base between the two pyramids. Even though it is often portrayed in this intuitive way, mathematically the HLS space is again a cylinder (see Fig. 12.15).

RGB→HSV

To convert from RGB to the HSV color space, we first find the *saturation* of the RGB color components $R, G, B \in [0, C_{\max}]$, with $C_{\max}$ being the maximum component value (typically 255), as

$$S_{\text{HSV}} = \begin{cases} \frac{C_{\text{rng}}}{C_{\text{high}}} & \text{for } C_{\text{high}} > 0 \\ 0 & \text{otherwise,} \end{cases} \tag{12.10}$$

and the luminance (*value*)

$$V_{\text{HSV}} = \frac{C_{\text{high}}}{C_{\max}}\,, \tag{12.11}$$

with C_{high}, C_{low}, and C_{rng} defined as

$$\begin{aligned} C_{\text{high}} &= \max(R, G, B), \quad C_{\text{low}} = \min(R, G, B), \quad \text{and} \\ C_{\text{rng}} &= C_{\text{high}} - C_{\text{low}}. \end{aligned} \tag{12.12}$$

Finally, we need to specify the *hue* value H_{HSV}. When all three RGB color components have the same value ($R = G = B$), then we are dealing with an *achromatic* (gray) pixel. In this particular case $C_{\text{rng}} = 0$ and thus the saturation value $S_{\text{HSV}} = 0$, consequently the hue is undefined. To compute H_{HSV} when $C_{\text{rng}} > 0$, we first normalize each component using

$$R' = \frac{C_{\text{high}} - R}{C_{\text{rng}}}, \qquad G' = \frac{C_{\text{high}} - G}{C_{\text{rng}}}, \qquad B' = \frac{C_{\text{high}} - B}{C_{\text{rng}}}. \tag{12.13}$$

Then, depending on which of the three original color components had the maximal value, we compute a preliminary hue H' as

$$H' = \begin{cases} B' - G' & \text{if } R = C_{\text{high}} \\ R' - B' + 2 & \text{if } G = C_{\text{high}} \\ G' - R' + 4 & \text{if } B = C_{\text{high}}. \end{cases} \tag{12.14}$$

Since the resulting value for H' lies on the interval $[-1 \ldots 5]$, we obtain the final hue value by normalizing to the interval $[0, 1]$ as

$$H_{\text{HSV}} = \frac{1}{6} \cdot \begin{cases} (H' + 6) & \text{for } H' < 0 \\ H' & \text{otherwise.} \end{cases} \tag{12.15}$$

Hence all three components H_{HSV}, S_{HSV}, and V_{HSV} will lie within the interval $[0, 1]$. The hue value H_{HSV} can naturally also be computed in another angle interval, for example in the 0 to 360° interval using