Constraining the Mass Loss Geometry of Beta Lyrae

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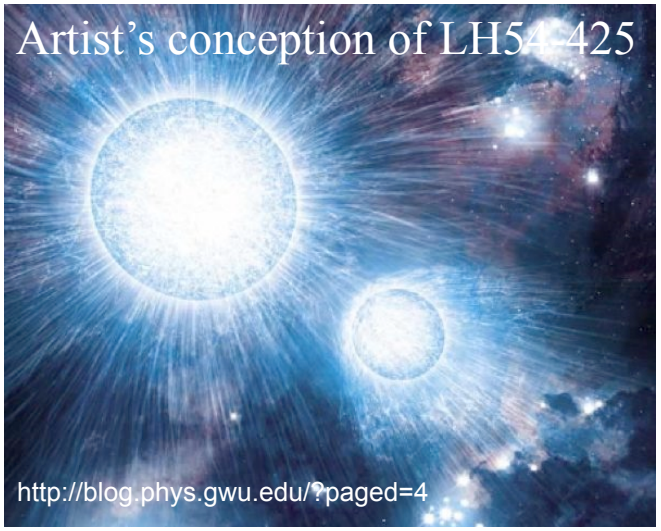
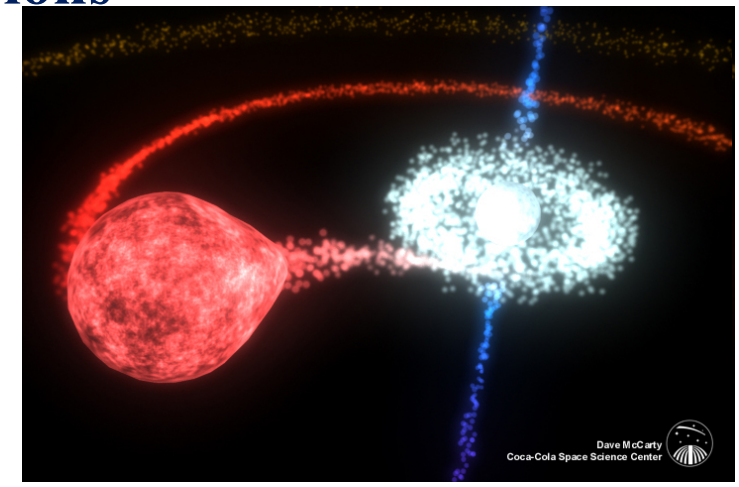
Collaborators: Jennifer Hoffman, Nick Elias and Bruce Holenstein

