Appendices

Appendix A  The Greek Alphabet

<table>
<thead>
<tr>
<th>Greek Alphabet</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>A, α</td>
</tr>
<tr>
<td>Beta</td>
<td>B, β</td>
</tr>
<tr>
<td>Gamma</td>
<td>Γ, γ</td>
</tr>
<tr>
<td>Delta</td>
<td>Δ, δ</td>
</tr>
<tr>
<td>Epsilon</td>
<td>Ε, ε</td>
</tr>
<tr>
<td>Zeta</td>
<td>Ζ, ζ</td>
</tr>
<tr>
<td>Eta</td>
<td>Η, η</td>
</tr>
<tr>
<td>Theta</td>
<td>Θ, θ</td>
</tr>
<tr>
<td>Iota</td>
<td>ι, i</td>
</tr>
<tr>
<td>Kappa</td>
<td>Κ, κ</td>
</tr>
<tr>
<td>Lambda</td>
<td>Λ, λ</td>
</tr>
<tr>
<td>Mu</td>
<td>Μ, μ</td>
</tr>
<tr>
<td>Nu</td>
<td>Ν, ν</td>
</tr>
<tr>
<td>Xi</td>
<td>Ξ, ξ</td>
</tr>
<tr>
<td>Omicron</td>
<td>Ο, ο</td>
</tr>
<tr>
<td>Pi</td>
<td>Π, π</td>
</tr>
<tr>
<td>Rho</td>
<td>Ρ, ρ</td>
</tr>
<tr>
<td>Sigma</td>
<td>Σ, σ, ζ</td>
</tr>
<tr>
<td>Tau</td>
<td>Τ, τ</td>
</tr>
<tr>
<td>Upsilon</td>
<td>Υ, υ</td>
</tr>
<tr>
<td>Phi</td>
<td>Φ, ϕ</td>
</tr>
<tr>
<td>Chi</td>
<td>Χ, χ</td>
</tr>
<tr>
<td>Psi</td>
<td>Ψ, ψ</td>
</tr>
<tr>
<td>Omega</td>
<td>Ω, ω</td>
</tr>
</tbody>
</table>
### Appendix B  The Brightest Stars

<table>
<thead>
<tr>
<th>Bayer name</th>
<th>Common name</th>
<th>RA.</th>
<th>Dec</th>
<th>V</th>
<th>B-V</th>
<th>D(pc)</th>
<th>Mv</th>
<th>Spectrum</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>α Canis Majoris</td>
<td>Sun</td>
<td>06:45:2</td>
<td>−26.74</td>
<td>0.65</td>
<td>−26.74</td>
<td>4.83</td>
<td>G2 V</td>
<td>Combined, V = −0.29</td>
<td></td>
</tr>
<tr>
<td>α Carinae</td>
<td>Canopus</td>
<td>06:24:0</td>
<td>−52:42</td>
<td>−0.72</td>
<td>0.15</td>
<td>70</td>
<td>F0 II</td>
<td>Standard star</td>
<td></td>
</tr>
<tr>
<td>α centauri</td>
<td>Rigel</td>
<td>14:39:6</td>
<td>−60:50</td>
<td>−0.01</td>
<td>0.71</td>
<td>1.33</td>
<td>4.37</td>
<td>G2 V</td>
<td></td>
</tr>
<tr>
<td>α Bootis</td>
<td>Arcturus</td>
<td>14:15:7</td>
<td>19:11</td>
<td>−0.04</td>
<td>1.23</td>
<td>10.3</td>
<td>−0.10</td>
<td>K1 V</td>
<td></td>
</tr>
<tr>
<td>α Lyrae</td>
<td>Vega</td>
<td>18:36:9</td>
<td>38:47</td>
<td>0.03</td>
<td>0.00</td>
<td>7.5</td>
<td>0.65</td>
<td>A0 V</td>
<td></td>
</tr>
<tr>
<td>α Aurigae</td>
<td>Capella</td>
<td>05:16:7</td>
<td>46:00</td>
<td>0.08</td>
<td>0.80</td>
<td>12.5</td>
<td>−0.40</td>
<td>G5 III G0 III</td>
<td></td>
</tr>
<tr>
<td>β Orionis</td>
<td>Rigel</td>
<td>05:14:5</td>
<td>−8:12</td>
<td>0.12</td>
<td>−0.03</td>
<td>265</td>
<td>−7.00</td>
<td>B8 Ia</td>
<td></td>
</tr>
<tr>
<td>α Canis Minoris</td>
<td>Procyon</td>
<td>07:39:3</td>
<td>5:14</td>
<td>0.38</td>
<td>0.42</td>
<td>3.4</td>
<td>2.71</td>
<td>F5 IV</td>
<td></td>
</tr>
<tr>
<td>α Eridani</td>
<td>Achernar</td>
<td>01:37:7</td>
<td>−57:14</td>
<td>0.46</td>
<td>−0.16</td>
<td>27</td>
<td>−1.70</td>
<td>B3 V</td>
<td></td>
</tr>
<tr>
<td>α Orionis</td>
<td>Betelgeuse</td>
<td>05:55:2</td>
<td>7:24</td>
<td>0.50</td>
<td>1.85</td>
<td>320</td>
<td>−7.00</td>
<td>M2 Ia</td>
<td></td>
</tr>
<tr>
<td>β Centauri</td>
<td>Hadar</td>
<td>14:03:8</td>
<td>−60:22</td>
<td>0.61</td>
<td>−0.23</td>
<td>95</td>
<td>−4.30</td>
<td>B1 III</td>
<td></td>
</tr>
<tr>
<td>α Aquilae</td>
<td>Altair</td>
<td>19:50:8</td>
<td>8:52</td>
<td>0.77</td>
<td>0.22</td>
<td>5</td>
<td>2.30</td>
<td>A7 V</td>
<td></td>
</tr>
<tr>
<td>α Tauri</td>
<td>Aldebaran</td>
<td>04:35:9</td>
<td>16:31</td>
<td>0.85</td>
<td>1.54</td>
<td>19</td>
<td>−0.49</td>
<td>K5 III</td>
<td></td>
</tr>
<tr>
<td>α Scorpii</td>
<td>Antares</td>
<td>16:29:4</td>
<td>−26:26</td>
<td>0.96</td>
<td>1.83</td>
<td>190</td>
<td>−5.40</td>
<td>M1.5 lb</td>
<td></td>
</tr>
<tr>
<td>α Virginis</td>
<td>Spica</td>
<td>13:25:2</td>
<td>−11:10</td>
<td>0.98</td>
<td>−0.23</td>
<td>67</td>
<td>−3.20</td>
<td>B2 V</td>
<td></td>
</tr>
<tr>
<td>α Crucis</td>
<td>Acrux</td>
<td>12:26:6</td>
<td>−63:06</td>
<td>1.58</td>
<td>−0.26</td>
<td>120</td>
<td>−7.10</td>
<td>B0.5 IV B1 V</td>
<td></td>
</tr>
<tr>
<td>β Geminorum</td>
<td>Pollux</td>
<td>07:45:3</td>
<td>28:02</td>
<td>1.14</td>
<td>1.00</td>
<td>10.6</td>
<td>1.00</td>
<td>K0 III</td>
<td></td>
</tr>
<tr>
<td>α Piscis</td>
<td>Fomalhaut</td>
<td>22:57:6</td>
<td>−29:37</td>
<td>1.16</td>
<td>0.09</td>
<td>6.7</td>
<td>2.02</td>
<td>A3 V</td>
<td></td>
</tr>
<tr>
<td>α Cygni</td>
<td>Deneb</td>
<td>20:41:4</td>
<td>45:17</td>
<td>1.25</td>
<td>0.09</td>
<td>500</td>
<td>−7.20</td>
<td>A2 Ia</td>
<td></td>
</tr>
<tr>
<td>β Crucis</td>
<td>Mimosa</td>
<td>12:47:7</td>
<td>−59:41</td>
<td>1.25</td>
<td>−0.23150</td>
<td>−4.60</td>
<td>B0.5 III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>α Leonis</td>
<td>Regulus</td>
<td>10:08:4</td>
<td>11:58</td>
<td>1.35</td>
<td>−0.11</td>
<td>22</td>
<td>−0.38</td>
<td>B7 V</td>
<td></td>
</tr>
<tr>
<td>ε Canis Majoris</td>
<td>Adhara</td>
<td>06:58:6</td>
<td>−28:58</td>
<td>1.50</td>
<td>−0.21</td>
<td>190</td>
<td>−4.90</td>
<td>B2 II</td>
<td></td>
</tr>
<tr>
<td>α Geminorum</td>
<td>Castor</td>
<td>07:34:6</td>
<td>31:53</td>
<td>1.59</td>
<td>0.03</td>
<td>15</td>
<td>0.72</td>
<td>A1 V</td>
<td></td>
</tr>
<tr>
<td>γ Crucis</td>
<td>Gacrux</td>
<td>12:31:2</td>
<td>−57:07</td>
<td>1.60</td>
<td>1.60</td>
<td>40</td>
<td>−0.56</td>
<td>M3.5 III</td>
<td></td>
</tr>
<tr>
<td>λ, Scorpii</td>
<td>Shaula</td>
<td>17:33:6</td>
<td>−37:06</td>
<td>1.60</td>
<td>−0.20</td>
<td>92</td>
<td>−3.44</td>
<td>B1.5 IV</td>
<td></td>
</tr>
<tr>
<td>γ Orionis</td>
<td>Bellatrix</td>
<td>05:25:1</td>
<td>6:21</td>
<td>1.60</td>
<td>−0.20</td>
<td>40</td>
<td>2.73</td>
<td>B2 III</td>
<td></td>
</tr>
</tbody>
</table>

