The Angular Diameter of \( \lambda \) Boötis

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  – PJ and Nils for helping with the observations
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The $\lambda$ Boo Class

- $\lambda$ Boo (A3V) is the prototype
  - About 50 stars (2% of all known A-stars)
- Chemically peculiar A/F V stars
  - C, N, O, S – solar abundances
  - Mg, Ca, Fe – highly depleted ([M/H]~ −2)
- Depletion may be related to gas/dust separations in disks
  - Strong infrared excess
    - Vega-like Phenomenon - Young (MYr)
    - Evolved stars with mass loss - Old (GYr)
  - Ages determined from HRD
    - Solar Metalliccity tracks only
      - No consideration of other metallicities
    - Ages: 10 – 1000 Myr
- Alternative hypothesis
  - Binary stars of similar spectral types
  - Blended spectra
- Been a general acceptance of the stars being young and related to the Vega-likes
CHARA Array Observations

• Predicted angular size: ~0.5 mas
  – Very small
  – Used the long baselines available at CHARA: 250 – 300 m
  – Wavelengths of observation: H and K
  – Added in archival PTI data (H and K @ 85 and 100 m)

• Data span 6 years
Angular Diameter and Stellar Parameters

- **Limb Darkened Model**
  - $\Theta_{LD} = 0.533 \pm 0.029$ mas

- **Linear Radius**
  - Using $D = 29.8 \pm 0.5$ pc
  - $R = 1.70 \pm 0.10 \, R_{\text{Sun}}$

- **Temperature**
  - Using $L = 16.3 \pm 0.6$ $L_{\text{Sun}}$ (determined from SED fit)
  - $T_{\text{eff}} = 8887 \pm 242$ K

- **Mass**
  - Surface gravity $\log(g) = 4.0 - 4.2$
  - $M = 1.1 - 1.7 \, M_{\text{Sun}}$

- Mass range mostly a result of the uncertainty in the $\log(g)$

- Radius uncertainty contributes only $\sim 0.1 \, M_{\text{Sun}}$ in mass uncertainty
In Comparison to other A-Stars …

<table>
<thead>
<tr>
<th>Star</th>
<th>Spectral Type</th>
<th>Radius ([R_{\text{Sun}}])</th>
<th>Gravity ([\text{cm s}^{-2}])</th>
<th>Mass ([M_{\odot}])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vega</td>
<td>A0V</td>
<td>2.78 ± 0.02 (eq)</td>
<td>3.98</td>
<td>2.3 ± 0.2</td>
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<tr>
<td></td>
<td></td>
<td>2.26 ± 0.07 (pole)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sirius</td>
<td>A1V</td>
<td>1.71 ± 0.01</td>
<td>4.31</td>
<td>2.01 ± 0.05</td>
</tr>
<tr>
<td>β Leo</td>
<td>A3V</td>
<td>1.72 ± 0.04</td>
<td>4.26</td>
<td>1.97 ± 0.09</td>
</tr>
<tr>
<td>λ boo</td>
<td>A3V kB9.5mB9.5</td>
<td>1.70 ± 0.10</td>
<td>4.0 – 4.1</td>
<td>1.1 – 1.7</td>
</tr>
</tbody>
</table>

![Graph showing stellar mass versus gravity]
HR Diagram and the Age of $\lambda$ Boo

- Solar-Metallicity Tracks Predict
  - $M \sim 2.0\ M_{\text{Sun}}$
  - pre-MS Age: 8 – 30 MYr
  - post-MS Age: 80 – 300 MYr
  - Derived mass does *not* agree with solar-metallicity mass

- Metal-Poor Tracks Predict
  - pre-MS: $M \sim 1.6\ M_{\text{Sun}}$, Age: 3 – 4 MYr
  - post-MS: $M \sim 1.2\ M_{\text{Sun}}$, Age: 1 – 2 GYr (!)
  - Likely *not* pre-MS – no evidence for HAeBe-like phenomenon

- This is only one $\lambda$ Boo star
  - Where do the rest fall?
  - Can the $\lambda$ Boo phenomenon occur during both ms and post-ms lifetimes?
  - Are metal-poor tracks appropriate for all $\lambda$ Boo stars?