Mass Loss in Binary Systems

Explosions

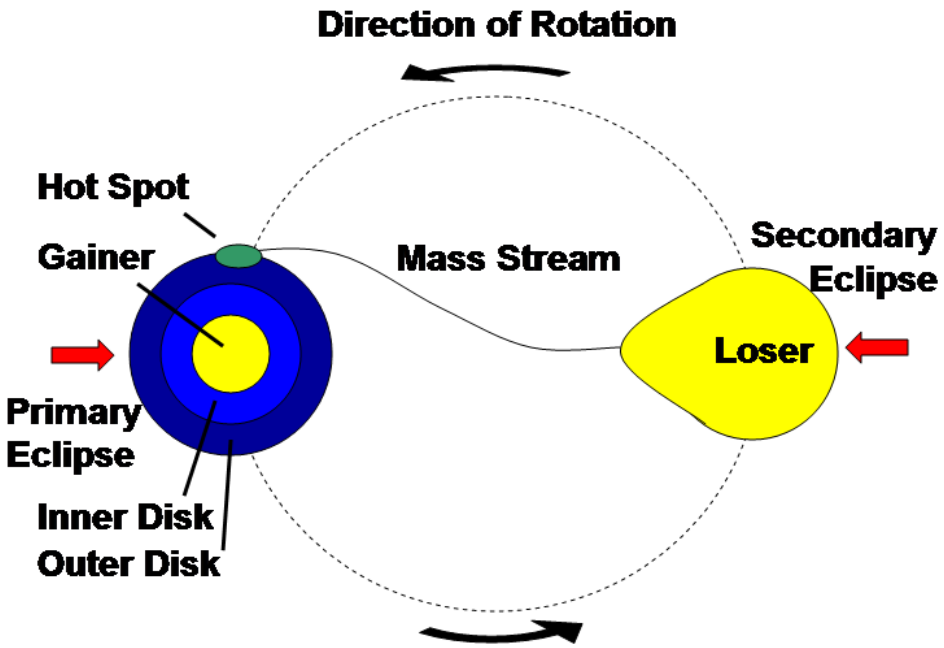


Stellar Winds

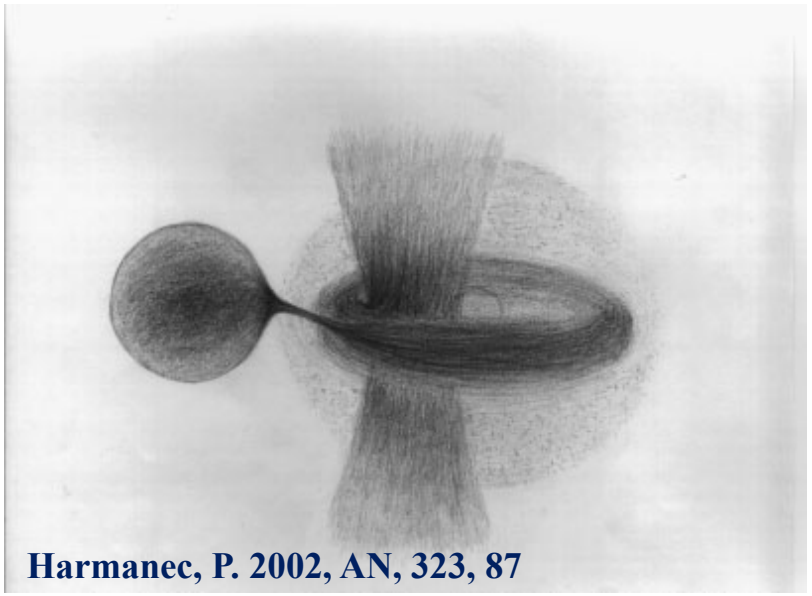


Roche lobe transfer

Beta Lyrae: What We Know



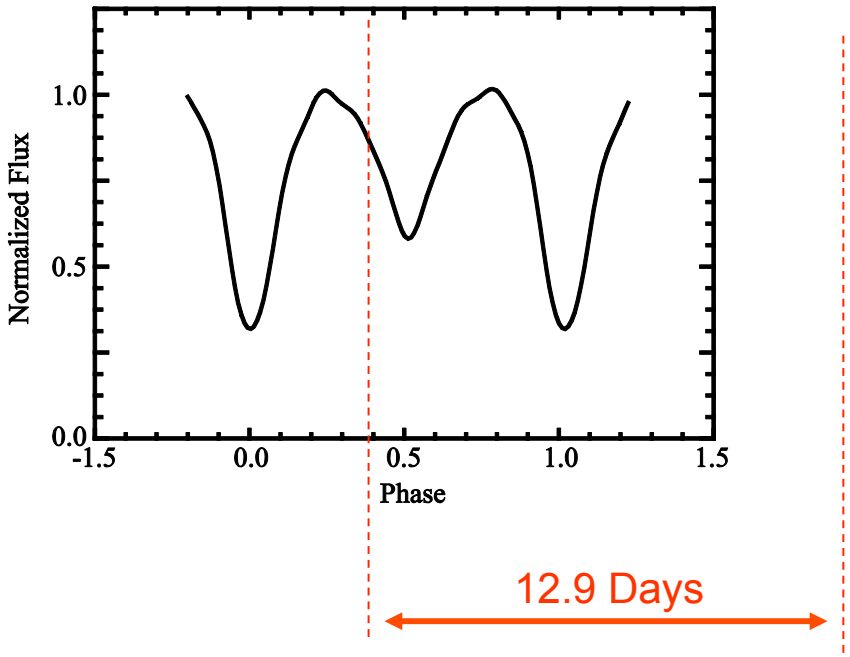
Polar View

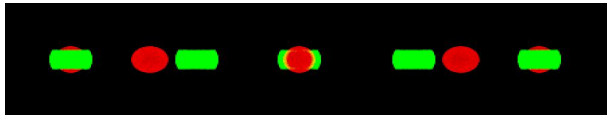


Edge On View

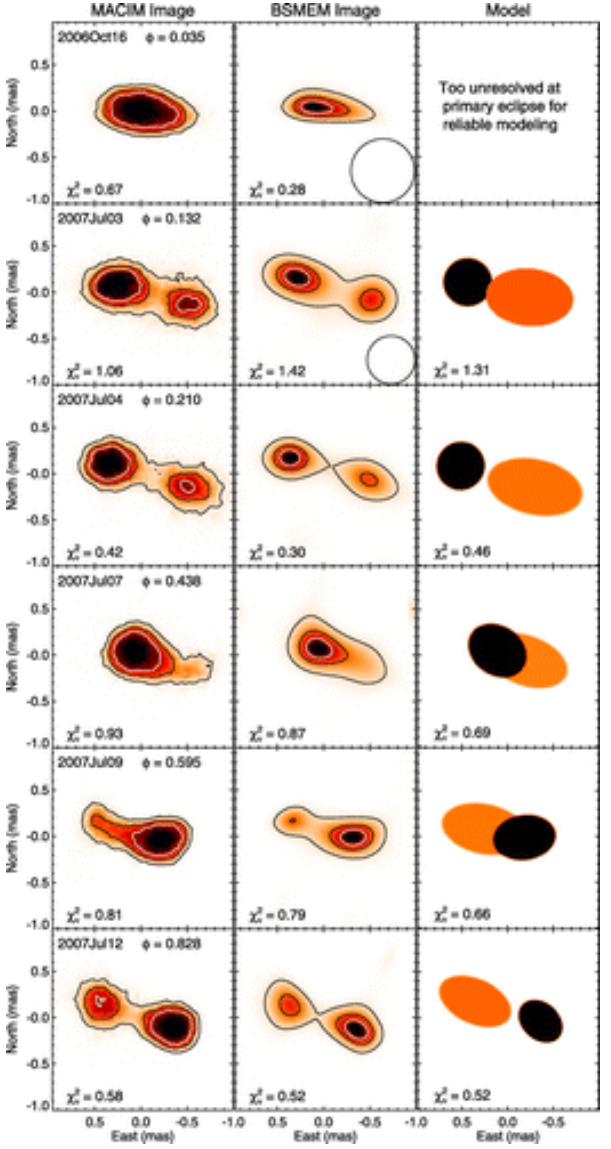
