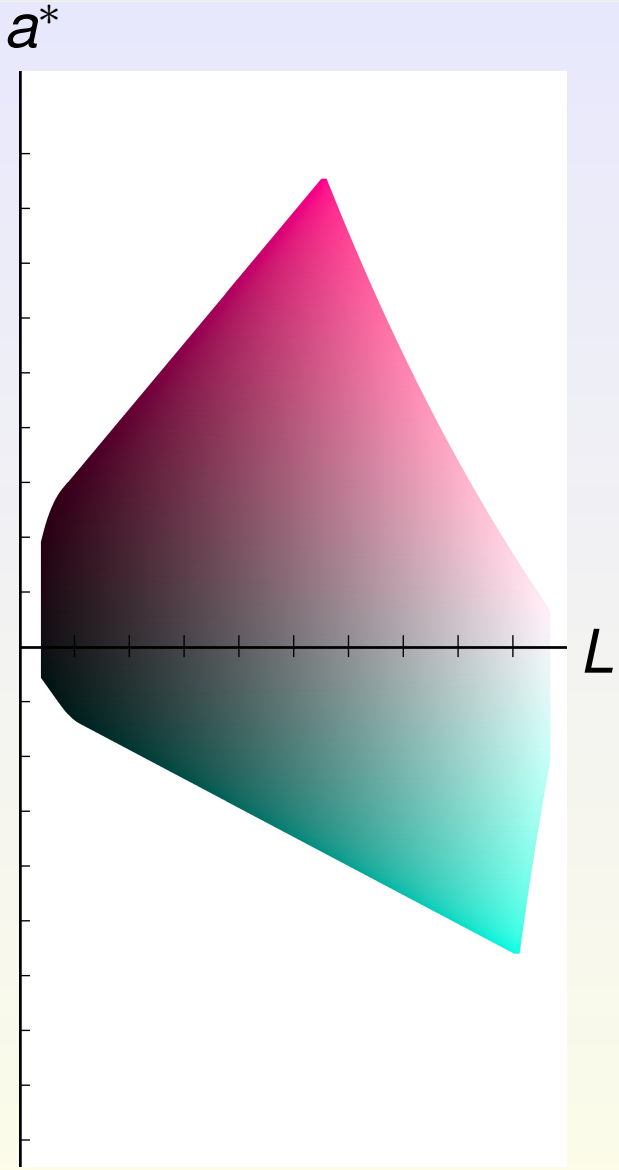
$b^* = -10$

CIE La*b* Color Space



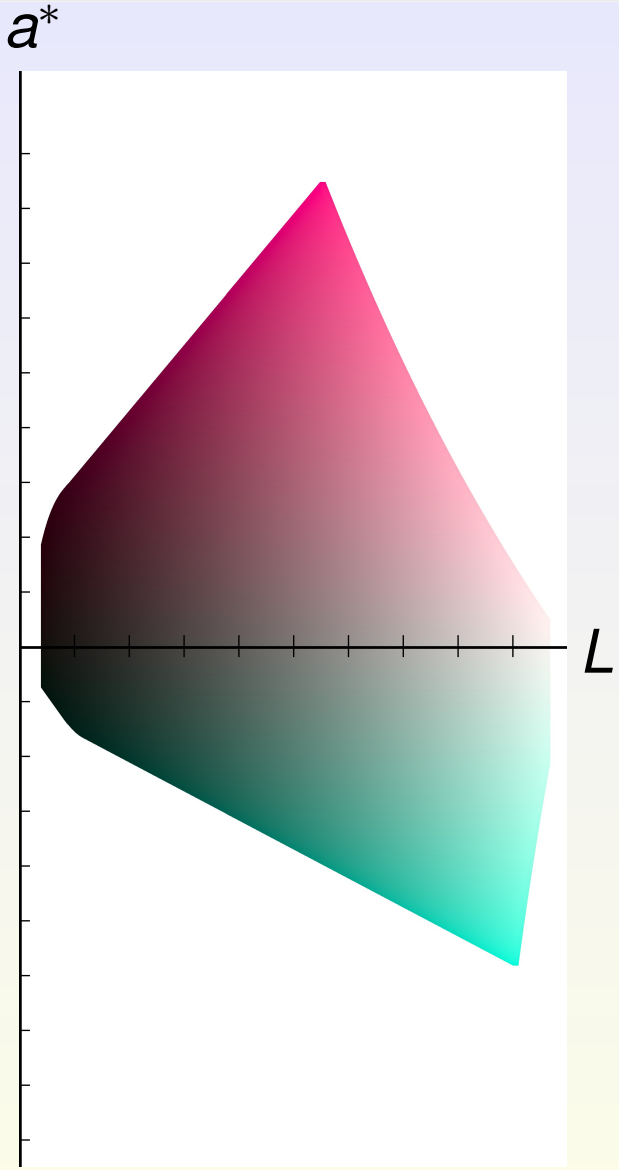
$b^* = -6$

CIE La*b* Color Space



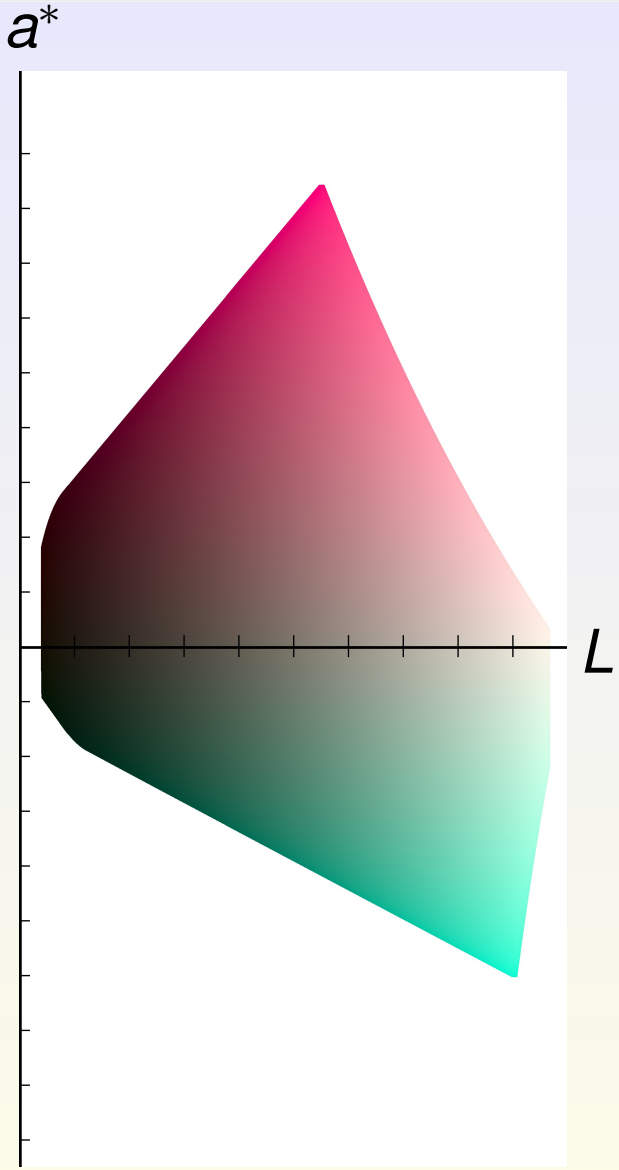
$b^* = -2$

CIE La*b* Color Space



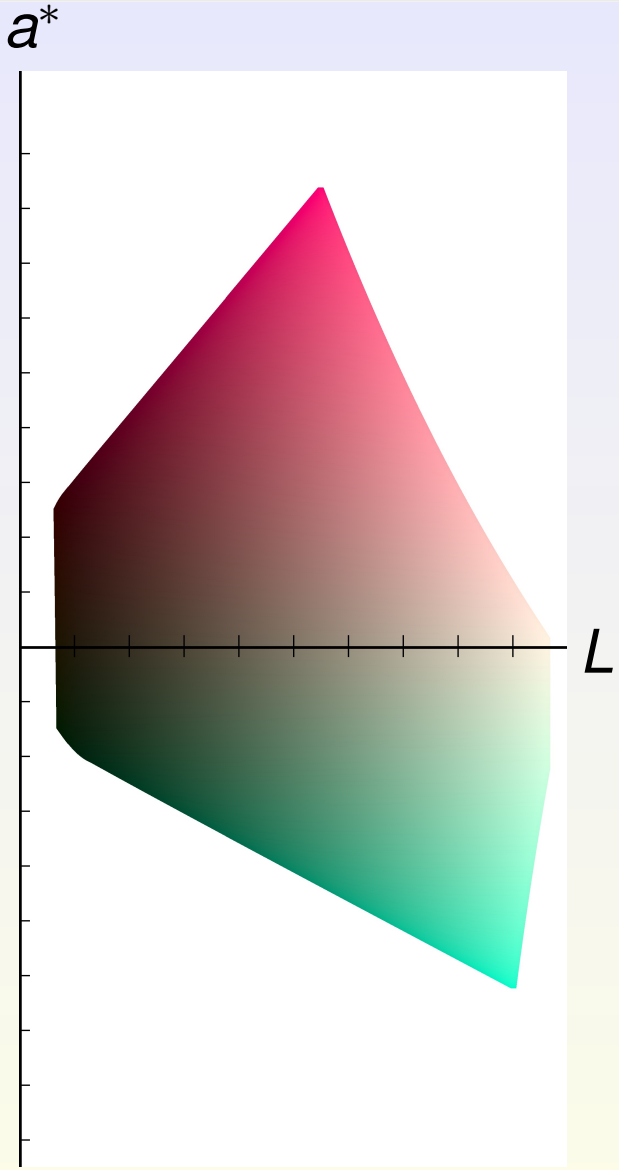
$b^* = 2$

CIE La*b* Color Space



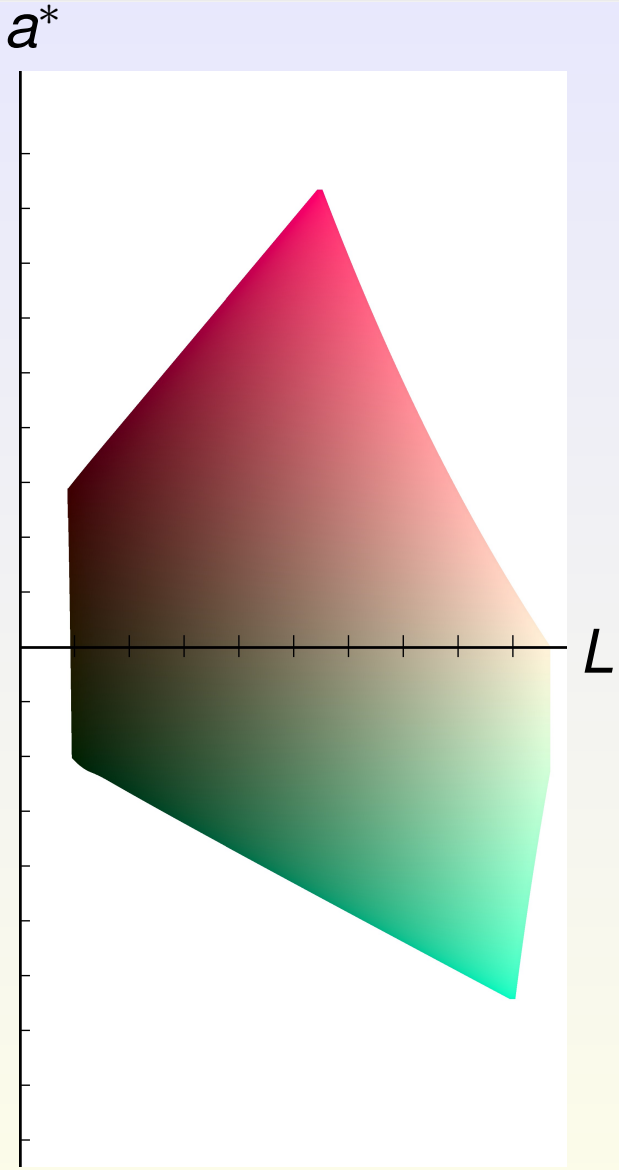
