Modelling the magnetic field of the B-type N-rich star ζ Cassiopeiae

Maryline Briquet & Coralie Neiner
First studies

- Optical line-profile variability (Si\textsc{iii} 4553) \sim day in this B2 IV star \rightarrow proposed as 53 Per variable

- Indirect indicators of presence of a magnetic field:
  Surface chemical peculiarities (N-rich)
  Variability in UV wind-sensitive resonance lines
- **IUE data** →
  - accurate rotation period
  - $P_{\text{rot}} = 5.37045$ days

- **Musicos data** →
  - Oblique magnetic dipole
  - $i = 18^\circ$ [14 - 22]
  - $\beta = 77^\circ$ [71 – 83]
  - $B_{\text{pol}} = 335$ G [270 - 455]

- confirmed as N-rich (also in Nieva & Przybilla 2012)
Our new study

82 Narval data covering well the various phases of rotation

LSD profiles for a mask - with all photospheric lines - with only N lines
Longitudinal magnetic field

![Graph showing longitudinal magnetic field versus rotation phase. The x-axis represents rotation phase ranging from 0 to 1, and the y-axis represents the magnetic field strength in Gauss (G)].
off-centered dipole model

LSD Stokes V – all lines
off-centered

\[ i = 34.5^\circ \quad [33.6 - 35.4] \]

\[ \beta = 104.5^\circ \quad [103.7 - 105.2] \]

\[ B_{\text{pol}} = 56.0 \, \text{G} \quad [55.5 - 56.5] \]

\[ d = 0.04145 \quad [0.03784 - 0.04564] \]

\[ \Phi = 0.06795 \quad [0.06662 - 0.06928] \]

\[ \chi^2 = 1.337 \]

centered

\[ i = 35.2^\circ \quad [34.3 - 36.1] \]

\[ \beta = 108.2^\circ \quad [107.6 - 108.8] \]

\[ B_{\text{pol}} = 55.3 \, \text{G} \quad [54.8 - 55.8] \]

\[ \Phi = 0.0695 \quad [0.06791 - 0.07065] \]

\[ \chi^2 = 1.363 \]

B_{\text{pol}} below the 300 G threshold (Aurière et al. 2007)
off-centered dipole model

LSD Stokes V – N lines
<table>
<thead>
<tr>
<th>N lines</th>
<th>All lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>i = 30.8° [29.3 - 32.3]</td>
<td>i = 34.5° [33.6 - 35.4]</td>
</tr>
<tr>
<td>β = 102.6° [101.5 - 103.7]</td>
<td>β = 104.5° [103.7 - 105.2]</td>
</tr>
<tr>
<td>B_{pol} = 91.9 G [90.5 - 93.3]</td>
<td>B_{pol} = 56.0 G [55.5 - 56.5]</td>
</tr>
<tr>
<td>d = 0.068 [0.061 - 0.075]</td>
<td>d = 0.04145 [0.03784 - 0.04564]</td>
</tr>
<tr>
<td>Φ = 0.07307 [0.07078 - 0.07535]</td>
<td>Φ = 0.06795 [0.06662 - 0.06928]</td>
</tr>
<tr>
<td>chi² = 1.148</td>
<td>chi² = 1.337</td>
</tr>
</tbody>
</table>
Line-profile variability

Only rotation period found ↔ chemical spots
No stellar pulsation detected although in β Cep/SPB instability strip
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