Beta Lyrae: What We Know

V Band Light Curve





IR H band: 1.5 to 1.8μm



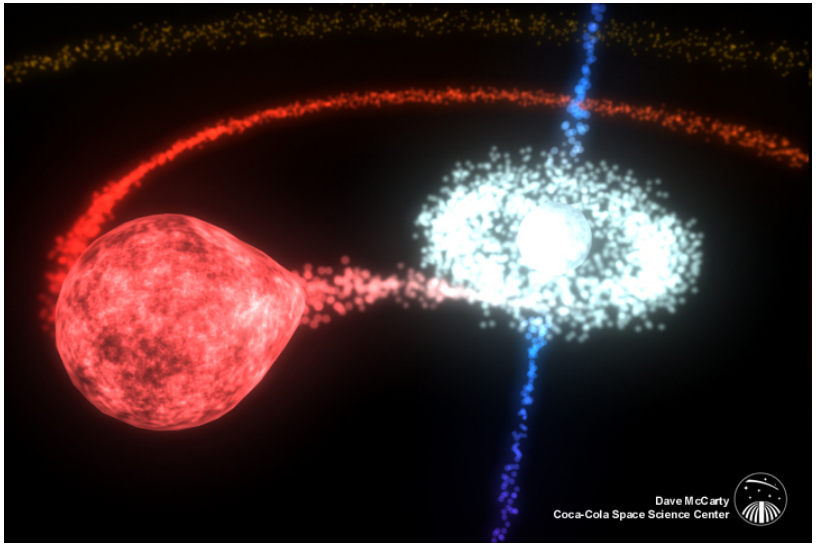
Harmanec et al., 1996, A&A, 312, 879
Zhao et al., 2008, ApJ, 684, L95

Beta Lyrae: What We Don't Know

Where is the mass lost?

How much matter is in the jets?

What are the characteristics of the jets and mass stream?