$b^* = 6$

CIE La*b* Color Space



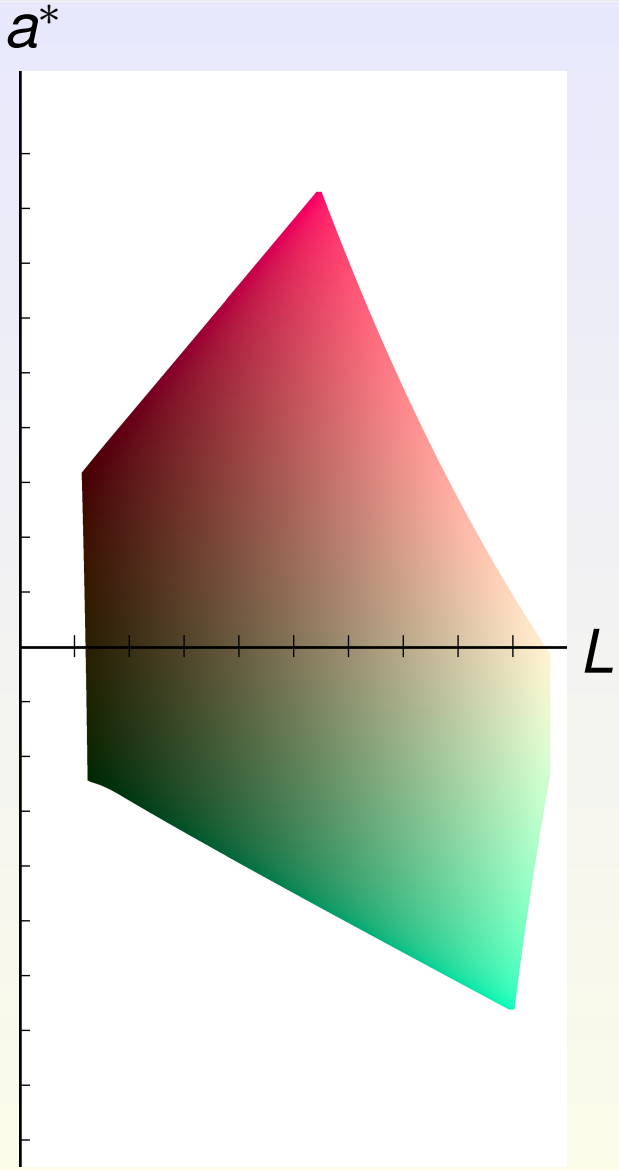
$b^* = 10$

CIE La*b* Color Space



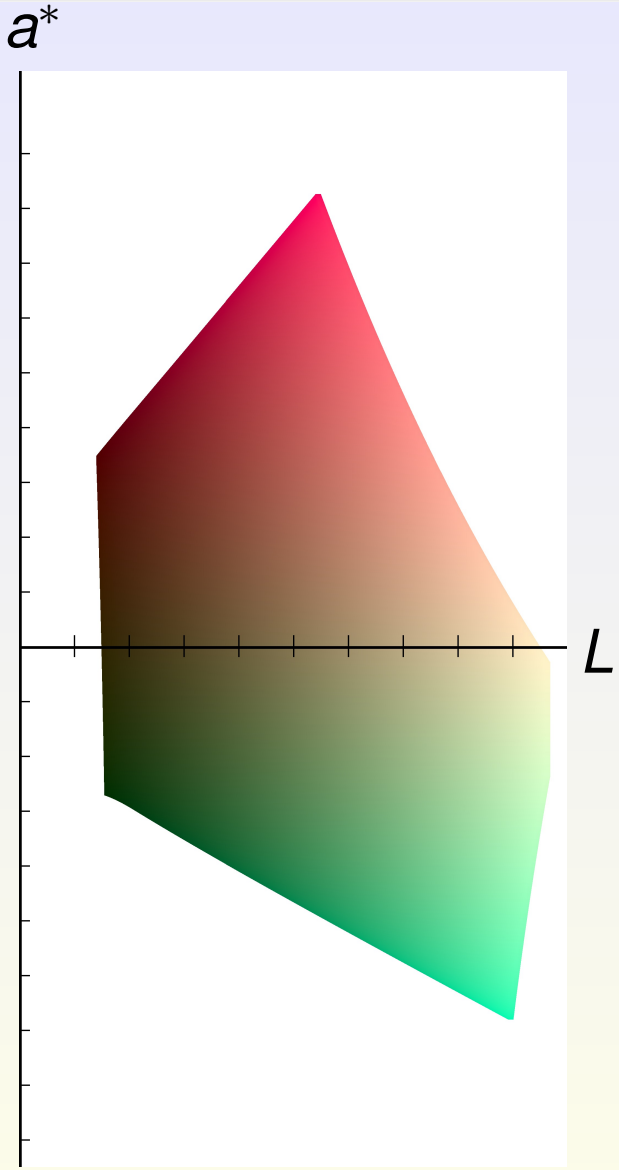
$b^* = 14$

CIE La*b* Color Space



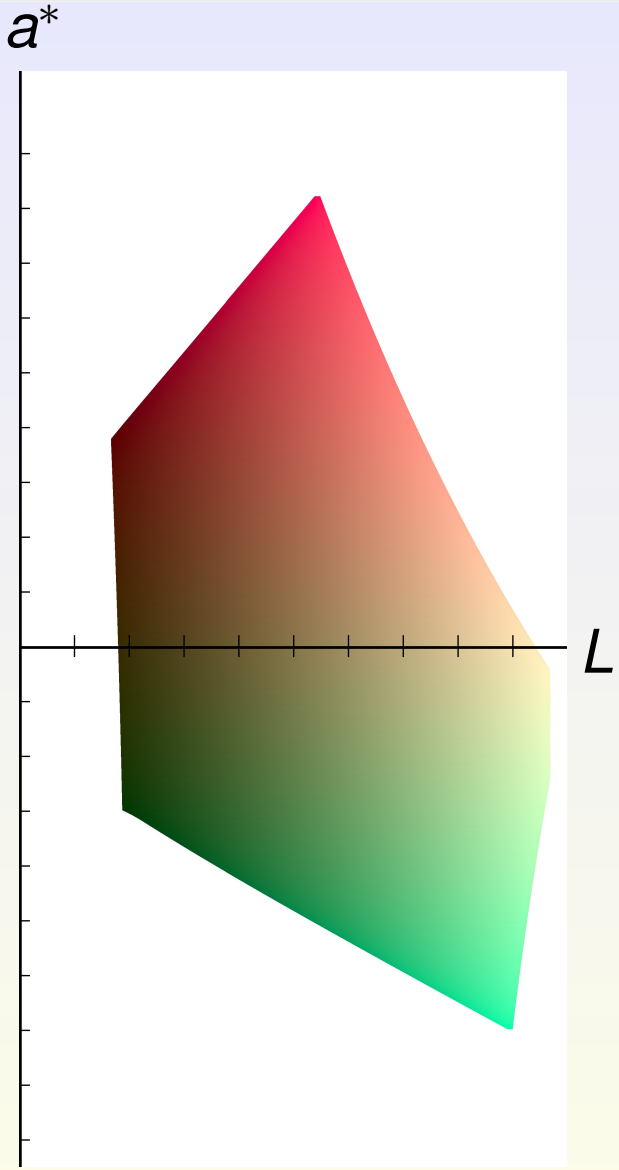
$b^* = 18$

CIE La*b* Color Space



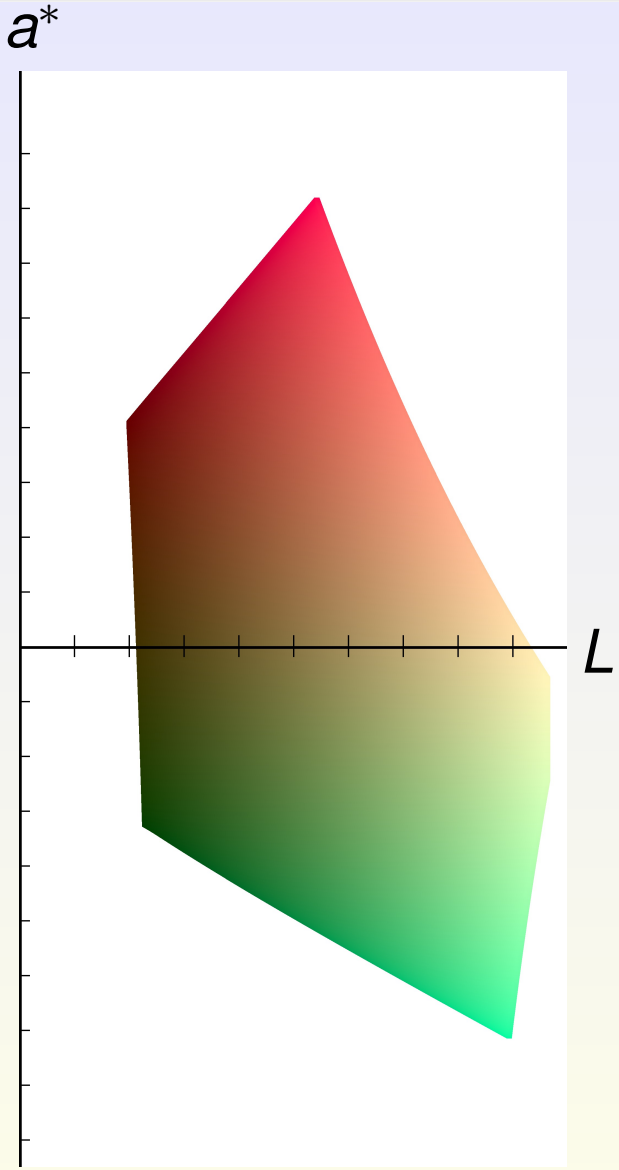
$b^* = 22$

CIE La*b* Color Space



