Equations for Use in HB Filter Reductions

Terminology

m_{Xj}	—	Reduced magnitude in the HB system
k_n	—	Continuum color (mag/1000Å)
		n=1, BC to GC; n=2, UC to BC; n=3, GC to RC
f_{Xj}	—	Measurement in the Xj filter, with continuum and contamination
		$f_{Xj} = 10^{-0.4 m_{Xj}}$
f'_{Xj}	—	Measurement in the Xj filter after decontamination
f'_{Xj_C}	—	Decontaminated continuum underlying the Xj filter
$F_{0_{Xj}}$	—	Absolute flux of a 0 magnitude star in filter Xj
F_{Xj}	—	Absolute flux in filter Xj before decontamination
F'_{Xj}	—	Absolute flux in filter Xj after decontamination

The constants that are to be used with these instructions are being sent on a separate sheet (or by email).

Accounting for missing continuum filters

If the Green Continuum Filter is missing and Blue Continuum exists:

$$k_1 \equiv 0 \tag{1-1}$$
$$f'_{GC} = f'_{BC} 10^{-0.4(m_{\odot GC} - m_{\odot BC})} \tag{1-2}$$

If the Blue Continuum Filter is missing and Green Continuum exists:

$$k_1 \equiv 0 \tag{1-3}$$
$$f'_{BC} = f'_{GC} 10^{-0.4(m_{\odot BC} - m_{\odot GC})} \tag{1-4}$$

If the UV Continuum Filter is missing:

$$k_2 \equiv k_1 \tag{1-5}$$
$$f'_{UC} = f'_{BC} 10^{-0.4(m_{\odot UC} - m_{\odot BC}) - 0.4008 k_2} \tag{1-6}$$

If the Red Continuum Filter is missing:

$$k_3 \equiv k_1 \tag{1-7}$$
$$f'_{RC} = f'_{GC} 10^{-0.4(m_{\odot RC} - m_{\odot GC}) + 0.7472 k_3} \tag{1-8}$$

Decontaminating the continuum filters

If the Blue Continuum filter exists (no contamination):

$$f'_{BC} \equiv f_{BC} \tag{2-1}$$

Decontaminating the Green Continuum filter if it exists (and if C2 exists):

$\longrightarrow$ If BC measurement exists:

$$f'_{GC} = f_{GC} - K_{GC1} f_{C2} + K_{GC3} (f'_{BC})^{+0.1469} (f'_{GC})^{+0.8531} \tag{2-2}$$

$\longrightarrow$ If BC measurement is missing:

$$f'_{GC} = f_{GC} - \frac{K_{GC1} f_{C2}}{1 - K_{GC2}} \tag{2-3}$$

Decontaminating the UV Continuum filter if it exists (and C3 exists):

$$f'_{UC} = f_{UC} - K_{UC1} f_{C3} + K_{UC3} (f'_{BC})^{+0.6128} (f'_{UC})^{+0.3872} \tag{2-4}$$

If the Red Continuum filter exists (no contamination):

$$f'_{RC} \equiv f_{RC} \tag{2-5}$$

Calculating the continuum colors

From BC to GC (mags / 1000 Å)

$$k_1 = 1.235 \left[2.5 \log \frac{f'_{GC}}{f'_{BC}} - (m_{\odot_{BC}} - m_{\odot_{GC}}) \right] \tag{3-1}$$

From UC to BC (mags / 1000 Å)

$$k_2 = 0.998 \left[2.5 \log \frac{f'_{BC}}{f'_{UC}} - (m_{\odot_{UC}} - m_{\odot_{BC}}) \right] \tag{3-2}$$

From GC to RC (mags / 1000 Å)

$$k_3 = 0.535 \left[2.5 \log \frac{f'_{RC}}{f'_{GC}} - (m_{\odot_{GC}} - m_{\odot_{RC}}) \right] \tag{3-3}$$