V = Visual Magnitude
B-V = Colour Index
D(pc) = Distance in parsecs (1 parsec = 3.26 light years)
Mv = Absolute visual magnitude
Spectrum = Spectral Classification
RA/Dec = Position based on J2000 coordinates
### Appendix C  The Brightest Be Stars

<table>
<thead>
<tr>
<th>Con.</th>
<th>Name</th>
<th>RA</th>
<th>Dec</th>
<th>V</th>
<th>Spectrum</th>
<th>VSini</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eri</td>
<td>α Eri</td>
<td>1:37:43</td>
<td>−57:14:12</td>
<td>0.50</td>
<td>B6Vpe</td>
<td>235</td>
</tr>
<tr>
<td>Cen</td>
<td>η Cen</td>
<td>14:35:30</td>
<td>−42:09:28</td>
<td>2.30</td>
<td>B2Ve</td>
<td>310</td>
</tr>
<tr>
<td>Sco</td>
<td>δ Sco</td>
<td>16:00:20</td>
<td>−22:37:18</td>
<td>2.30</td>
<td>B0.2IVe</td>
<td>175</td>
</tr>
<tr>
<td>Cas</td>
<td>γ Cas</td>
<td>0:56:43</td>
<td>+60:43:00</td>
<td>2.39</td>
<td>B0IVpe</td>
<td>432</td>
</tr>
<tr>
<td>Cas</td>
<td>γ cas</td>
<td>0:01:25</td>
<td>+63:30:15</td>
<td>2.40</td>
<td>B0Ve</td>
<td></td>
</tr>
<tr>
<td>UMa</td>
<td>γ Uma</td>
<td>11:53:50</td>
<td>+53:41:41</td>
<td>2.43</td>
<td>A0Ve</td>
<td>167</td>
</tr>
<tr>
<td>Oph</td>
<td>ζ Oph</td>
<td>16:37:10</td>
<td>−10:34:02</td>
<td>2.58</td>
<td>O9Ve</td>
<td>348</td>
</tr>
<tr>
<td>Col</td>
<td>α Col</td>
<td>5:39:39</td>
<td>−34:04:27</td>
<td>2.60</td>
<td>B9Ve</td>
<td>180</td>
</tr>
<tr>
<td>Ara</td>
<td>α Ara</td>
<td>17:31:50</td>
<td>−49:52:34</td>
<td>2.84</td>
<td>B2Vne</td>
<td>290</td>
</tr>
<tr>
<td>Tau</td>
<td>Alcyone</td>
<td>3:47:29</td>
<td>+24:06:18</td>
<td>2.87</td>
<td>B7IIIe</td>
<td>140</td>
</tr>
<tr>
<td>CMi</td>
<td>β CMi</td>
<td>7:27:09</td>
<td>+08:17:22</td>
<td>2.89</td>
<td>B8Ve</td>
<td>230</td>
</tr>
<tr>
<td>Tau</td>
<td>ζ Tau</td>
<td>5:37:39</td>
<td>+21:08:33</td>
<td>3.03</td>
<td>B2IVe</td>
<td>245</td>
</tr>
<tr>
<td>Car</td>
<td>ω Car</td>
<td>10:13:44</td>
<td>−70:02:16</td>
<td>3.30</td>
<td>B8IIIe</td>
<td>240</td>
</tr>
<tr>
<td>Ara</td>
<td>γ Ara</td>
<td>17:25:24</td>
<td>−56:22:40</td>
<td>3.31</td>
<td>B1IIIe</td>
<td>302</td>
</tr>
<tr>
<td>Cas</td>
<td>ε Cas</td>
<td>1:54:24</td>
<td>+63:40:12</td>
<td>3.34</td>
<td>B3IIIe</td>
<td>30</td>
</tr>
<tr>
<td>Car</td>
<td>ρ Car</td>
<td>10:32:01</td>
<td>−61:41:07</td>
<td>3.36</td>
<td>B4Vne</td>
<td>266</td>
</tr>
<tr>
<td>Ori</td>
<td>η Ori</td>
<td>5:24:29</td>
<td>−02:23:50</td>
<td>3.38</td>
<td>B0.5Ve</td>
<td>170</td>
</tr>
<tr>
<td>CMa</td>
<td>κ CMa</td>
<td>6:49:50</td>
<td>−32:30:31</td>
<td>3.52</td>
<td>B1.5Ve</td>
<td>243</td>
</tr>
<tr>
<td>Lyr</td>
<td>β Lyr</td>
<td>18:50:05</td>
<td>+33:21:46</td>
<td>3.52</td>
<td>B7Ve</td>
<td>120</td>
</tr>
<tr>
<td>UMa</td>
<td>κ UMa</td>
<td>9:03:38</td>
<td>+47:09:23</td>
<td>3.60</td>
<td>A1Vne</td>
<td>201</td>
</tr>
</tbody>
</table>
### Appendix D  The Brightest Wolf-Rayet (WR) Stars