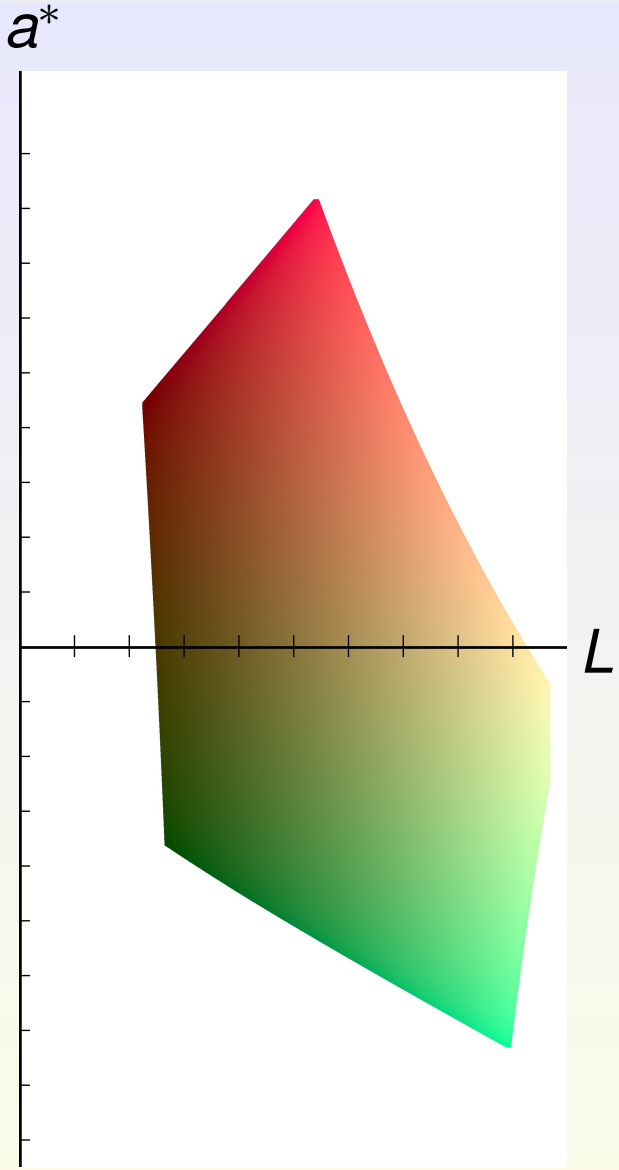
$b^* = 26$

CIE La*b* Color Space



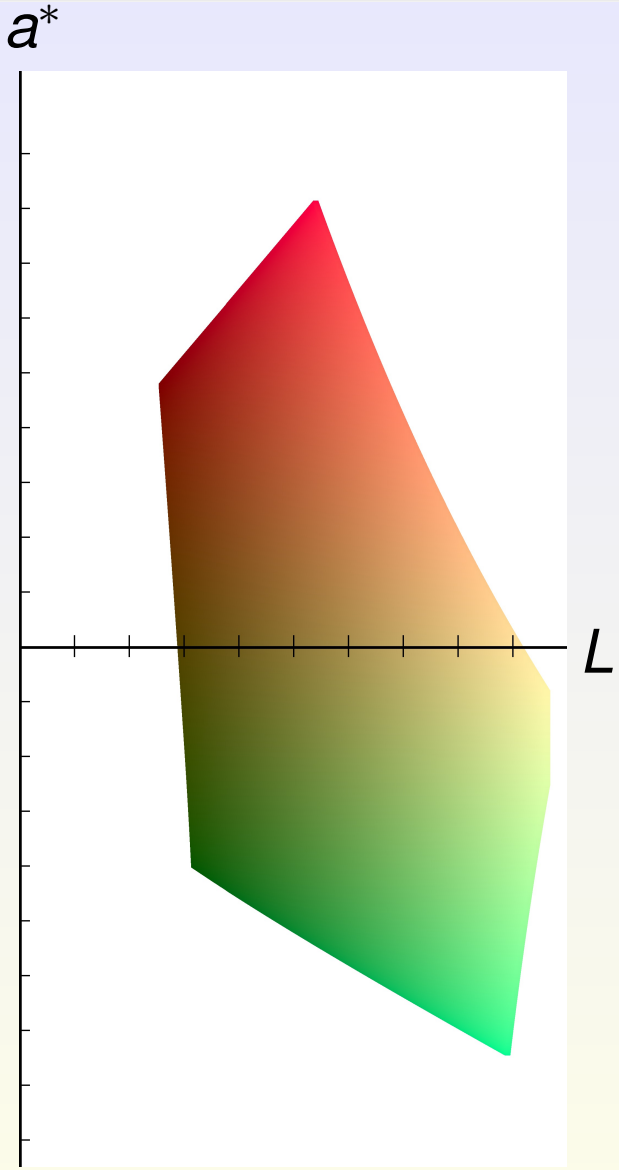
$b^* = 30$

CIE La*b* Color Space



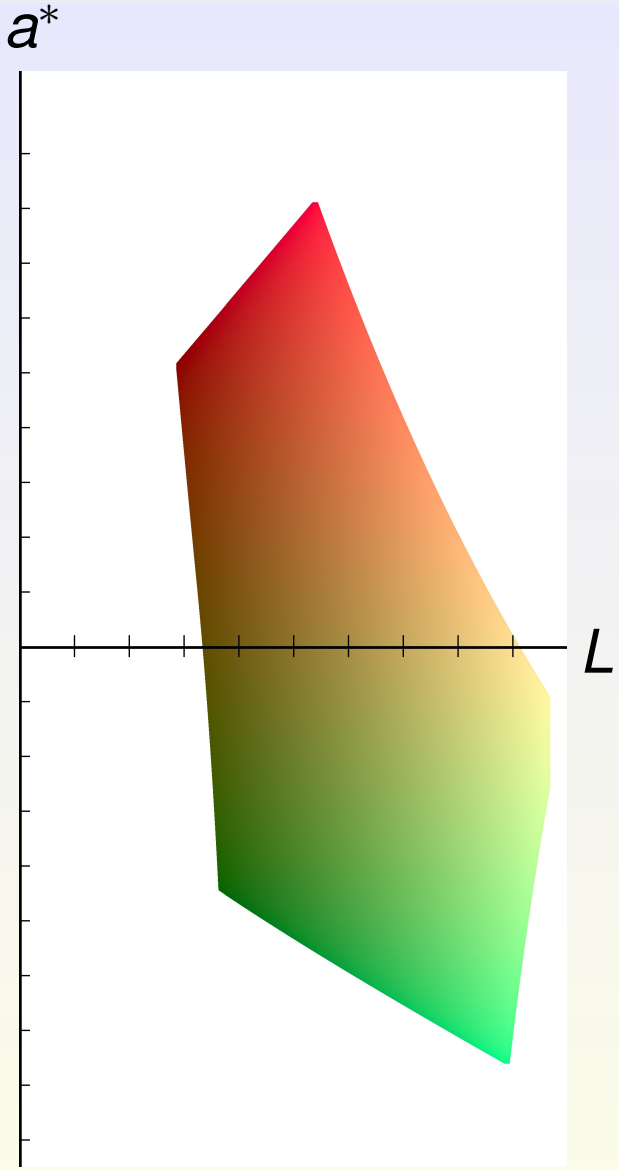
$b^* = 34$

CIE La*b* Color Space



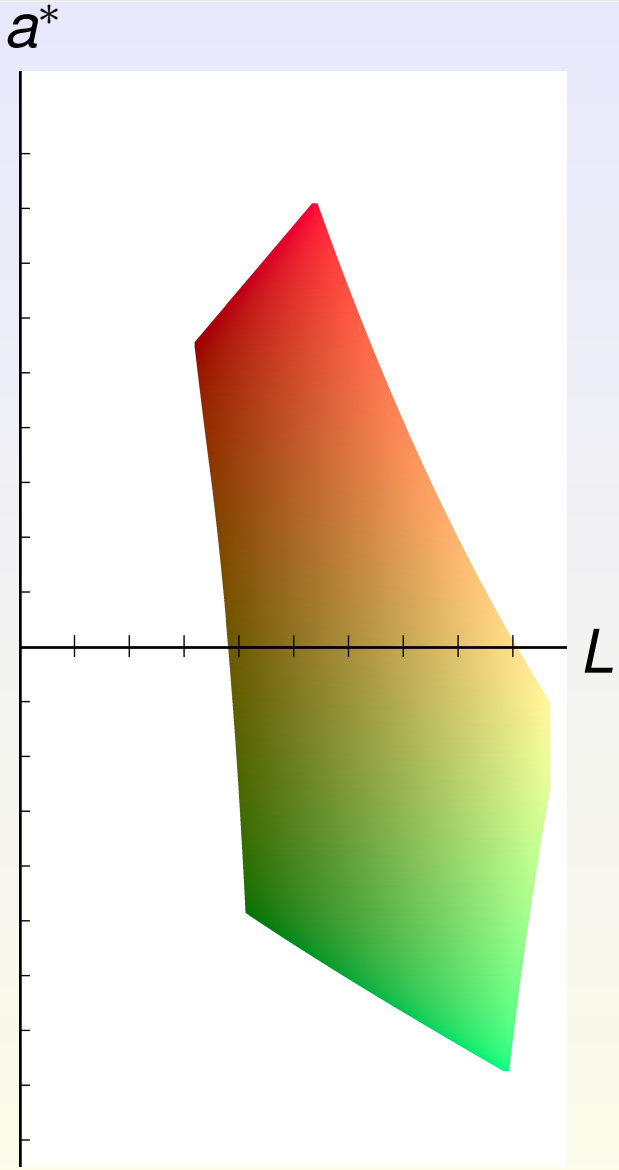
$b^* = 38$

CIE La*b* Color Space



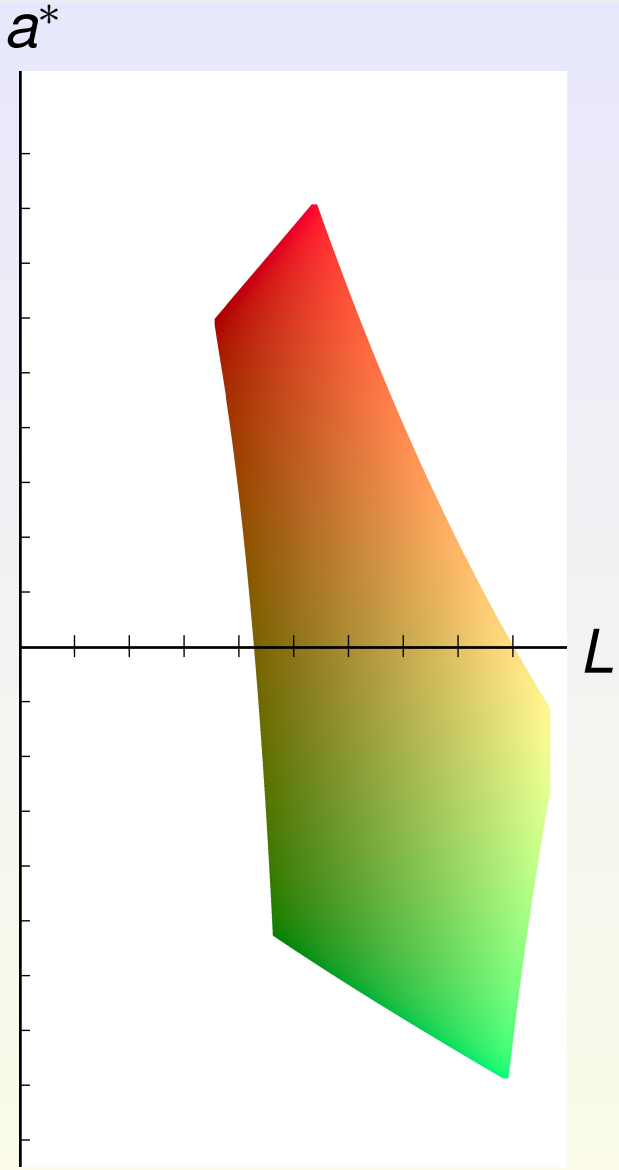
