λ Andromeda: All dredged–up?

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A mystery star trained in the art of deception.
• The subgiant of the RS CVn system λ And is exhibiting an interesting C/N ratio; this is at odds with its position on evolutionary tracks.

- We find λ And’s C/N = 3 (red) and similar to that of α Per, a MS giant. But λ And lies on the vertical branch, from its stellar parameters, where normally one would have expected a lower C/N ratio — 1.
- The C/N ratio is distinctive to other similar RS CVn: UX Ari, KIC 337144 (CV & GV) and HR 1099 (VI + GV).

- We used the Drake (2005) method to evaluate the C/N ratio for λ And: C/N = 1.85 ± 0.25, where L_t and L_s are the number of counts in the C IV (42" Å) and N IV (30" Å) lines, respectively. The values 1.85 and 0.25 are the effective sources normalizing factors at the appropriate wavelengths (Pfeuer et al. 2002).

- The results are consistent with the Drake et al. (2005) analysis and confirm the anomalous nature of λ And.

λ And: G8 III–IV + ?

Tracks from STARS et al. (2004)

Discrepancy between where a star with C/N = 3 should lie and where lambda And appears on the evolutionary tracks.

Possible explanations
• Pollution idea (be similar to stars where the primary has a high mass and a giant is orbiting it). The secondary star has a higher C/N ratio, and the star is dredging up the lower C/N material.

- Mixing parameters (based on): It has been shown that the secondary stars in close binary systems (e.g., R Cor) have high C/N ratios. The C/N ratio is thought to be lower in the primary star. The increase in C/N ratio is due to the mixing process in the secondary star. The mixing process is thought to occur in AGB stars and is responsible for the high C/N ratios seen in binary systems.

- Stellar models: We note that the AGB models can produce higher C/N ratios, and it is possible that mixing occurs in the secondary star.

- Convection theory: The mixing is due to the convection in the secondary star and is responsible for the high C/N ratios seen in binary systems.

Table 1: Summary of photometric and derived properties for λ And.

<table>
<thead>
<tr>
<th>Star</th>
<th>M_0 (M_S)</th>
<th>B_V</th>
<th>V_B</th>
<th>M_2 (M_S)</th>
<th>P(B)</th>
<th>Log(g)</th>
<th>Log(T)</th>
<th>Log(L/L₀)</th>
<th>C/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>λ And</td>
<td>1.5 ± 0.5</td>
<td>1.11</td>
<td>1.47</td>
<td>1.68 ± 0.2</td>
<td>4.4</td>
<td>4.45</td>
<td>4.4</td>
<td>4.4</td>
<td>3.9</td>
</tr>
</tbody>
</table>

1 All photometric values are taken from Stanek et al. (2012).
2 Use estimate taken from Duquennoy et al. (2011).
3 Use estimate taken from Hourihane et al. (2014).
4 Use estimate taken from Stanek et al. (2012).

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Figures

Subgiant primary

White dwarf, low–mass MS, brown dwarf secondary?