<table>
<thead>
<tr>
<th>HD#</th>
<th>WR# (Name)</th>
<th>RA.</th>
<th>Dec</th>
<th>Type</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>68273</td>
<td>11, γ2 Vel</td>
<td>09:31.9</td>
<td>−47:20:12</td>
<td>WC8 + O7.5III-V</td>
<td>1.74</td>
</tr>
<tr>
<td>152408</td>
<td>79a</td>
<td>54:58.5</td>
<td>−41:09:03</td>
<td>WN9ha</td>
<td>5.29</td>
</tr>
<tr>
<td>113904</td>
<td>48, 0 Mus</td>
<td>08:07.2</td>
<td>−65:18:23</td>
<td>WC6(+O9.5/B0Iab)</td>
<td>5.88</td>
</tr>
<tr>
<td>92740</td>
<td>22</td>
<td>41:17.5</td>
<td>−59:40:37</td>
<td>WN7h + O9III-V</td>
<td>6.44</td>
</tr>
<tr>
<td>93131</td>
<td>24</td>
<td>43:52.3</td>
<td>−60:07:04</td>
<td>WN6ha</td>
<td>6.49</td>
</tr>
<tr>
<td>151932</td>
<td>78</td>
<td>52:19.2</td>
<td>−41:51:16</td>
<td>WN7h</td>
<td>6.61</td>
</tr>
<tr>
<td>190918</td>
<td>133</td>
<td>05:57.3</td>
<td>+35:47:18</td>
<td>WN5 + O9I</td>
<td>6.70</td>
</tr>
<tr>
<td>50896</td>
<td>6, EZ CMa</td>
<td>54:13.0</td>
<td>−23:55:42</td>
<td>WN4</td>
<td>6.94</td>
</tr>
<tr>
<td>152270</td>
<td>79</td>
<td>54:19.7</td>
<td>−41:49:11</td>
<td>WC7 + O5-8</td>
<td>6.95</td>
</tr>
<tr>
<td>193793</td>
<td>140, V1687 Cyg</td>
<td>20:28.0</td>
<td>+43:51:16</td>
<td>WC7pd + O4-5</td>
<td>7.07</td>
</tr>
<tr>
<td>156385</td>
<td>90</td>
<td>19:29.9</td>
<td>−45:38:24</td>
<td>WC7</td>
<td>7.45</td>
</tr>
<tr>
<td>192163</td>
<td>136, V1770 Cyg</td>
<td>12:06.5</td>
<td>+38:21:18</td>
<td>WN6(h)</td>
<td>7.65</td>
</tr>
<tr>
<td>96548</td>
<td>40, V385 Car</td>
<td>06:17.2</td>
<td>−65:30:35</td>
<td>WN8h</td>
<td>7.85</td>
</tr>
<tr>
<td>193077</td>
<td>138</td>
<td>17:00.0</td>
<td>+37:25:24</td>
<td>WN5 + B?</td>
<td>8.10</td>
</tr>
<tr>
<td>193576</td>
<td>139, V444 Cyg</td>
<td>19:32.4</td>
<td>+38:43:54</td>
<td>WN5 + O6III-V</td>
<td>8.10</td>
</tr>
<tr>
<td>93162</td>
<td>25</td>
<td>44:10.3</td>
<td>−59:43:11</td>
<td>WN6h + O4f</td>
<td>8.14</td>
</tr>
<tr>
<td>192641</td>
<td>137, V1679 Cyg</td>
<td>14:31.8</td>
<td>+36:39:39</td>
<td>WC7pd + O9</td>
<td>8.15</td>
</tr>
<tr>
<td>165763</td>
<td>111</td>
<td>08:28.5</td>
<td>−21:15:11</td>
<td>WC5</td>
<td>8.23</td>
</tr>
<tr>
<td>191765</td>
<td>134, V1769 Cyg</td>
<td>10:14.2</td>
<td>+36:10:35</td>
<td>WN6</td>
<td>8.23</td>
</tr>
<tr>
<td>97152</td>
<td>42, V431 Car</td>
<td>10:04.1</td>
<td>−60:58:45</td>
<td>WC7 + O7V</td>
<td>8.25</td>
</tr>
</tbody>
</table>
# Appendix E  The Brightest Red and Carbon Stars