$b^* = 42$

CIE La*b* Color Space



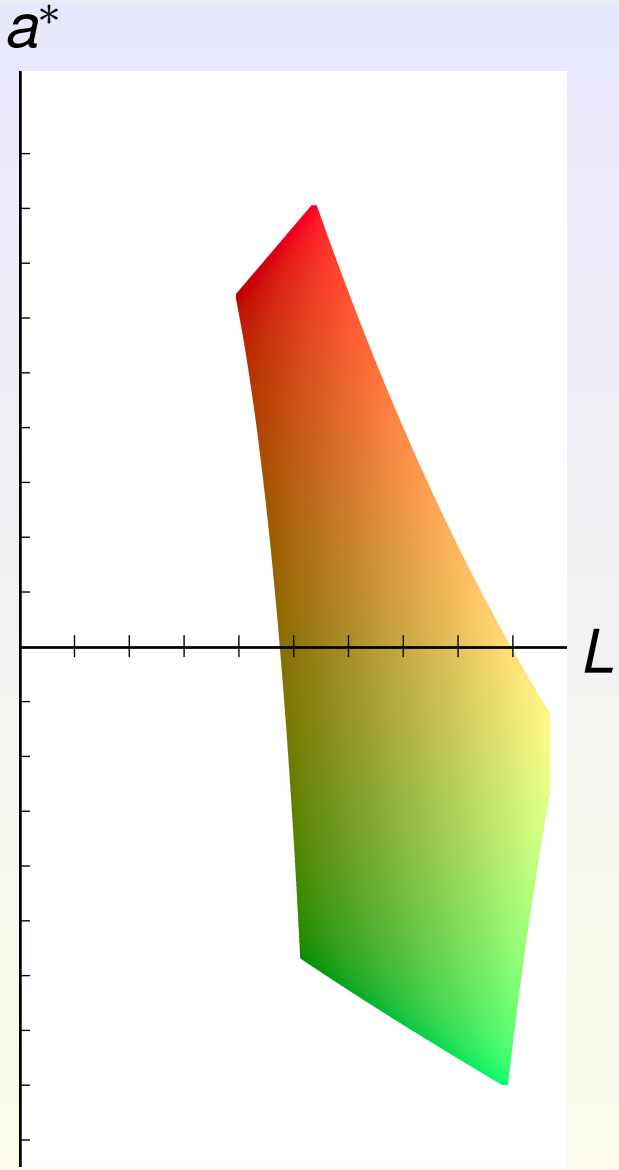
$b^* = 46$

CIE La*b* Color Space



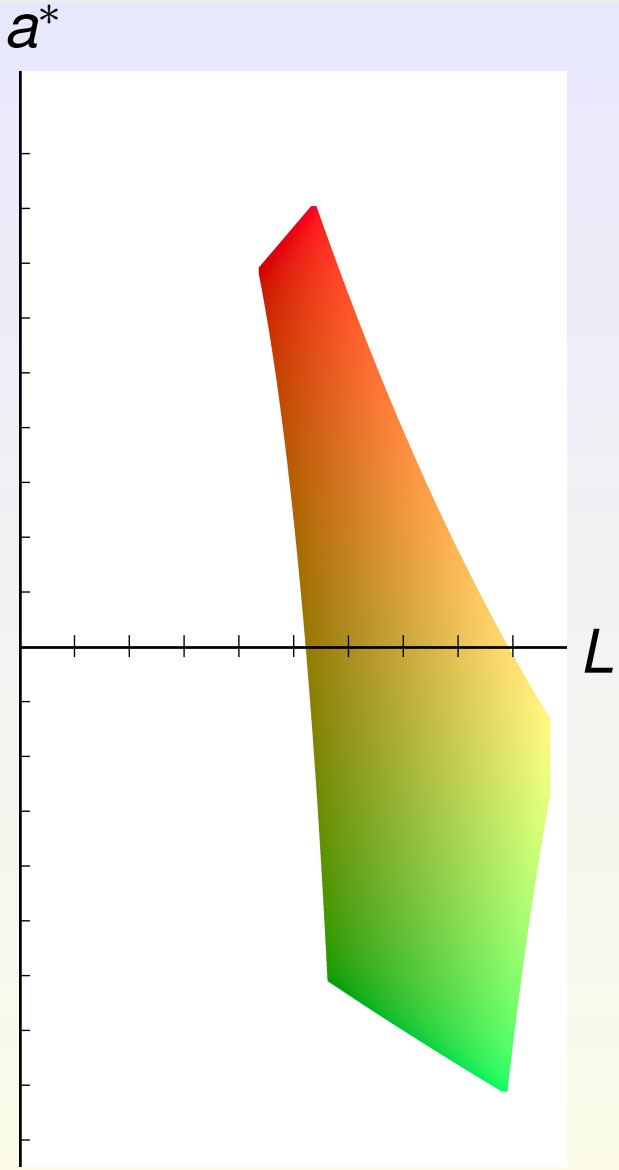
$b^* = 50$

CIE La*b* Color Space



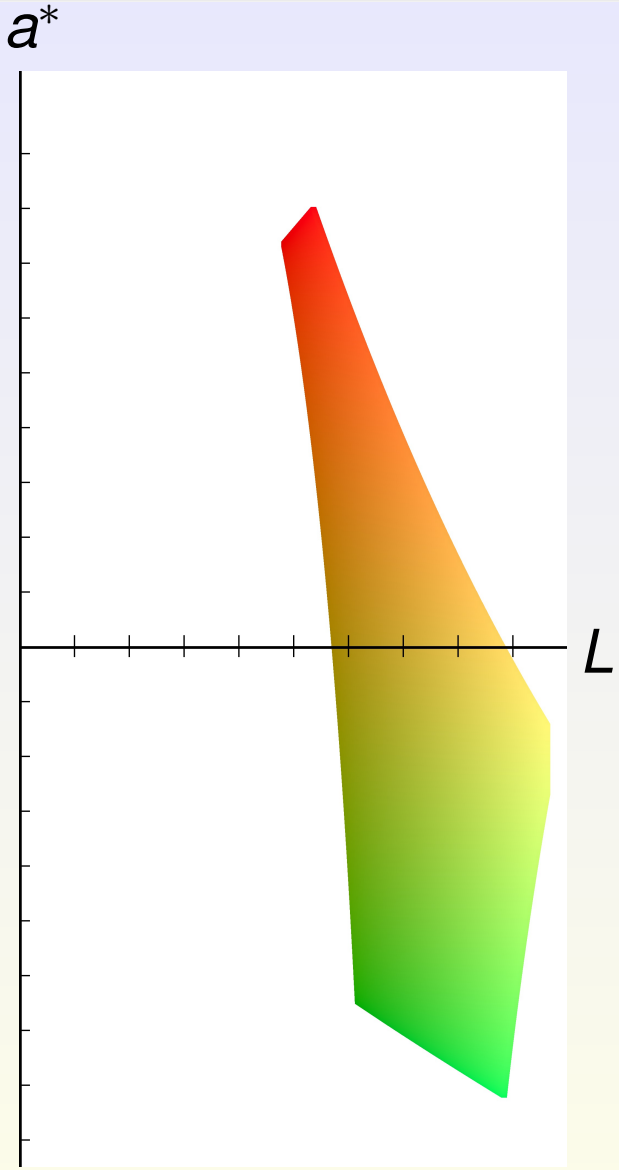
$b^* = 54$

CIE La*b* Color Space



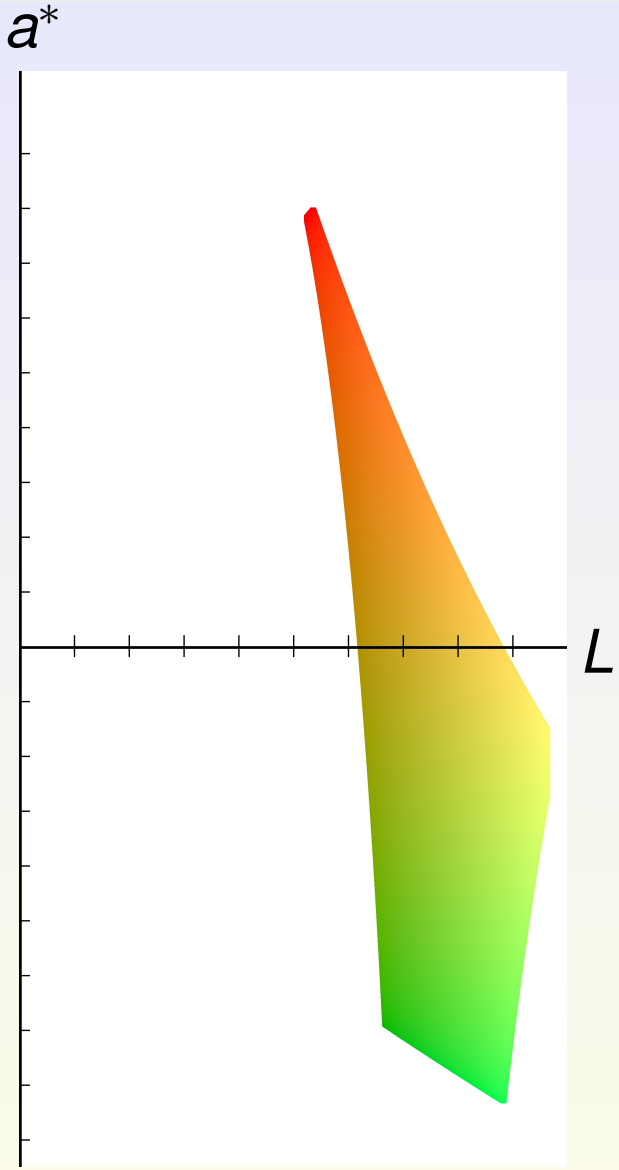
$b^* = 58$

