Yes, CHARA Can Image Cool Starspots, But Can It See Them Move?

* A Case Study of Lambda Andromedae

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The CHArA team
Goals

Strassmeier et al. 2003

HD 171488 average temperature map

Strassmeier 1999
Goals

• Directly image cool starspots
  – Precisely measure cool starspot properties

• Observe stellar rotation via cool starspot motion

• Develop techniques for imaging other active stars → compare with Doppler maps
“Lambdy Andy”

G8 III
SB1
\( \pi = 38.74 \pm 0.68 \text{ mas} \)
D ~ 25 pc
\( \text{vsini} = 6.5 \text{ km/s} \)
\( P_{\text{phot}} = 54.33 \text{ days} \)
\( H \text{ mag} = 1.501 \)
\( \Delta V \text{ mag} = 0.22 \)
\( \theta \sim 2.75 \text{ mas} \)
Fig. 2.—1976–1991 $V$ light curve of $\lambda$ And from the data sources listed in Table 1. Each point is the mean of (usually) three differential observations in the sense of $\lambda$ And minus $\Psi$ And. While the 54 day rotation period is difficult to see at this scale, the changing amplitude of the spot wave and the long-term variations in mean magnitude are readily apparent.
Lam And Light Curve 2007-2011
CHARA Observations

MIRC – H band
R ~ 40
27 epochs
11/17/07 to 10/24/12
Evolving observing strategy
Lam And

Aug 17th, 2008
S1-E1-W1-W2
Aug 25th, 2009
S1-E1-W1-W2 &
S2-E2-W1-W2
Aug 24th & 25th, 2010
S1-E1-W1-W2 &
S2-E2-W1-W2
Lam And

Sept 19th, 2011
S1-S2-E1-E2-W1-W2
Parametric Model & Reconstructions

MODEL

Power-law limb darkening

2 stellar parameters
  • $\theta, \alpha$

N spot parameters
  • $(\varphi, b, l, f)$ per spot

Downhill simplex

MACIM & BSMEM
First find stellar diameter and limb darkening coefficient only using $1^{st}$ lobe visibility data

$\theta: 2.777 \pm 0.027$ (mas)

$\alpha: 0.241 \pm 0.014$

$R_{\text{star}} = 9.64 \pm 0.19 \ R_{\text{sun}}$
Observing Cadence: ~ 8 days (15%)
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Are These Spots Real?

- Consistency between models and reconstructions

- Consistent spot parameters
  - $\varphi = 0.101 \pm 0.033$
  - $F_{sp}/F_{ph} = 0.789 \pm 0.035$

- Starspot temperature consistent with expectations
  - $\Delta T \sim 500$ K
Rotation?
<table>
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<th>Spot</th>
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<th>1</th>
<th>2</th>
<th>3</th>
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Observing Cadence: ~ 4 days (7%)
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Amoeba solutions highly dependent on initial positions and search scales.