Calculating the continuum underlying the gas species

$$f'_{OH_C} = f'_{BC} 10^{-0.4(m_{\odot_{OH}} - m_{\odot_{BC}})} 10^{-0.5440 k_2} \tag{4-1}$$

$$f'_{NH_C} = f'_{BC} 10^{-0.4(m_{\odot_{NH}} - m_{\odot_{BC}})} 10^{-0.4352 k_2} \tag{4-2}$$

$$f'_{CN_C} = f'_{BC} 10^{-0.4(m_{\odot_{CN}} - m_{\odot_{BC}})} 10^{-0.2320 k_2} \tag{4-3}$$

$$f'_{C3_C} = f'_{BC} 10^{-0.4(m_{\odot_{C3}} - m_{\odot_{BC}})} 10^{-0.1552 k_2} \tag{4-4}$$

$$f'_{CO^+_C} = f'_{BC} 10^{-0.4(m_{\odot_{CO^+}} - m_{\odot_{BC}})} 10^{-0.0736 k_2} \tag{4-5}$$

$$f'_{C2_C} = f'_{BC} 10^{-0.4(m_{\odot_{C2}} - m_{\odot_{BC}})} 10^{+0.2764 k_1} \tag{4-6}$$

$$f'_{H2O^+_C} = f'_{GC} 10^{-0.4(m_{\odot_{H2O^+}} - m_{\odot_{GC}})} 10^{+0.7040 k_3} \tag{4-7}$$

Converting linearized magnitudes to absolute fluxes

$$
\begin{aligned}
F'_{UC} &= F_{0_{UC}} f'_{UC} && \text{(5-1)}\\
F'_{BC} &= F_{0_{BC}} f'_{BC} && \text{(5-2)}\\
F'_{GC} &= F_{0_{GC}} f'_{GC} && \text{(5-3)}\\
F'_{RC} &= F_{0_{RC}} f'_{RC} && \text{(5-4)}
\end{aligned}
$$

$$
\begin{aligned}
F'_{OH_C} &= F_{0_{OH}} f'_{OH_C} && \text{(6-1)}\\
F'_{NH_C} &= F_{0_{NH}} f'_{NH_C} && \text{(6-2)}\\
F'_{CN_C} &= F_{0_{CN}} f'_{CN_C} && \text{(6-3)}\\
F'_{C3_C} &= F_{0_{C3}} f'_{C3_C} && \text{(6-4)}\\
F'_{C0^+_C} &= F_{0_{CO+}} f'_{CO^+_C} && \text{(6-5)}\\
F'_{C2_C} &= F_{0_{C2}} f'_{C2_C} && \text{(6-6)}\\
F'_{H2O^+_C} &= F_{0_{H2O+}} f'_{H2O^+_C} && \text{(6-7)}
\end{aligned}
$$

$$
\begin{aligned}
F_{OH} &= F_{0_{OH}} f_{OH} && \text{(7-1)}\\
F_{NH} &= F_{0_{NH}} f_{NH} && \text{(7-2)}\\
F_{CN} &= F_{0_{CN}} f_{CN} && \text{(7-3)}\\
F_{C3} &= F_{0_{C3}} f_{C3} && \text{(7-4)}\\
F_{C0+} &= F_{0_{CO+}} f_{CO+} && \text{(7-5)}\\
F_{C2} &= F_{0_{C2}} f_{C2} && \text{(7-6)}\\
F_{H2O+} &= F_{0_{H2O+}} f_{H2O+} && \text{(7-7)}
\end{aligned}
$$

Removing continuum and contamination from the gas species

$$
\begin{aligned}
F'_{OH} &= (\gamma_{OH/OH})^{-1}[F_{OH} - F'_{OH_C}] && \text{(8-1)}\\
F'_{C3} &= (\gamma_{C3/C3})^{-1}[F_{C3} - F'_{C3_C}] && \text{(8-2)}\\
F'_{C2} &= (\gamma_{C2/C2})^{-1}[F_{C2} - F'_{C2_C}] && \text{(8-3)}\\
F'_{NH} &= (\gamma_{NH/NH})^{-1}[F_{NH} - F'_{NH_C} - \gamma_{NH/C3} F'_{C3}] && \text{(8-4)}\\
F'_{CN} &= (\gamma_{CN/CN})^{-1}[F_{CN} - F'_{CN_C} - \gamma_{CN/C3} F'_{C3}] && \text{(8-5)}\\
F'_{CO+} &= (\gamma_{CO+/CO+})^{-1}[F_{CO+} - F'_{CO+_C} - \gamma_{CO+/C3} F'_{C3}] && \text{(8-6)}\\
F'_{H2O+} &= (\gamma_{H2O+/H2O+})^{-1}[F_{H2O+} - F'_{H2O+_C}] && \text{(8-7)}
\end{aligned}
$$