CIE La*b* Color Space



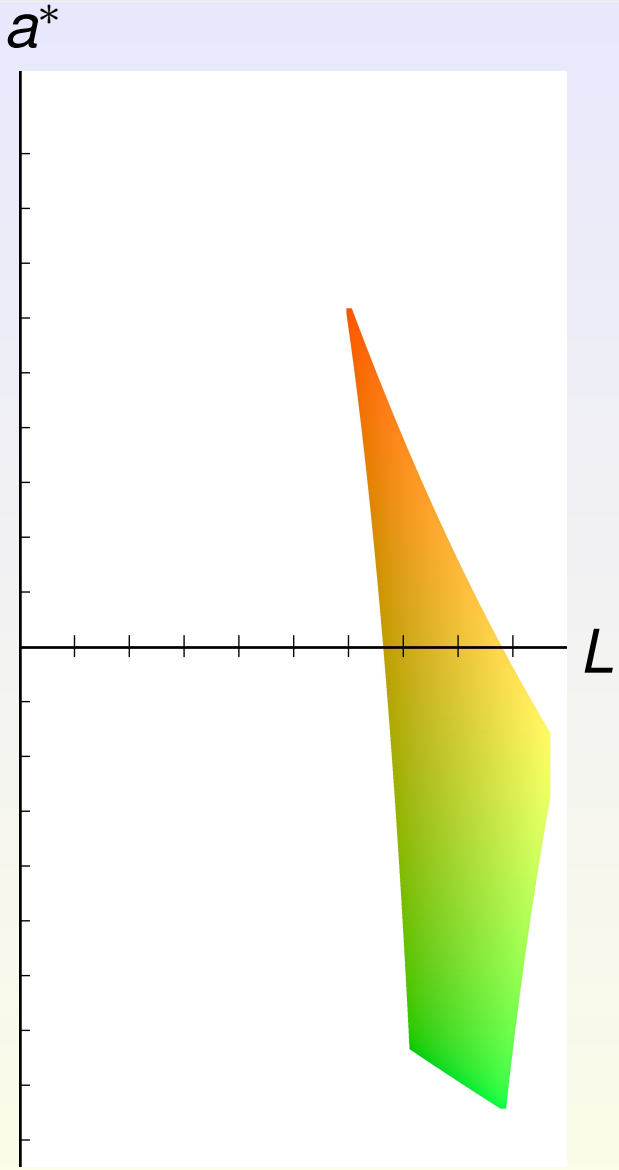
$b^* = 62$

CIE La*b* Color Space



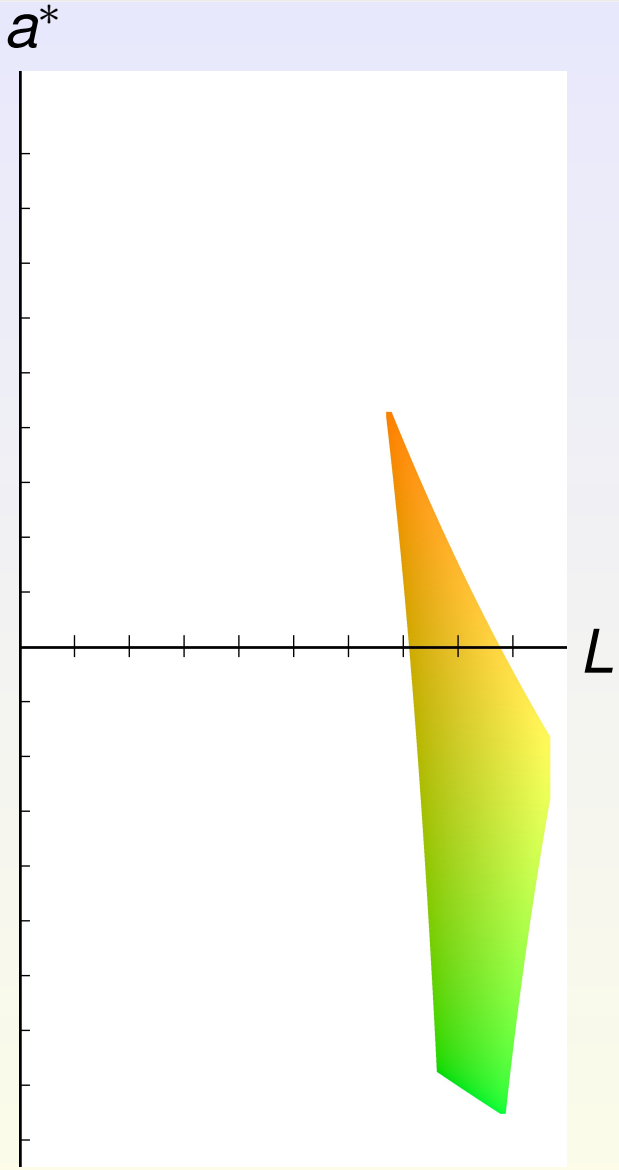
$b^* = 66$

CIE La*b* Color Space



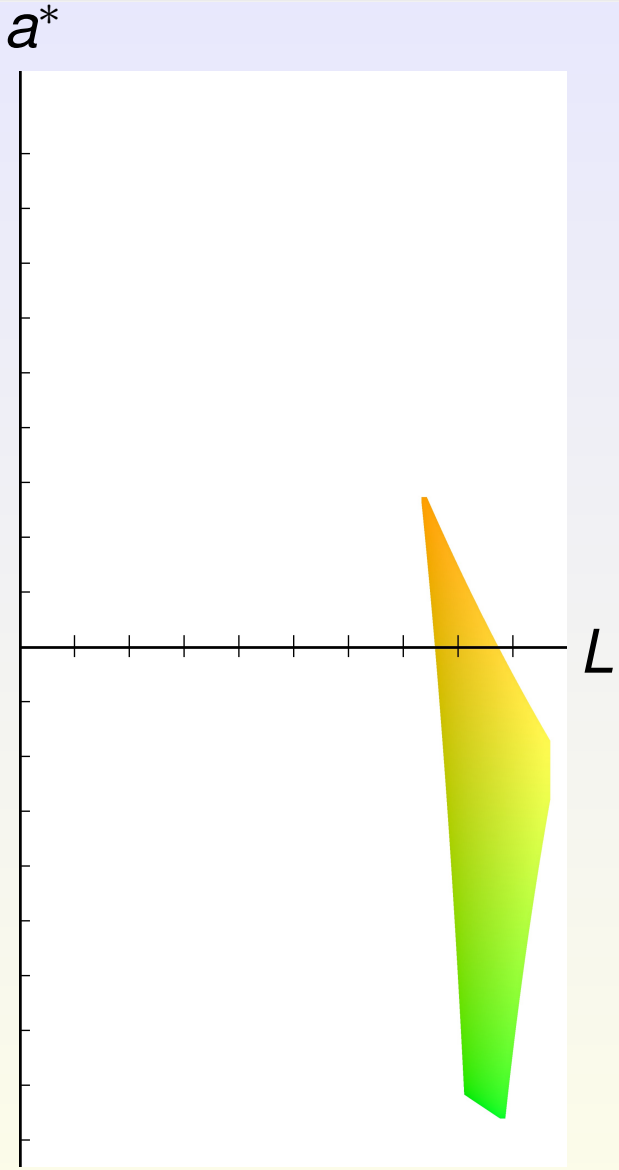
$b^* = 70$

CIE La*b* Color Space



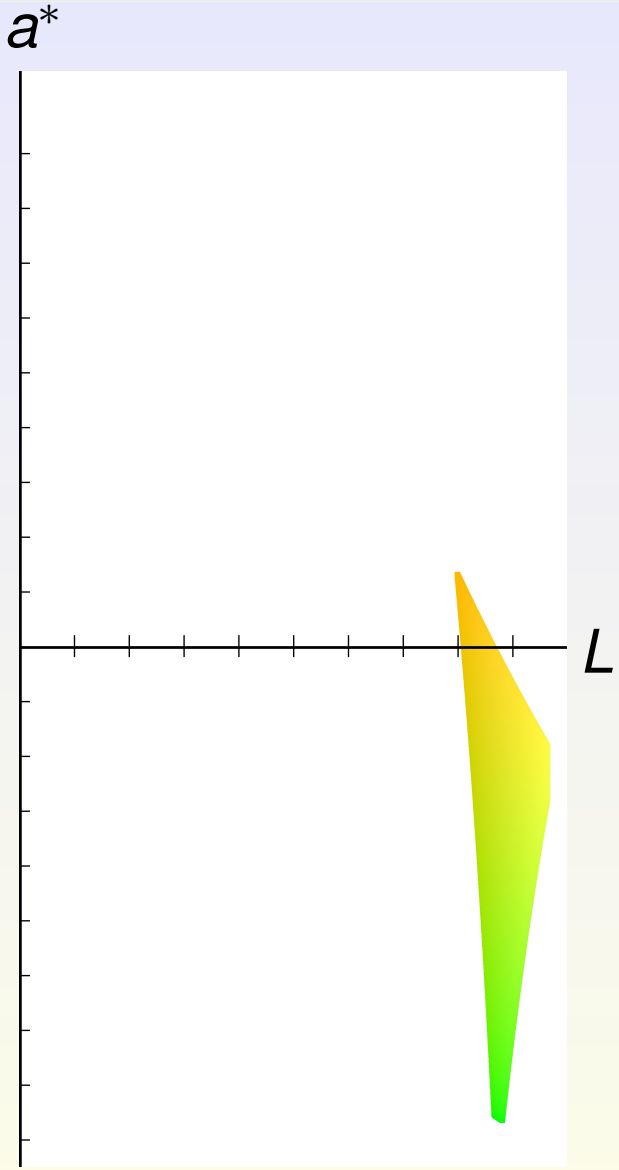
$b^* = 74$

CIE La*b* Color Space