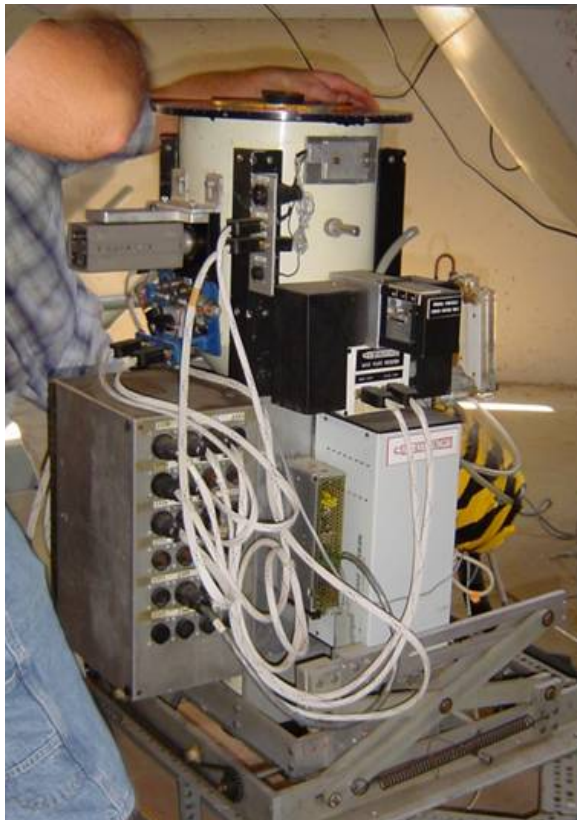


The Data Set

HPOL: 14 Reticon (3200-7500Å)
53-55 CCD (3200-10,500Å)

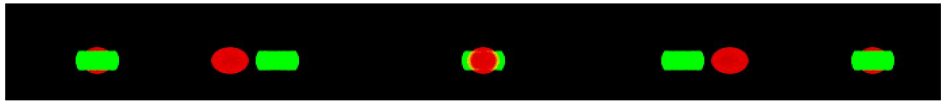
Appenzeller & Hiltner (1969): 37 *B*
127 *V*

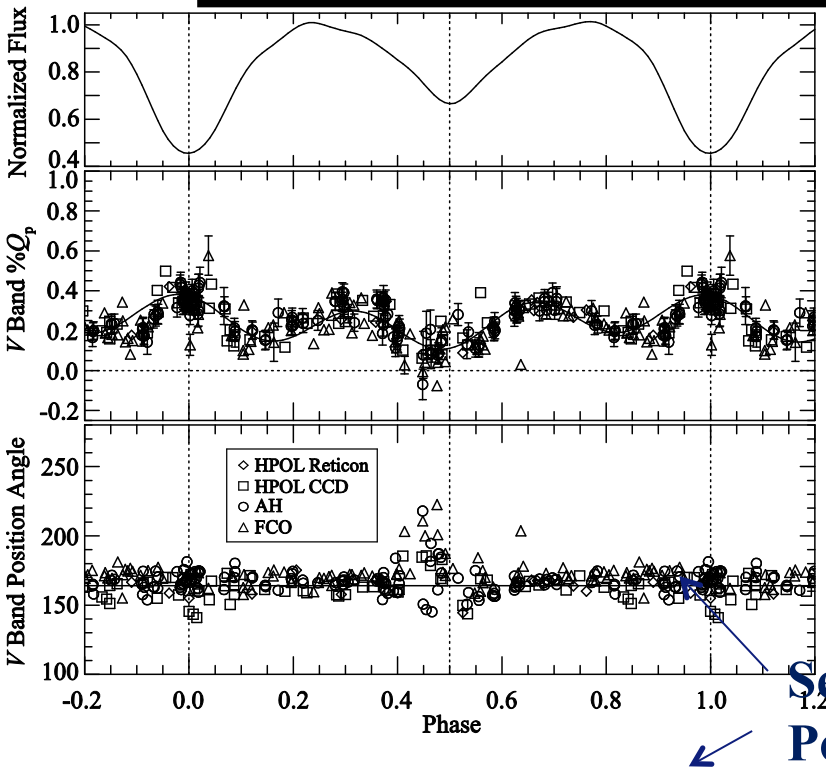
Flower & Cook Observatory: 19 *B*
88 *V*
17 *R*