<table>
<thead>
<tr>
<th>Con.</th>
<th>Name</th>
<th>RA.</th>
<th>Dec.</th>
<th>V</th>
<th>Spectrum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cet</td>
<td>AE Cet</td>
<td>0:14:36</td>
<td>−18:56:00</td>
<td>4.4</td>
<td>M3</td>
</tr>
<tr>
<td>Cet</td>
<td>o Cet</td>
<td>2:19:18</td>
<td>−02:59:00</td>
<td>2</td>
<td>M6e</td>
</tr>
<tr>
<td>Ari</td>
<td>ρ2 Ari</td>
<td>2:55:48</td>
<td>+18:20:00</td>
<td>5.9</td>
<td>M6</td>
</tr>
<tr>
<td>Per</td>
<td>ρ Per</td>
<td>3:05:12</td>
<td>+38:50:00</td>
<td>3.4</td>
<td>M4</td>
</tr>
<tr>
<td>Hor</td>
<td>TW Hor</td>
<td>3:12:36</td>
<td>−57:19:00</td>
<td>5.7</td>
<td>C5</td>
</tr>
<tr>
<td>For</td>
<td>HD 20729</td>
<td>3:19:36</td>
<td>−24:07:00</td>
<td>5.6</td>
<td>M2</td>
</tr>
<tr>
<td>Cam</td>
<td>BD Cam</td>
<td>3:42:09</td>
<td>+63:13:00</td>
<td>5.1</td>
<td>S5,3</td>
</tr>
<tr>
<td>Eri</td>
<td>DV Eri</td>
<td>4:34:12</td>
<td>−08:14:00</td>
<td>5.1</td>
<td>M3</td>
</tr>
<tr>
<td>Dor</td>
<td>R Dor</td>
<td>4:36:48</td>
<td>−62:05:00</td>
<td>5.7</td>
<td>M7</td>
</tr>
<tr>
<td>Lep</td>
<td>R Lep</td>
<td>4:59:36</td>
<td>−14:48:00</td>
<td>5.9</td>
<td>N6</td>
</tr>
<tr>
<td>Lep</td>
<td>RX Lep</td>
<td>5:11:24</td>
<td>−11:51:00</td>
<td>5.7</td>
<td>M6</td>
</tr>
<tr>
<td>Tau</td>
<td>CE Tau</td>
<td>5:33:12</td>
<td>+18:36:00</td>
<td>4.7</td>
<td>M</td>
</tr>
<tr>
<td>Ori</td>
<td>α Ori</td>
<td>5:55:12</td>
<td>+07:42:00</td>
<td>0.4</td>
<td>M2</td>
</tr>
<tr>
<td>Dor</td>
<td>η2 Dor</td>
<td>6:11:18</td>
<td>−65:35:00</td>
<td>5.1</td>
<td>M2</td>
</tr>
<tr>
<td>Gem</td>
<td>η Gem</td>
<td>6:14:54</td>
<td>+22:30:00</td>
<td>3.3</td>
<td>M3</td>
</tr>
<tr>
<td>Lyn</td>
<td>UW Lyn</td>
<td>6:17:54</td>
<td>+61:31:00</td>
<td>5</td>
<td>M3</td>
</tr>
<tr>
<td>Pup</td>
<td>L2 Pup</td>
<td>7:13:30</td>
<td>−44:38:00</td>
<td>5.1</td>
<td>M5</td>
</tr>
<tr>
<td>Pup</td>
<td>KQ Pup</td>
<td>7:33:48</td>
<td>−14:31:00</td>
<td>4.8</td>
<td>M2</td>
</tr>
<tr>
<td>Leo</td>
<td>R Leo</td>
<td>9:47:30</td>
<td>+11:26:00</td>
<td>6</td>
<td>M8</td>
</tr>
<tr>
<td>Ant</td>
<td>U Ant</td>
<td>10:35:12</td>
<td>−39:34:00</td>
<td>6</td>
<td>N;C5</td>
</tr>
<tr>
<td>Hya</td>
<td>U Hya</td>
<td>10:37:36</td>
<td>−13:23:00</td>
<td>4.5</td>
<td>N2</td>
</tr>
<tr>
<td>UMa</td>
<td>VY UMa</td>
<td>10:45:06</td>
<td>+67:25:00</td>
<td>6</td>
<td>N0</td>
</tr>
<tr>
<td>CVn</td>
<td>2 CVn</td>
<td>12:16:06</td>
<td>+40:40:00</td>
<td>5.7</td>
<td>M1</td>
</tr>
<tr>
<td>Com</td>
<td>12 Com</td>
<td>12:22:30</td>
<td>+25:17:00</td>
<td>4.8</td>
<td>G0</td>
</tr>
<tr>
<td>Vir</td>
<td>SS Vir</td>
<td>12:25:12</td>
<td>+00:46:00</td>
<td>6</td>
<td>Ne</td>
</tr>
<tr>
<td>Cru</td>
<td>γ Cru</td>
<td>12:31:12</td>
<td>−57:07:00</td>
<td>3.6</td>
<td>M4</td>
</tr>
<tr>
<td>CVn</td>
<td>Y CVn</td>
<td>12:45:06</td>
<td>+45:26:00</td>
<td>4.8</td>
<td>N3</td>
</tr>
<tr>
<td>CVn</td>
<td>TU CVn</td>
<td>12:54:54</td>
<td>+47:12:00</td>
<td>5.8</td>
<td>M5</td>
</tr>
<tr>
<td>TrA</td>
<td>X Tra</td>
<td>15:14:18</td>
<td>−70:05:00</td>
<td>5.8</td>
<td>C5</td>
</tr>
<tr>
<td>Nor</td>
<td>HD 145384</td>
<td>16:13:12</td>
<td>−53:40:00</td>
<td>5.8</td>
<td>M0</td>
</tr>
<tr>
<td>Oph</td>
<td>V2105 Oph</td>
<td>16:27:42</td>
<td>−07:36:00</td>
<td>5.2</td>
<td>M2</td>
</tr>
<tr>
<td>Sco</td>
<td>α Sco</td>
<td>16:29:36</td>
<td>−26:26:00</td>
<td>0.9</td>
<td>M1</td>
</tr>
<tr>
<td>Her</td>
<td>α Her</td>
<td>17:14:36</td>
<td>+14:23:00</td>
<td>2.7</td>
<td>M5</td>
</tr>
<tr>
<td>Pav</td>
<td>V Pav</td>
<td>17:43:18</td>
<td>−57:40:00</td>
<td>5.6</td>
<td>N7</td>
</tr>
<tr>
<td>Her</td>
<td>95 Her</td>
<td>18:01:30</td>
<td>+21:36:00</td>
<td>4.3</td>
<td>G8</td>
</tr>
<tr>
<td>Lyr</td>
<td>XY Lyr</td>
<td>18:38:06</td>
<td>+39:41:00</td>
<td>6</td>
<td>M5</td>
</tr>
<tr>
<td>Lyr</td>
<td>δ2 Lyr</td>
<td>18:54:30</td>
<td>+36:54:00</td>
<td>4.3</td>
<td>M4</td>
</tr>
<tr>
<td>Lyr</td>
<td>R Lyr</td>
<td>18:55:18</td>
<td>+43:57:00</td>
<td>4</td>
<td>M5</td>
</tr>
<tr>
<td>Vul</td>
<td>HD 183556</td>
<td>19:26:30</td>
<td>+19:53:00</td>
<td>5.8</td>
<td>M0</td>
</tr>
<tr>
<td>Cap</td>
<td>υ Cap</td>
<td>20:40:00</td>
<td>−18:08:00</td>
<td>5.2</td>
<td>M2</td>
</tr>
<tr>
<td>Cyg</td>
<td>W Cyg</td>
<td>21:36:00</td>
<td>+45:22:00</td>
<td>5.5</td>
<td>M5</td>
</tr>
<tr>
<td>Cep</td>
<td>Mu Cep</td>
<td>21:43:30</td>
<td>+58:47:00</td>
<td>4.2</td>
<td>M2</td>
</tr>
<tr>
<td>Psc</td>
<td>TX Psc</td>
<td>23:46:24</td>
<td>+03:29:00</td>
<td>5.3</td>
<td>N0;C7</td>
</tr>
</tbody>
</table>
Appendix F  Suppliers of Spectroscope Gratings and Accessories

Star Analyser Grating
AVA ASTRO CORP, DBA – Adirondack Video Astronomy
72 Harrison Avenue
Hudson Falls, NY 12839, USA

Field Tested Software
http://www.RSpec-astro.com/sa100

Paton Hawksley Education Ltd
Rockhill Laboratories, Wellsway, Keynsham
Bristol, BS31 1PG, U.K.
http://www.patonhawksley.co.uk/staranalyser.html

Shelyak Instruments
Les Roussets
38420 Revel
France
http://www.shelyak.com/

Rainbow Optics Star Spectroscope
Rainbow Optics
2116 Regent Way
Castro Valley, CA 94546
http://www.staRSpectroscope.com/

RS Spectroscope
Rigel Systems
26850 Basswood Avenue
Rancho Palos Verdes
CA 90275, USA
http://www.rigelsys.com/

Diffraction Gratings
Optometrics
8 Nemco Way
Stony Brook Industrial Park
Ayer, MA 01432
http://www.optometrics.com/

Paton Hawksley (See above)

ThorLabs, Inc.
435 Route 206 North
Newton, NJ 07860
http://www.thorlabs.de/
Newport Corp.- (Richardson Gratings)  
705 St. Paul St, Rochester, NY 14605  