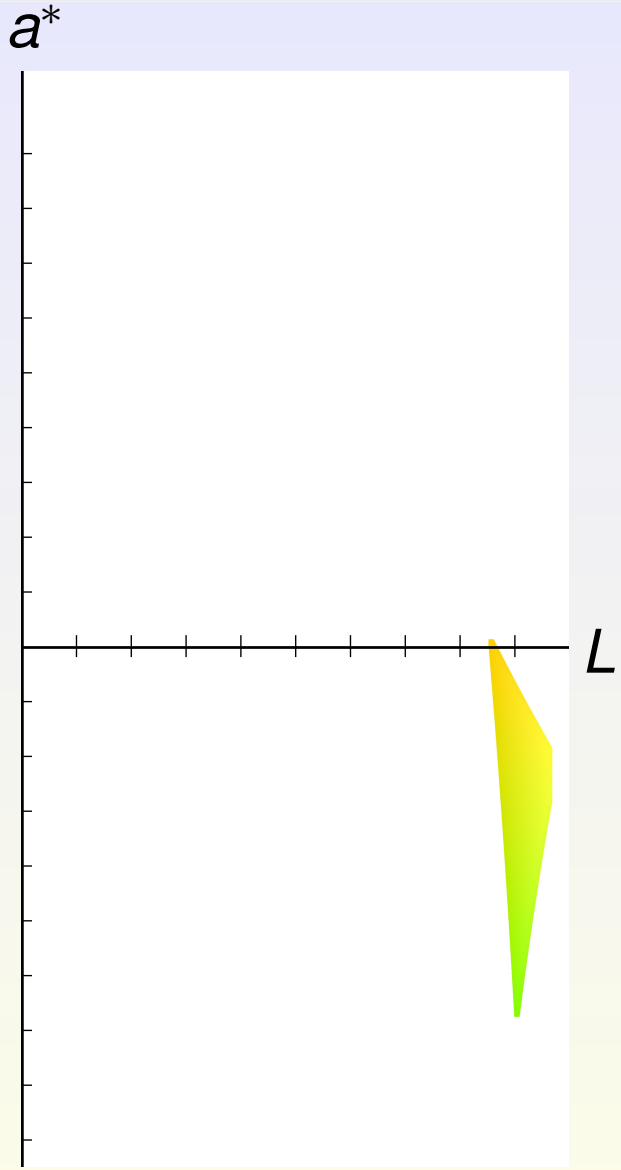
$b^* = 78$

CIE La*b* Color Space



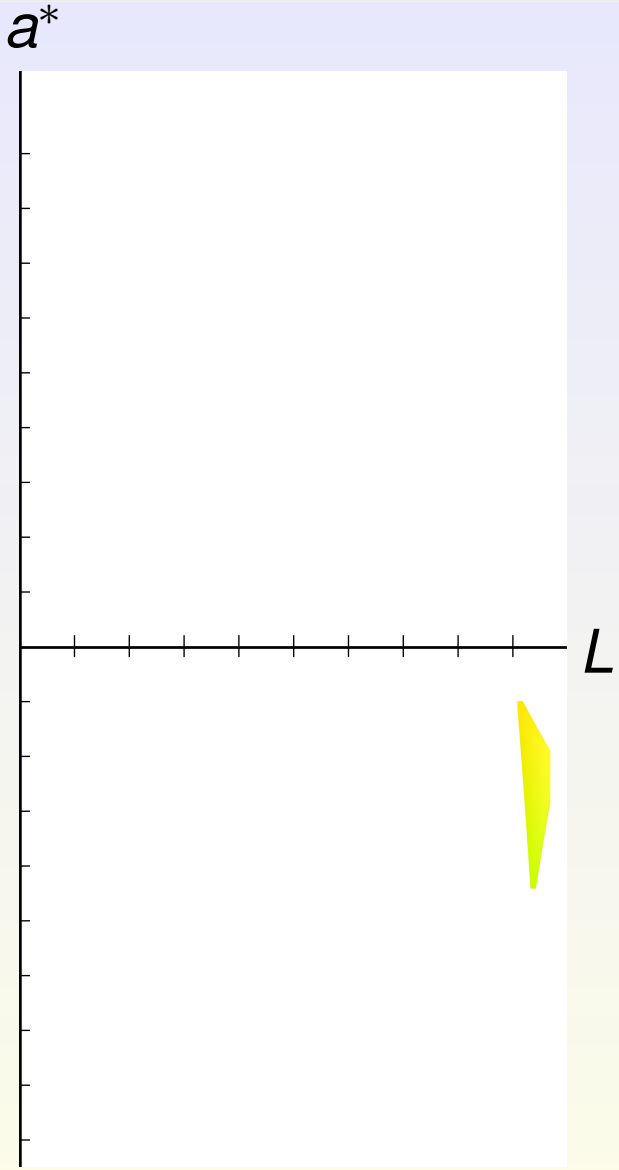
$b^* = 82$

CIE La*b* Color Space



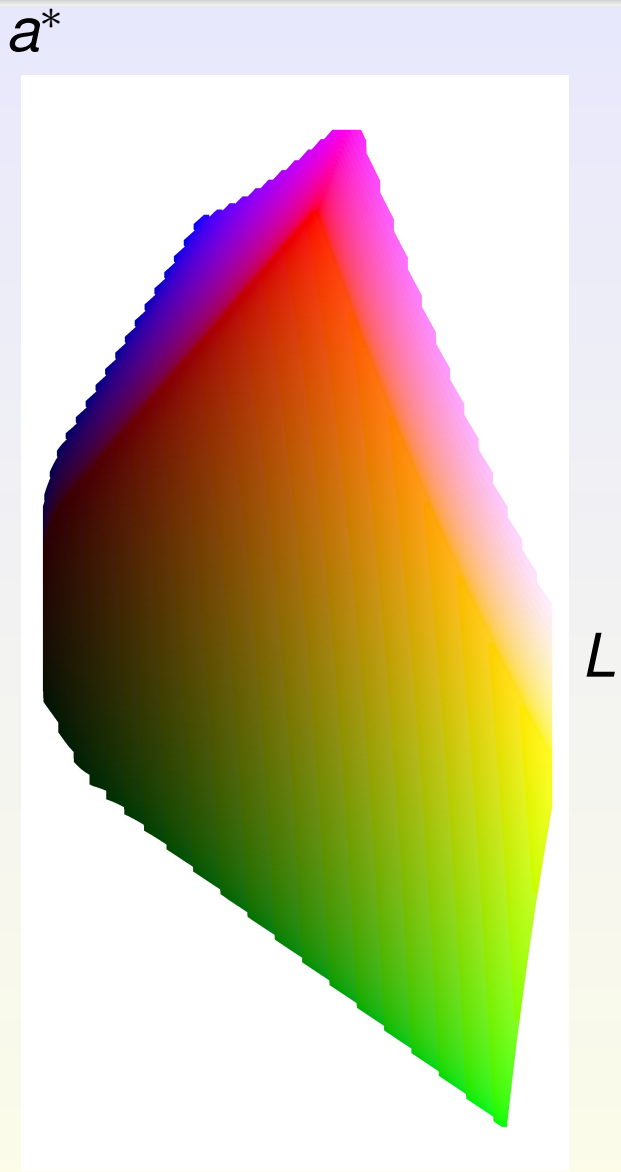
$b^* = 86$

CIE La*b* Color Space



$b^* = 90$

CIE La*b* Color Space



For a fixed (L, a^*), each point has the largest b^* that maps to that location.