Hoffman et al., 1998, AJ, 115, 1576

V Band Polarized Light Curve

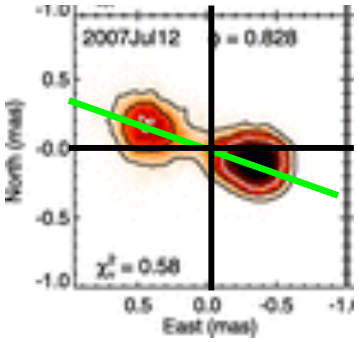




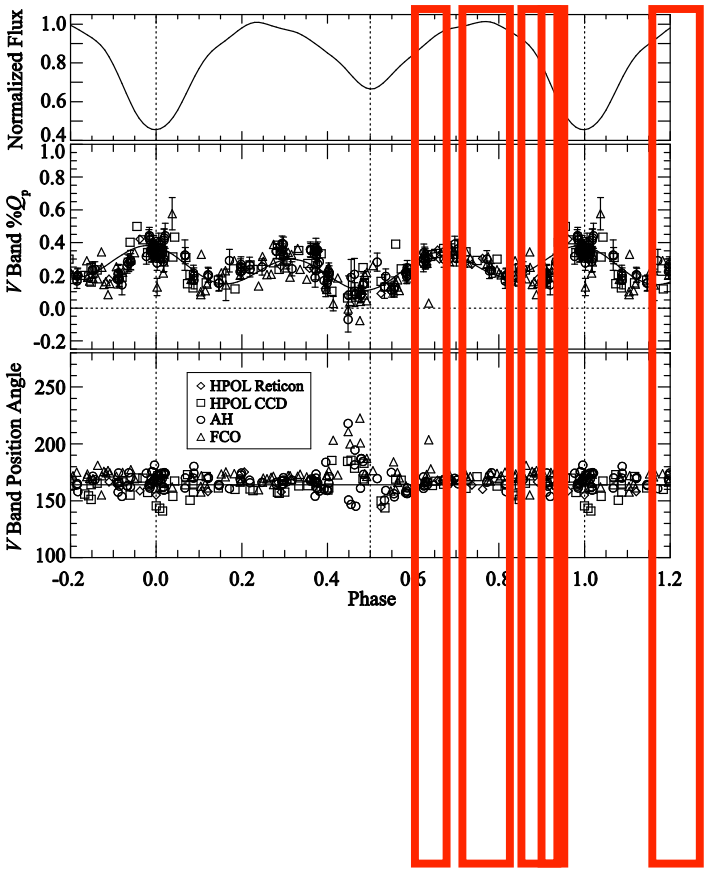
Secondary Eclipse in Polarized Light!

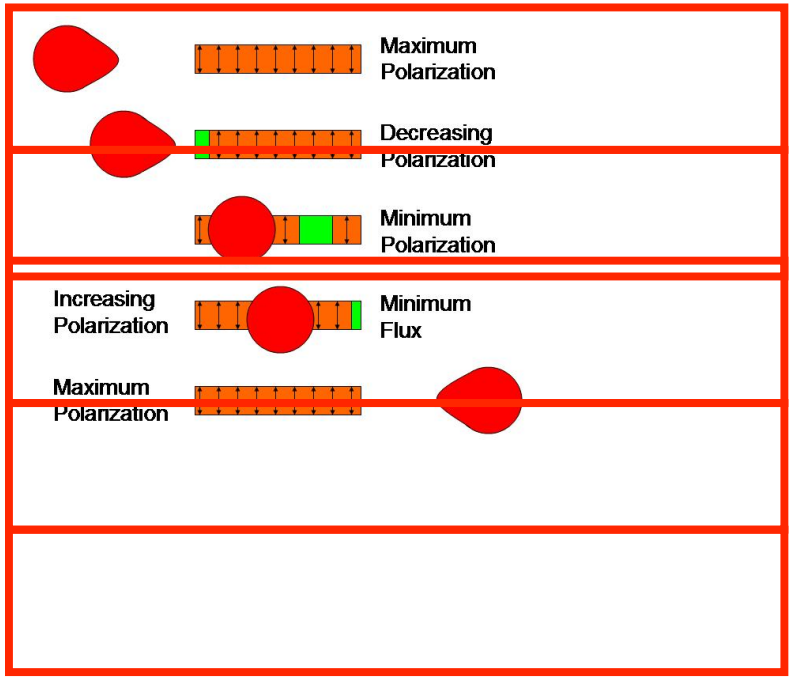
Zhao et. al. (2008):
253º±1.97º
251º± 1.83º