Edmund Optics, Inc.  
101 East Gloucester Pike  
Barrington, NJ 08007-1380  
http://www.edmundoptics.com/  

Surplus Shed  
1050 Maidencreek Road  
Fleetwood, PA 19522  
http://www.surplusshed.com/  

**Entrance Slits**  
Surplus Shed (See above)

Lennox Laser  
12530 Manor Road  
Glen Arm, MD 21057  
http://www.lenoxlaser.com/

**Lenses**  
Surplus Shed (See above)  
Edmund Optics (See above)  
Thorlabs (See above)
Appendix G  Spectroscopy Forums

Forums
http://tech.groups.yahoo.com/group/astronomical_spectroscopy/?yguid=322612425
http://tech.groups.yahoo.com/group/staranalyser/?yguid=322612425
http://tech.groups.yahoo.com/group/amateur_spectroscopy/?yguid=322612425
http://tech.groups.yahoo.com/group/Iris_software/?yguid=322612425
http://spektroskopie.fg-vds.de/
http://www.astrospectroscopy.de/

Other Websites
http://www.threehillsobservatory.co.uk/astro/spectroscopy.htm

Olivier Thizy (Shelyak) has also prepared a “recommended” spectroscopy reading list: http://www.shelyak.com/en(links).html

Yahoo Technical Support Group
A support group dedicated to assisting amateurs in astronomical spectroscopy has been set up by the author.
  http://tech.groups.yahoo.com/group/astronomical_spectroscopy/?yguid=322612425

Membership in this group is open to any interested amateur, which is an ideal forum in which to raise questions on any and all aspects of spectroscopy. There are many files available in the “knowledge base” covering spectroscope design and construction as well as the practical aspects of spectral imaging and subsequent analysis. Spectrum images are regularly uploaded to assist the novice, and there are many experienced amateurs who are more than willing to discuss any problem you may have as you move up the learning curve.

The TransSpec V2 Excel spreadsheet for calculating grating performance (see Chaps. 2 and 7) is available in the files area of the group.

Berndt Marquandt’s SkySpecV2 – spectral processing software (see Chap. 4) is also available.

Any amendments to this book will be published on the Astronomical Spectroscopy forum. See you there!
For Further Information

Chapter 1. Some Background and Basics

Books


Websites

http://astrosurf.com/aras/staranalyser/userguide.htm
http://www.astrosurf.com/buil/staranalyser/obs.htm
http://laserstars.org/spectra/index.html
http://www.staRSpectroscope.com/

Chapter 2. Imaging a Spectrum with the Grating

Books

M.A. Covington, *Digital SLR Astrophotography* (Cambridge University Press, 2007)

Websites

http://tech.dir.groups.yahoo.com/group/ccd-newastro/files/CCDCalc%20Install%20Files/
http://www.stark-labs.com/
http://www.ap-i.net/skychart/start
http://www.stellarium.org/
http://www.licha.de/astro_article_ccd_sortable_compare.php
http://www.eaas.co.uk/news(astrophotography_resources.html

Books


Websites

http://www.supernovae.net/
http://users.erols.com/njastro/faas/articles/west01.htm
http://www.regulusastro.com/regulus/spectra/index.html
http://www.peripatus.gen.nz/Astronomy/SteCla.html
http://www.peripatus.gen.nz/Astronomy/Index.html
http://www.astrosurf.com/aras/CICyg/C1_Cyg.html
http://www.cfa.harvard.edu/supernova//SNarchive.html
http://www.astronomie-amateur.fr/Projets%20Spectro1.html (in French)
http://www.delphes.net/messier/planetar.html
http://www.rochesterastronomy.org/snimages/
http://www.imo.net/
http://members.shaw.ca/epmajden/index.htm
http://www.amsmeteors.org/spectro.html
http://www.pha.jhu.edu/~qzhang/seminar1bfigs/node2.html

Chapter 4. Processing Spectra

Websites

http://www.astronomie.be/registax/
http://deepskystacker.free.fr/english/index.html
http://www.astrosurf.com/vdesnoux/
http://www.RSpec-astro.com/
http://www.eso.org/sci/software/esomidas/
Chapter 5. Improving Your Grating Spectroscope

Books


Websites

http://www.threehillsobservatory.co.uk/astro/spectra_33.htm
http://www.telescope-service.com/baader/adaptors/adaptors.html#Large
http://www.surplusshed.com/pages/item/m1570d.html
http://fermi.jhuapl.edu/liege/s00_0000.html
http://fermi.jhuapl.edu/liege/s00_0000.html
http://www.samirkharusi.net/spectrograph.html
http://e.sarrazin.free.fr/spectro/sepsa.htm (in French)
http://astrosurf.com/buil/filters/curves.htm
http://astrosurf.com/buil/calibration/lamp1.html
http://www.sherwoods-photo.com/digiscoping_brackets/digi-scoping_adapters_and_brackets.htm
http://astrosurf.com/buil/
http://www.eso.org/projects/caos/
http://spectroscopy.wordpress.com/documents/
http://www.telescope.com/Astrophotography/Autoguiding-Solutions/pc/4/60.uts

Chapter 6. Some Technical (Nice to Know) Stuff

Books

G.D. Roth (ed.), Handbook of Practical Astronomy (Springer-Verlag, 2009), pp. 175–204
R. Scott Ireland, Photoshop Astronomy (Willmann Bell, 2005)

Websites

http://www.stark-labs.com/craig/articles/assets/Debayering_API.pdf
http://www.starrywonders.com/ccdcameraconsiderations.html
http://users.erols.com/njastro/faas/articles/west01.htm
http://www.cfai.dur.ac.uk/old/projects/dispersion/grating_spectroscopy_theory.pdf
http://hyperphysics.phy-astr.gsu.edu/HBASE/phyopt/gratcal.html
http://www.newport.com

Chapter 7. Spectra Analysis: A Bit of Theory

Books

A.G.D. Philip (ed.), Objective-Prism and Other Surveys (L. Davis Press, 1991)
K. Robinson, Spectroscopy: The Key to the Stars (Springer, 2007)
K. Robinson, Starlight – An Introduction to Stellar Physics for Amateurs (Springer, 2009)

Websites

http://nedwww.ipac.caltech.edu/level5/ASS_Atlas/frames.html
http://www.ucm.es/info/Astrof/invespectadia/spectra.html
http://users.erols.com/njastro/faas/pages/starcat.htm
http://zebu.uoregon.edu/spectra.html
http://stars.astro.illinois.edu/sow/spectra.html
http://atlas.obs-hp.fr/elodie/
http://www.sc.eso.org/santiago/uvespop/field_stars_uptonow.html
Absorption lines  Dark lines seen in a stellar spectrum. Caused by the change in the energy level of an atom.

Achromatic  Color correction of a lens, where at least two different wavelengths are brought to a common focus.

ADU  Analogue to Digital Unit. The measure of intensity used by CCD cameras. Related to bit depth of the chip.

Angstrom  Measure of wavelength. One Å is $10^{-10}$ m and 10 Å equals a nanometer (nm).