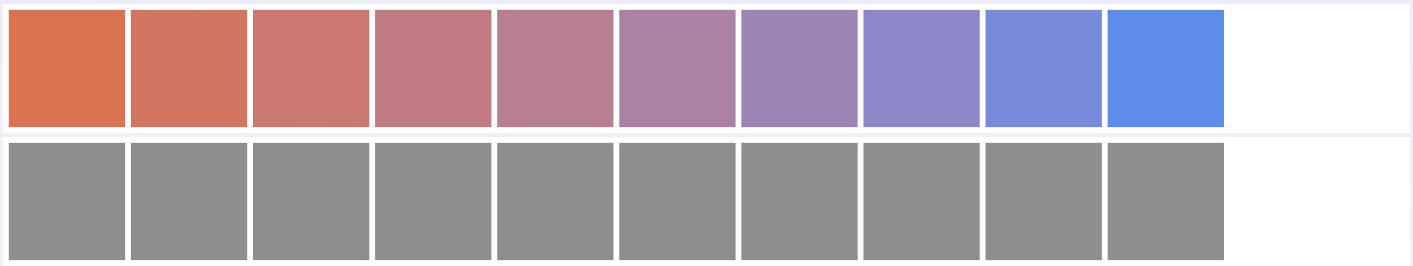
Perceptual Difference: ΔE

$$\Delta E = \sqrt{(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2}$$

If there are N colors along a line beginning with (L_1, a_1, b_1) and ending with (L_2, a_2, b_2), then the perceptual difference between successive colors is given by

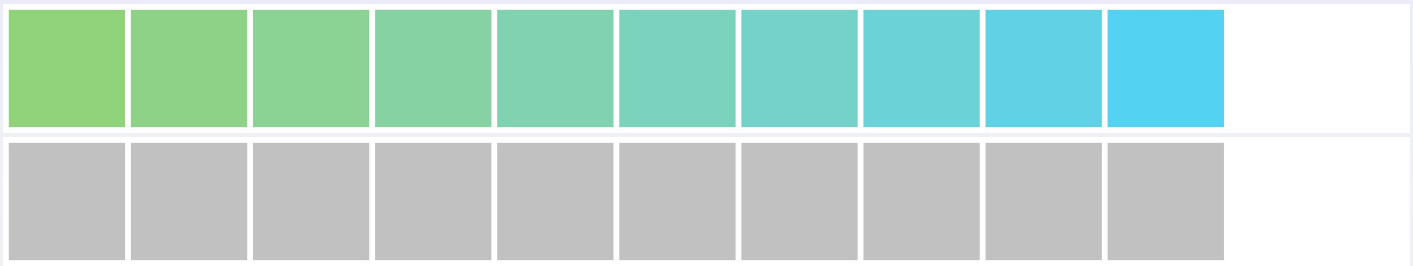
$$\Delta E = \frac{1}{N-1}\sqrt{(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2}$$

Constant Luminance Palette



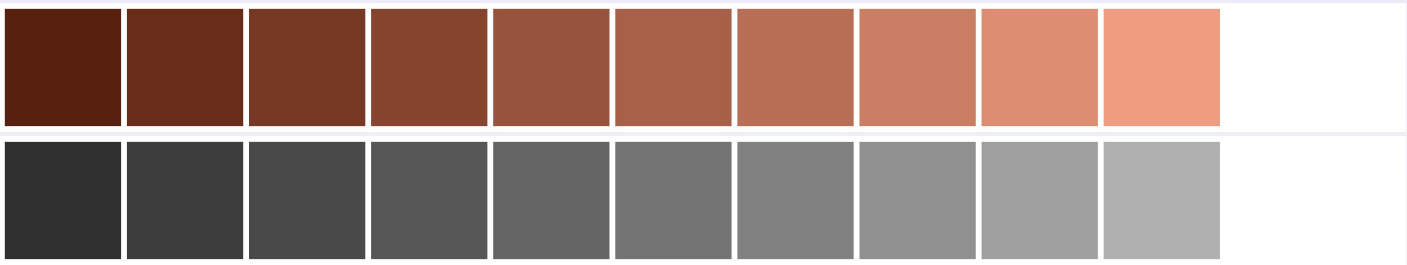
$$
\begin{aligned}
(L_1, a_1, b_1) &= (62, 35, 35) \\
(L_2, a_2, b_2) &= (62, 10, -50) \\
\Delta E &= 9.8445
\end{aligned}
$$

Constant Luminance Palette



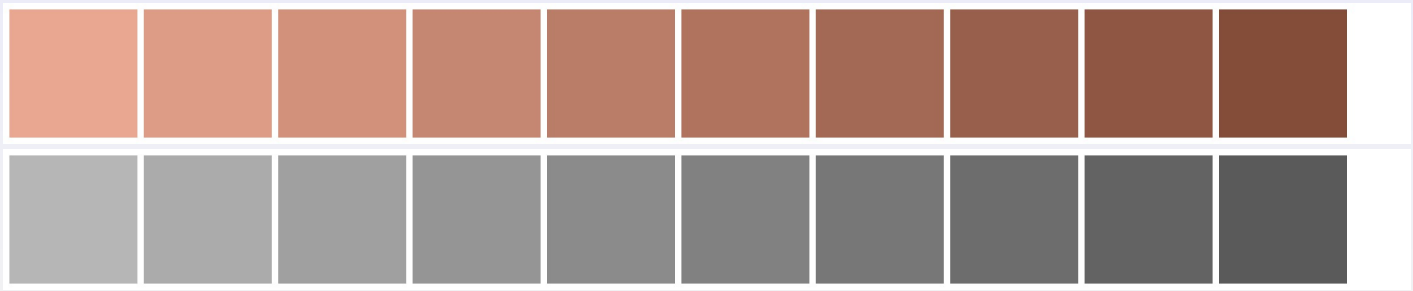
$$
\begin{aligned}
(L_1, a_1, b_1) &= (80, -35, 35) \\
(L_2, a_2, b_2) &= (80, -25, -25) \\
\Delta E &= 6.7586
\end{aligned}
$$

Constant Hue Palette



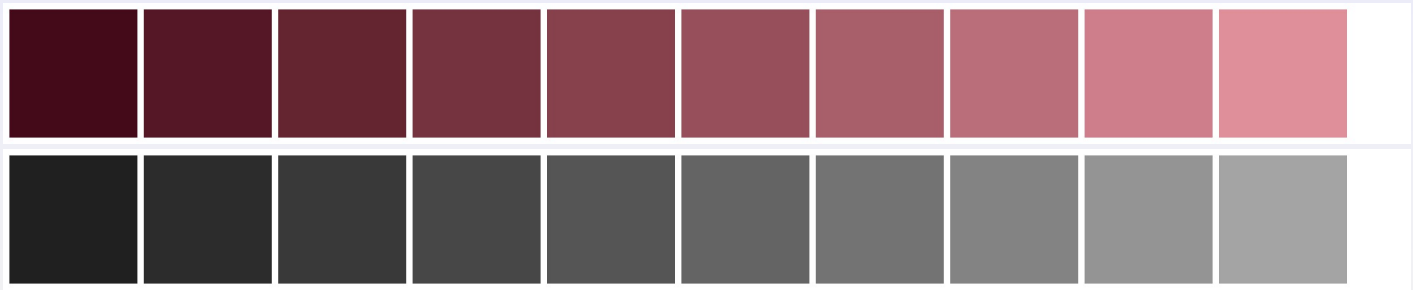
$$
\begin{aligned}
(L_1, a_1, b_1) &= (24, 25, 25) \\
(L_2, a_2, b_2) &= (74, 25, 25) \\
\Delta E &= 5.5556
\end{aligned}
$$

Constant Hue Palette



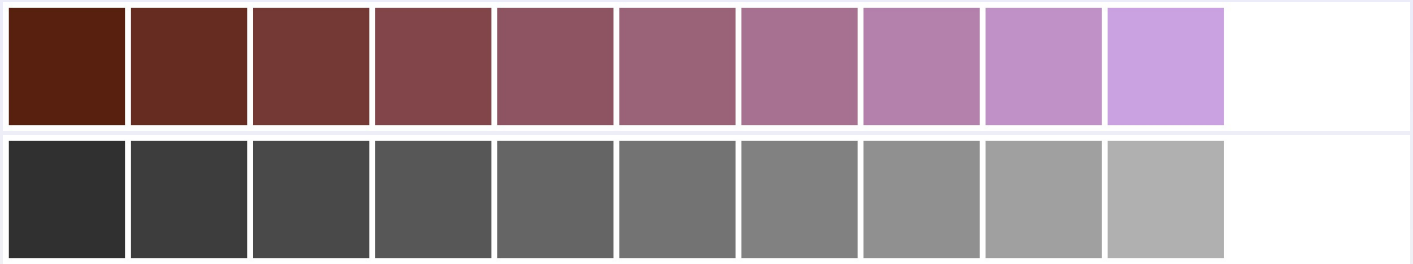
$$
\begin{aligned}
(L_1, a_1, b_1) &= (76, 20, 20) \\
(L_2, a_2, b_2) &= (42, 20, 20) \\
\Delta E &= 3.7778
\end{aligned}
$$

Constant Hue Palette



$$
\begin{aligned}
(L_1, a_1, b_1) &= (16, 30, 6) \\
(L_2, a_2, b_2) &= (70, 30, 6) \\
\Delta E &= 6.0000
\end{aligned}
$$

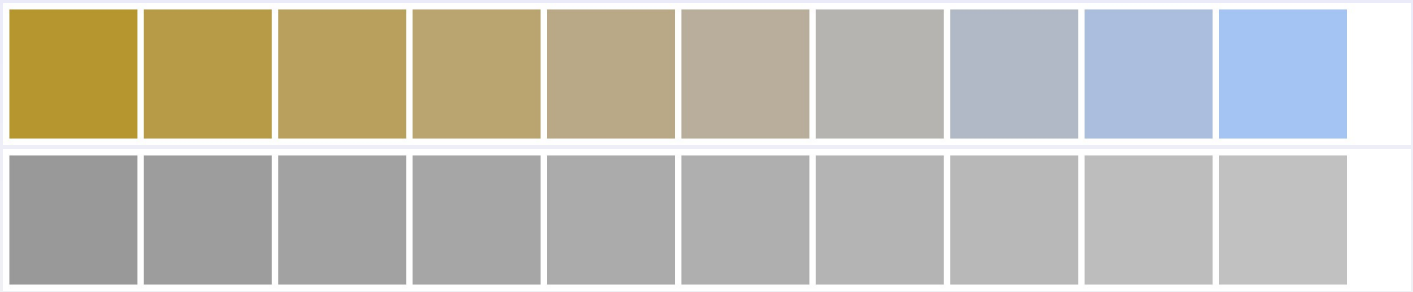
Varying Luminance and Hue Palette



$$
\begin{aligned}
(L_1, a_1, b_1) &= (24, 25, 25) \\
(L_2, a_2, b_2) &= (74, 25, -25) \\
\Delta E &= 7.8567
\end{aligned}
$$