HPOL Observations:
164º (± 1º)+90º=254º

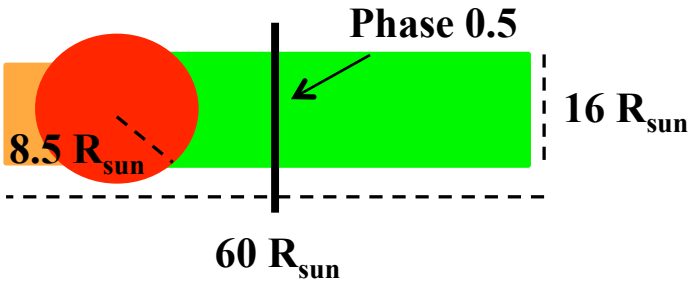


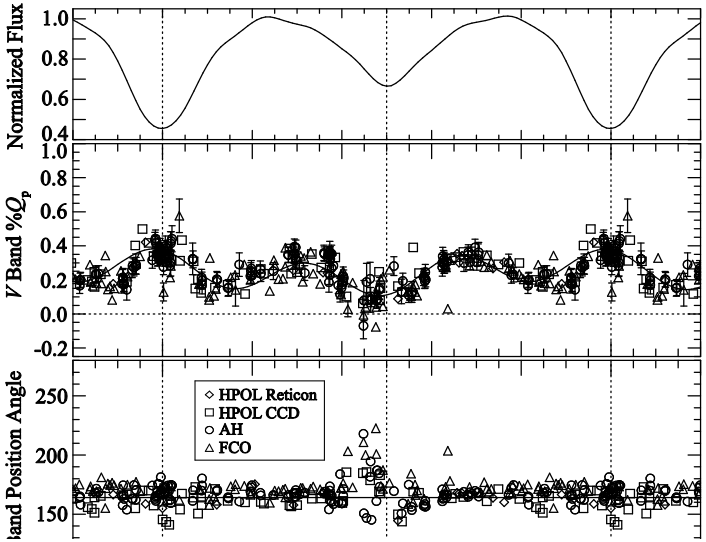
Proposed Geometry





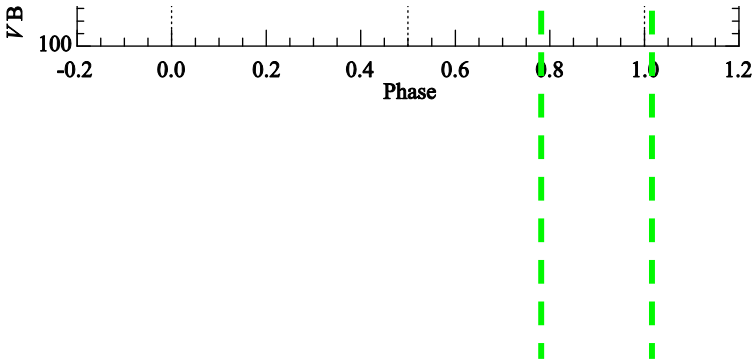
Hot Spot %Q_p Size Estimate

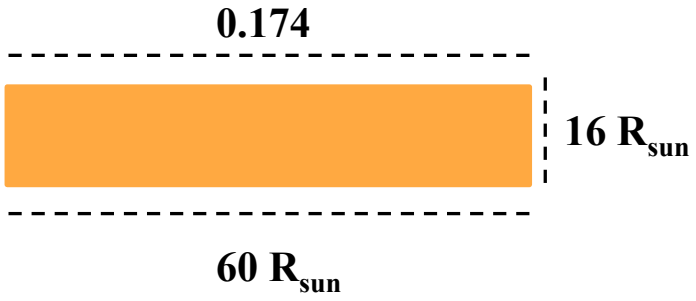




Band	2nd ary Phase	%Q_p Hot Spot Size
B	0.449	28 R_{sun}
V	0.457	28 R_{sun}
R	0.482	40 R_{sun}
I	0.455	40 R_{sun}