Angular measure  In astronomy, full circle = 24 h or 360°, 1° = 60 arc min, 1 arc min = 60 arc sec. One minute of time equals 15 arc min.

APO  Apochromatic. Where a lens is color corrected to bring three different wavelengths to a common focus.

Arc sec/min  Seconds of arc, etc. See angular measure.

Atmospheric lines  See telluric lines.

Balmer series  A series of absorption lines seen in a stellar spectrum. Caused by the various energy levels of the element hydrogen. The strongest line (Hα) is in the red portion of the spectrum.

Bandwidth  The measure of a transmission width of a filter, in wavelengths.

Bayer letter  A Greek letter used to identify a star within a constellation. The brightest star would be α. For example, Deneb = α Cyg.

Bayer matrix  A method of applying filters, normally red, green and blue, to a CCD chip to allow it to record colored images.

Be star  A bright B-type star that shows emission spectra.

Beamsplitter  A semi-reflective optical plate that can transmit and reflect light.

Bias  Sometimes called read noise. The added noise signal applied to an image by the electronics controlling a CCD when the signal is transferred from the chip.
**Binary system** Two or more stars in close orbit around each other.

**Bit depth** The maximum intensity recorded by the pixel in a CCD. A bit depth of 16 gives a maximum ADU count of 65,000. \((2^{16})\).

**Blackbody curve** The intensity curve of a continuum spectrum that reflects the temperature of the star.

**Black hole** A region of space where the intense gravity field prevents the emission of any light or radiation. Associated with the death of large stars.

**Blazed gratings** A diffraction grating that has the shape of the grooves angled to improve the illumination of the first order spectrum.

**BMP** A bit-mapped image format. Commonly used in Windows applications.

**Carpenter prism** See grism.

**Cataclysmic variable** A type of variable star. The change in brightness is sudden and irregular. Thought to be surrounded by a shell of material.

**CCD** Charge coupled device. Used in cameras to record photons and convert them into electrons, which are then used to generate an image.

**CFAR** The Harvard Smithsonian Center for Astrophysics. Location of a large database on supernovae.

**Chromatic aberration** An optical aberration in a telescope or lens where different colors come to a different focal point. See achronatic.

**Chromatic coma** See spectral coma.

**Chromosphere** The outer atmosphere of a star. Gives rise to absorption lines in the spectrum.

**Color index** Measure of a star’s color. The difference in the star’s brightness as recorded by various filters. For example, U-B or B-V color index.

**Continuum** The continuous underlying spectrum of a star.

**Cylindrical lens** A lens that only focuses in one axis. Produces a line image from a point source.

**Dark** An image obtained from a camera in the absence of light. Used to compensate for noise in images.

**Deviation angle** The angle between the incident light ray and the emerging colored ray from a prism or grating. Varies with the wavelength of light.

**Diagonal** A prism or mirror used to divert the light in a telescope through 90°.

**Dispersion** The ability to break white light into various colors. Normally associated with prisms and gratings.

**Doppler shift** Change in frequency due to the speed of recession or approach. Redshift is a measure of the speed of recession based on the Doppler effect.

**Drift enlarging** Using the movement of a star in the field of view to increase the height of a spectrum.

**DSLR** Digital single lens reflex camera. Uses a CCD sensor. The lens can usually be removed from the camera body.

**DSO** Deep sky object. Astronomical objects other than stars and planets.

**Electromagnetic spectrum** The range of radiation energy going from the very short wavelengths (X-rays) to the longer wavelengths of radio. The visible spectrum is a small part of this range.
Glossary

**ELODIE** A high resolution spectrograph used at the Observatoire de Haute Provence (OHP). Extensive source of spectra used by astronomers.

**Emission lines** A bright line seen in a spectrum. Caused by the electrons of various atoms dropping energy levels.

**Entrance slit** A narrow opening (can be adjustable) positioned at the entrance of a spectroscope to improve the resolution.

**Equatorial mount** A telescope mounting that allows tracking of the stars. Usually having two axes of rotation – a declination axis (Dec), which gives movements north-south and an RA axis that points towards the celestial pole and rotates for tracking.

**Exit pupil** The image of the objective seen in an eyepiece. Equal to the size of the objective divided by the magnification of the system.

**Exoplanet** A body orbiting a distant star. Normally evident by slight drops in star brightness as the body moves between the observer and the star.

**Eye relief** The distance the eye should be positioned behind an eyepiece to see the whole field of view.

**Field curvature** An optical aberration. The plane of the best focus position varies from the center to the edge.

**First order spectrum** The brightest and least dispersed spectrum formed by a grating.

**FITS** Flexible Image Transport System. A digital file structure that allows the maximum information to be recorded. Details of the file contents are encoded into a readable header. Widely used in astronomy.

**Flamsteed number** A numbering sequence for the stars within a constellation developed by John Flamsteed. The numbers start from the western border of the constellation through to the east. For example, Deneb = α Cyg = 50 Cyg.

**Flat** An image taken of a uniform illuminated surface. Used in imaging to correct vignetting and dust defects.

**Focal length** The distance between the objective lens/mirror of a telescope and the point of focus.

**Focal ratio** The focal length of a lens/mirror divided by the aperture.

**Focal reducer** A secondary lens that, when placed in a telescope, reduces the effective focal length.

**Focus shift** Change in focus position required to bring differing wavelengths into focus. Normally associated with field curvature.

**Fraunhofer lines** Prominent dark lines seen in the solar spectrum. First recorded by Joseph Fraunhofer.

**Free spectral range** The span of a spectrum that shows no overlap with a subsequent spectral order. Associated with multiple orders from a grating.

**FWHM** Full Width Half Maximum. A measure of the effective size of a spectral line or star image.

**Gain** Amplification applied to the signal within a CCD. A gain of ×5 will give an ADU readout five times higher than a gain of ×1.
Grating transmission A series of grooves (lines) embossed on a plastic layer bonded to a glass support plate. Light is dispersed when it travels through the grating.

Grism The name given to a small prism when it is combined with a grating to correct the deviation angle.

HD number A number sequence used to identify a star in the Henry Draper spectroscopic catalog. For example, Deneb = HD 197345.

Imaging software Computer software used to manipulate images. Can also be used to control the camera settings and exposures. Some examples are AstroArt5, Maxim DL and IRIS.

Instrument response A spectral profile curve that represents the efficiency of an optical system across the spectral range.

IRIS An image processing software package (freeware) developed by Christian Buil.

ISO settings Term used with DSLR cameras to define the gain applied to the signal. An ISO 200 has twice the gain of an ISO 100.

Kelvin Temperature scale based on absolute zero (−273°C).

Kirchhoff’s laws Three laws developed to explain the spectral continuum and absorption and emission lines.

Light year An astronomical unit of measure. 0.9461 × 10^{16} m. The distance traveled by light in one year.

Linear dispersion See plate scale.

Line broadening The increase in width of a spectra line due to pressure or temperature.

Micron 10^{-6} m. A common measure for CCD pixel sizes and other small dimensions.

Mono CCD A CCD where each pixel is responsive to all wavelengths.