$a^* = 25$ held constant

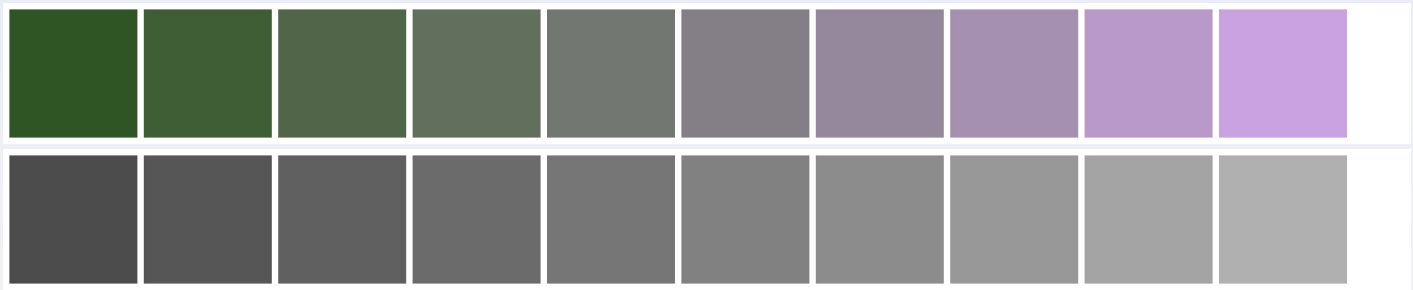
Varying Luminance and Hue Palette



$$
\begin{aligned}
(L_1, a_1, b_1) &= (66, 0, 55) \\
(L_2, a_2, b_2) &= (80, 0, -25) \\
\Delta E &= 9.0240
\end{aligned}
$$

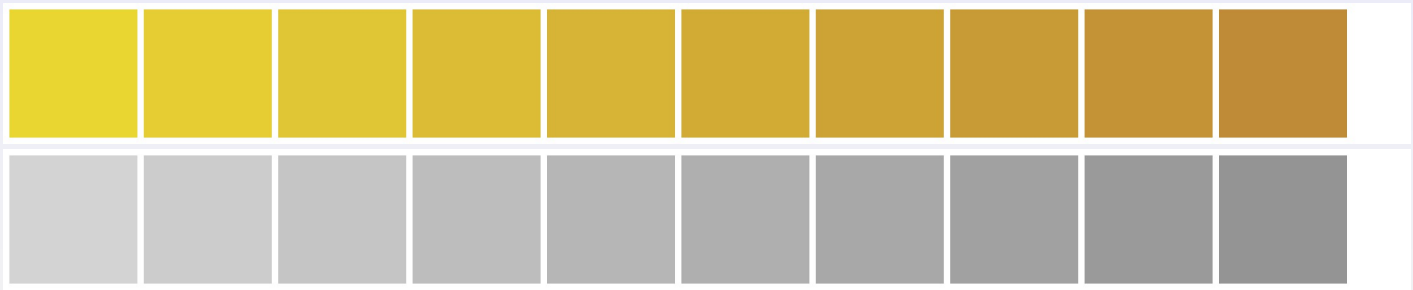
$a^* = 0$ held constant

Varying Luminance and Hue Palette



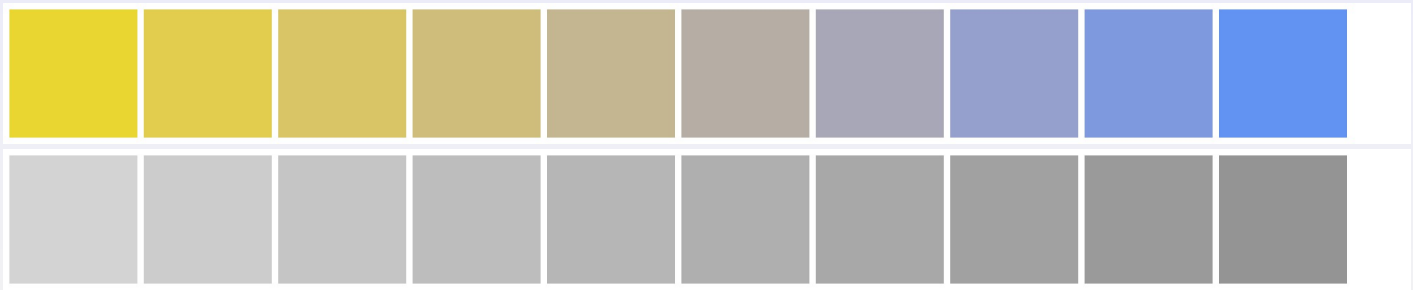
$$
\begin{aligned}
(L_1, a_1, b_1) &= (36, -25, 25) \\
(L_2, a_2, b_2) &= (74, 25, -25) \\
\Delta E &= 8.9194
\end{aligned}
$$

Varying Luminance and Hue Palette



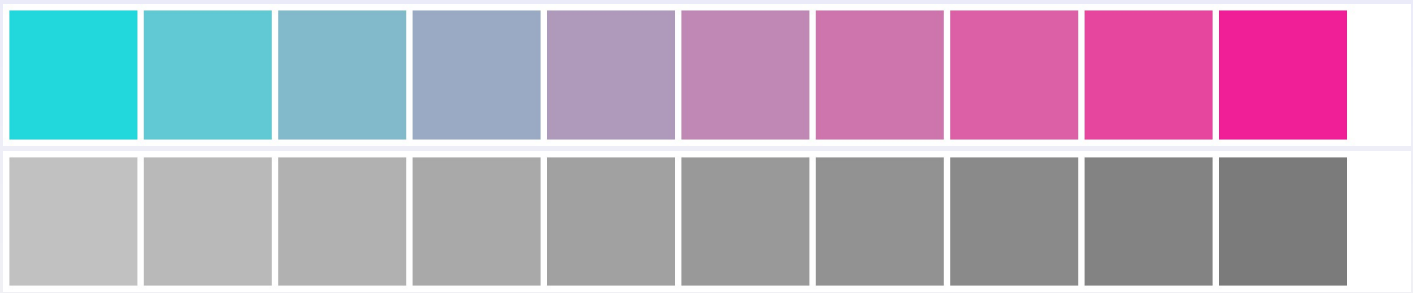
$$
\begin{aligned}
(L_1, a_1, b_1) &= (86, -10, 75) \\
(L_2, a_2, b_2) &= (64, 10, 50) \\
\Delta E &= 4.3162
\end{aligned}
$$

Varying Luminance and Hue Palette



$$
\begin{aligned}
(L_1, a_1, b_1) &= (86, -10, 75) \\
(L_2, a_2, b_2) &= (64, 10, -50) \\
\Delta E &= 14.2764
\end{aligned}
$$

Varying Luminance and Hue Palette



$$
\begin{aligned}
(L_1, a_1, b_1) &= (80, -40, -14) \\
(L_2, a_2, b_2) &= (55, 80, -14) \\
\Delta E &= 13.6196
\end{aligned}
$$

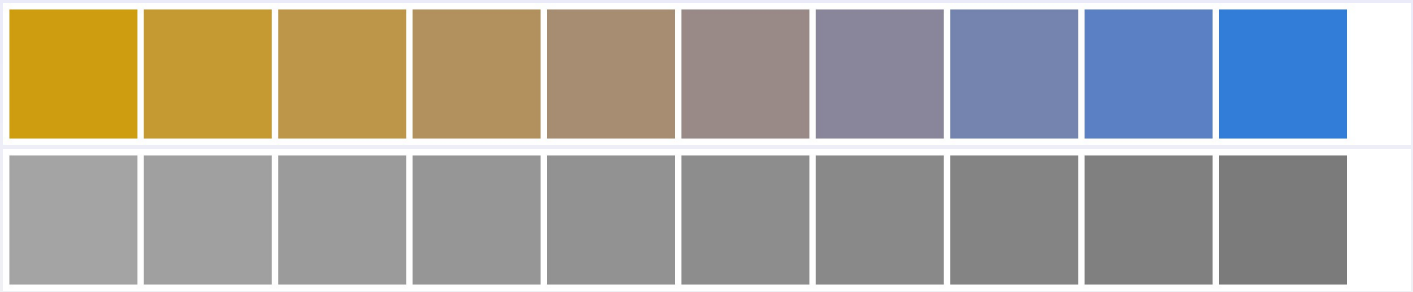
$b^* = -14$ held constant

Varying Luminance and Hue Palette

$$
\begin{aligned}
(L_1, a_1, b_1) &= (70, 5, 70) \\
(L_2, a_2, b_2) &= (55, 5, 50) \\
\Delta E &= 1.6667
\end{aligned}
$$

$a^* = 5$ held constant

Varying Luminance and Hue Palette



$$
\begin{aligned}
(L_1, a_1, b_1) &= (70, 5, 70) \\
(L_2, a_2, b_2) &= (55, 5, -50) \\
\Delta E &= 13.4371
\end{aligned}
$$

$a^* = 5$ held constant

Websites

- Palettes and Colors
  - geog.uoregon.edu/datagraphics/color_scales.htm
  - colorbrewer2.org/
  - www.easyrgb.com/index.php?X=HOME
- Color System Conversions and Theory
  - www.brucelindbloom.com/index.html?Eqn_RGB_XYZ_Matrix.html
  - www2.lawrence.edu/fast/GREGGJ/CMSC420/chapter19/color_theory.pdf
  - www.lasalle.edu/ didio/courses/hon462/goethe_chaos.htm