Nanometer Measure of wavelength. 1 nm = 10^{-9} m = 10 Å.

Neutron star Extremely massive star with low luminosity. The possible remnant of a supernova explosion.

Non-uniform spectra Normally associated with prisms. The spectrum produced is non-linear in scale. The red section is less spread out than the blue section.

Nova A star that shows an extreme increase in brightness due to an explosion that destroys the star.

Nyquist sampling Information transfer theory developed by Harry Nyquist. As applied to spectroscopy, it can be used to evaluate the accuracy of the spectrum image. Normally a minimum of two pixels are required to determine resolution. Less than two is called “under sampling.”

Objective The main (front) lens (or mirror) of a telescope or camera lens. The size of the objective determines the amount of light collected. Larger objectives allow fainter objects to be seen or recorded.

Objective grating When a transmission grating is placed in front of the objective of a camera lens.

Optical aberrations Image distortions caused by the optical system. These can be chromatic aberrations, coma and field curvature, etc.
Optical axis  The virtual line through the center of all the optical components such as in a telescope/lens, etc. Optical aberrations are usually at a minimum on the optical axis such as the coma.

OSC  One shot color. Applied to a CCD fitted with a Bayer filter to record images in color.

parsec  An astronomical unit of measure. 3.0857 × 10^{16} m, or 3.26 light years.

P Cygni profile  A profile of a spectral line that shows both absorption and emission features. Associated with gaseous shells surrounding a star.

Periodic Table  A tabulated listing of all known elements, grouped by similar properties.

Pixel size  An important measure for CCD chips. Measured in microns, for example, 6.4 × 6.4 μm pixels. Larger pixels are usually more sensitive to incoming light. The size of the pixel can affect the final resolution of the image.

Planck constant  Symbol h = 6.6256 × 10^{-34} Js (Joule second). Used in the energy equation, ΔE = hν that relates the energy change (ΔE) of an electron to the frequency (ν) of the emitted/absorbed wavelength of light.

Planck curves  A series of stellar spectrum intensity curves that show the peak wavelength position changes with temperature.

Planetary nebula  Gaseous shell formed by the collapse of a star or as the result of a nova.

Plate scale  Also called linear dispersion. The scale, in Å/mm or Å/pixels of a spectrum. The higher the plate scale, the smaller the size of the spectrum and the lower the final resolution.

Prism  Shaped piece of glass that produces a spectrum due to dispersion. Can be used with a grating to compensate for the deviation angle (grism).

Quantum theory  A branch of physics that deals with small particles. Uses both wave and particle analogies to resolve interactions at a subatomic level.

Quasar  Quasi-stellar object. An object in a distant galaxy that shows significant redshift in its spectrum.

RAW  A proprietary image format used by manufacturers of DSLR cameras. It contains additional information on each color channel and provides the maximum amount of image data.

R value  A measure of the resolving power of a spectroscope. Equal to the wavelength (λ) of a pair of lines, just separated, divided by the distance between them (Δλ). For example, R = λ/Δλ. R = 100 is a low resolution spectroscope. R = 40,000 is a very high resolution instrument.

Redshift  Symbol, z  A measure of large Doppler shifts in the spectrum due to the expansion of the universe. z = (λ_o – λ)/λ_o.

Reflecting telescope  A telescope, such as a Newtonian, that uses mirrors to form the image. Does not suffer from chromatic aberration, as all wavelengths of light come to a common focus.

Refractive index  Symbol n, a measure of the dispersing power of a prism. The refractive index varies with the wavelength of light. Glass has a typical index of n = 1.5.
**Resolution**  The ability to see two close lines as separate lines. Measured by the smallest distance between them, normally in Å.

**RGB**  Red, green, blue. The sequence of color filters used in the Bayer matrix.

**RSpec**  Commercial software package for the processing of spectral images.

**SCT**  Schmidt Cassegrain telescope, such as Meade/Celestron. A corrector lens is used with a spherical mirror to provide an optically corrected image. Usual focal ratio of f10.

**Seeing**  The size of a star’s disk as seen through a telescope. The size varies with atmospheric conditions. Usually measured in arc seconds.

**SEPSA**  Slit Eyepiece Projection for Star Analyzer. A method of using an entrance slit with a filter grating.

**Sidereal tracking**  An astronomical mount fitted with a drive motor. This rotates the polar axis in RA at a rate of 360° per sidereal day (23 h 56 min 4 s), thereby keeping track of the celestial movement of the sky.

**Slitless**  In spectroscopy, where the entrance slit is much wider than the star image.

**SNR**  Signal to noise ratio. A measure of the unwanted interference (noise) found in images and spectra. An SNR > 50 is normally required in results for professional acceptance.

**Spectral coma**  An optical aberration where the edge of the field of view shows distorted images that vary in size and color.

**Spectral lines**  Bright or dark lines seen in a spectrum. Caused by the absorption (or emission) of energy by atoms.

**Spectroscope**  Instrument containing a dispersion element (prism or grating) to form an image of the spectrum.

**Star bloat**  Enlarged star image usually caused by chromatic aberrations.

**Star classification**  A sequence of star spectra based on absorption features. Originally based on the visibility and clarity of hydrogen absorption lines. The classification sequence is OBAFGKM.

**Supergiant**  Large luminous star with an absolute magnitude greater than −4.6. The majority of supergiants are K- and M-type stars. They are identified in the star classification system with the suffixes Ia and IIa, for example, M5 Ia.

**Supernova**  An exploding star where the magnitude change is more than 10 mag. Usually old massive stars go supernova at the end of their stellar evolution cycle.

**Swan bands**  Dark absorption bands in the spectrum caused by molecules. The original swan bands were identified with carbon compounds.

**Telluric lines**  Absorption lines in the spectrum caused by oxygen and water vapor in Earth’s atmosphere.

**TIFF**  Tagged image file format. Uncompressed high quality image format.

**T thread**  An M42×0.75 mm pitch thread, commonly used on camera adaptors.

**UVES**  A high resolution spectrograph used by the European Southern Observatory (ESO). Extensive source of spectra used by astronomers.

**Vignetting**  Light loss in an optical system caused by interference to the light path. Usually seen as darker edges in an image.
Visible spectrum The part of the electromagnetic spectrum visible to the human eye. Usually from 4000 to 8000 Å. Also called the optical spectrum.

Visual magnitude Apparent brightness of a star. Sometimes called apparent magnitude. The brightest star is seen at a magnitude −1.46 (Sirius), and the faintest naked eye star is about +6.0 mag.

VSpec Freeware software by Valerie Desnoux for processing spectra.

Wavelength A characteristic of electromagnetic energy. Short wavelengths give gamma rays, X-rays, etc., and long wavelengths infrared and radio. A small portion of the electromagnetic energies with wavelengths between 4000 and 8000 Å are visible (optical or visual spectrum).

White dwarf Low luminosity star, usually a B- to F-type star with an absolute magnitude <10.0. Identified with the suffix D.

Wolf-Rayet star A star that shows emission lines in the spectrum. Caused by high rates of mass loss.

Zero order image The undeviated image of the target star seen with a grating. The zero order image lies on the optical axis and represents a zero wavelength position. For example, for calibration purposes, zero order wavelength, \( \lambda_o = 0000 \) Å.
## Index

### A
- Aberrations, 8, 19, 79, 120–124
- Absolute brightness, 36
- Absolute visual magnitude, 137, 146
- Absorption lines, 14, 33, 35, 40–42, 60, 74, 127, 128, 138
- Adjustable slit mechanism, 87
- Afocal camera adaptor, 87
- Analogue to digital unit (ADU), 110
- Angstrom, 4, 30, 58
- Angular dispersion, 6, 29, 116
- AstroArt V4, 58

### B
- Balmer lines, 35, 58, 131
- Balmer series, 40, 76, 113, 139
- Bayer matrix, 21, 109
- Be stars, 40–41, 128, 147
- Be Star Spectra database, 41
- Bias frame, 54
- Binning, 68, 109
- Black body theory, 128
- Blazed grating, 17
- Blazing, 6, 120
- Bright Star Catalogue, 61

### C
- Calibrated profile, 60, 70
- Calibration factor, 59
- Calibration spectrum, 84

### D
- Camera response, 73–78, 83, 113–114
- Canon, A.J., 134
- Carpenter prism, 122
- Carte du Ciel, 16
- Cataclysmic variables, 42
- CCD adaptor for a camera lens, 92–93
- CCDCalc, 16
- CCD chip sizes, 110
- Change in focus, 23
- Chromatic aberration, 8
- Chromatic coma, 121. See also Aberrations
- Collimated light beam, 88
- Continuum co-efficient, 74
- Continuum removal, 62, 77
- Coronium, 131
- Correcting spectra using the instrument/camera response curve, 75–78
- Creating additional stellar reference profiles, 77
- Crowded star fields, 22
E
ELODIE. See Reference spectra
Emission nebula, 7, 45, 131
ESO-MIDAS, 67
Exposure, 5, 14, 18–20, 27–29, 35, 42, 54, 80, 87–89, 114

F
Field curvature. See Aberrations
Field of view, 13, 21, 29, 99, 103, 121, 158
Filters, 1–3, 15–17, 23, 44, 79, 83–91, 95, 119, 139
First amateur results, 47
First order spectrum, 6, 18, 80, 118
First spectrum, 13, 16–19, 33–52
Flat frame, 55
Fluro spectrum, 83
Focus, 9, 16–19, 28, 64, 86, 92–98, 120
Focusing the spectrum, 9, 16, 28, 82, 103, 120
Forbidden lines, 131–133
FOV. See Field of view
Fraunhofer lines, 141–142
Free spectral range, 118
Full width half maximum, 76, 117
FWHM. See Full width half maximum

G
Grating equation, 118, 125
Grating theory, 78, 115–116
Gray, R.O., 61
Grism, 92, 99, 102, 120–124
Grotrian diagrams, 131

H
Hansen, T., 16, 37
Harvard Smithsonian Center for Astrophysics, 45
Henry Draper catalogue, 23, 134
Hydrogen emission lines, 45, 71

I
Imaging source, 11, 16, 29
Improving your grating spectroscope, 79–104
Instrument response, 9, 19, 59, 68, 78, 84
Instrument response curve, 66, 113, 139
Intensity values, 58, 68
In the converging beam, 14, 23, 32, 86, 91, 120
Ionization, 131–133

IR blocking filter. See Filters
IRIS, 54, 56–58
ISIS, 66–67
ISO setting, 9, 18, 111

K
Kirchhoff’s laws, 127–128, 130

L
Liege Atlas. See Reference spectra
Light pollution lines, 66, 142–143
Linear dispersion. See Plate scale
Line broadening, 36
Line spectrum, 80, 128
Linux, 67
Luminosity classes. See Stellar classification

M
Maximum grating to CCD distance, 20
MKK spectral sequence. See Stellar classification
Molecular bands, 135
Multiple exposures, 55

N
Nebulium, 131
Needle reflection slit, 80
Neon spectrum, 84, 140
Newton, I., 3
Non linearity of the spectrum, 124–125
Normalized profile, 67, 70, 71
Nova, 39, 42–45, 108, 135
Nuclear process, 39
Nyquist-Shannon sampling theory, 108

O
Object binning, 68
Objective grating, 13, 22–28, 32, 49, 80, 91
One point calibration, 66

P
P Cygni profile, 41, 161
Pic format, 61
PICKLES. See Reference spectra
Pickles library, 61, 66, 77
Index

Pixel profile graph, 57–60, 68–73
Pixel size, 10, 21, 31, 96, 108–110
Planck curves, 36, 40, 129
Planck’s constant, 131
Planetary nebula, 7, 45
Planetary spectroscopy, 48–51
Plate scale, 20, 29–32, 70, 116–124
Point and shoot camera, 9, 88–89
Preparing the raw image file for processing, 54–56
Prism, 3–5, 79, 92, 104, 122–124
Processing Spectra, 53–78

Q
QE curve, 110–112
Quantum theory, 36, 127, 129–131

R
Radial velocity, 133
Rayleigh limit, 116
Redshift, 47–48, 133–134
Reference lines. See Standard spectral lines
Reference points, 57, 69
Reference spectra, 61, 138–141
Refractive index, 122, 161
Registax, 9, 19, 55
Relative response. See QE curve
Remote controller, 28
Removing the sky background, 20, 56
Resolution, 4, 7, 19–23, 30, 46, 64, 76, 116, 120, 139
Rlhires, 66
RSpec, 64–66
RS spectroscope, 88
R value, 30, 31, 117, 161

S
Sagan, C., 39
Seeing. See Seeing conditions
Seeing conditions, 11, 21, 31, 117
Shell stars, 40–41
Shot noise, 114
Signal-to-noise ratio (SNR), 20, 54, 77–78, 114–115
SkySpec, 62
Slitless configuration, 4, 98
Slit tube, 80

SNR. See Signal-to-Noise Ratio (SNR)
Solar spectrum, 51
Spectral type, 61
Spectrum, 16, 53, 127
Standard spectral lines, 138–142
Star stuff, 1, 39, 42
Stellar classification, 35, 61, 134–137
Stellar classification atlas, 35
Stellarium, 16
Stellar spectral atlas, 34, 36
Supernovae, 42–45, 47
Swan bands, 48, 87

T
T2 camera adaptor, 10, 26
Tarantula Nebula, 46
telluric lines, 72, 81, 142, 157, 162
Theoretical spectral resolution, 116
Tilt of a spectrum, 57
Transmission filter grating. See Diffraction gratings
Transmission gratings. See Diffraction gratings
TransSpec.xls, 79

U
UVES. See Reference spectra

V
Variable stars, 42–45
Visual Spec. See VSpec
VSpec, 61, 68, 137

W
Walker, R., 37, 139
Wavelength calibrated, 60
Wavelength calibration, 37, 54, 68–73, 100, 125
Well depth, 110
White Dwarf, 36, 42, 44
Wolf-Rayet stars, 42
WR stars. See Wolf-Rayet stars

Z
Zero order image, 5, 10, 17, 69–72, 89, 99–101, 117, 120