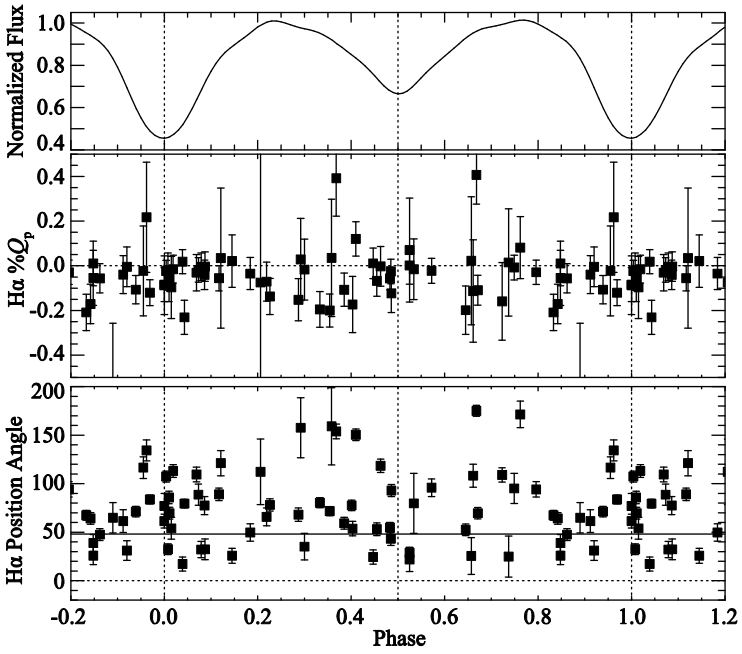
Hot Spot PA Size Estimate

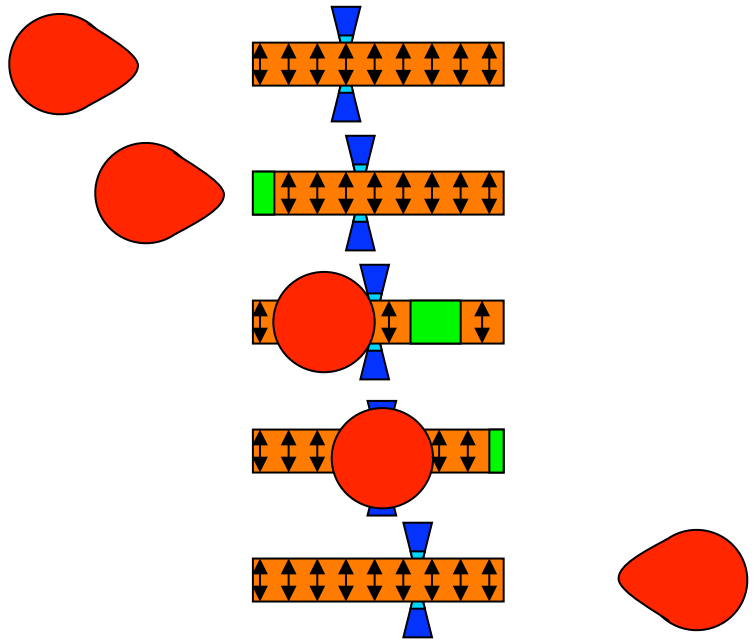




Band	Size in Phase	Max Hot Spot Size
B	0.14	48 R_{sun}
V	0.16	55 R_{sun}
R	0.125	43 R_{sun}
I	0.09	31 R_{sun}

Hα Line


Normalized Flux
1.0
0.8
0.6
0.4
Hα %Q_p
0.4
0.2
0.0
-0.2
-0.4
Hα Position Angle
200
150
100
50
0
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Phase



Conclusions

Band	PA Hot Spot Size	$\%Q_p$ Hot Spot Size
B	48 R_{sun}	28 R_{sun}
V	55 R_{sun}	28 R_{sun}
R	43 R_{sun}	40 R_{sun}
I	21 R_{sun}	40 R_{sun}

Line polarimetry suggests origin of jets is not hot spot

Do other Roche lobe-transfer systems show secondary eclipse effect?

What does the jet location mean in terms of evolution?

Future Work:

X-ray data

Line polarization

Better monitoring near secondary eclipse

Period Analysis

Acknowledgements:

Jennifer Hoffman

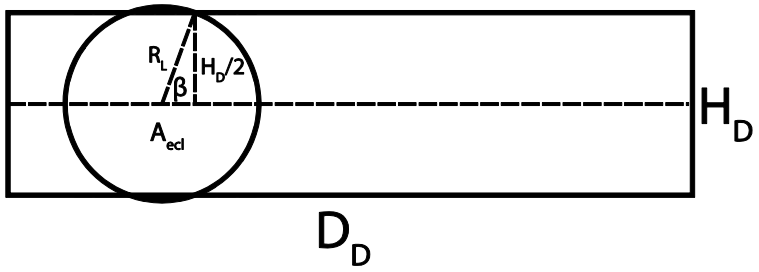
Marilyn R. Meade

Ken Nordsieck

Brian Babler

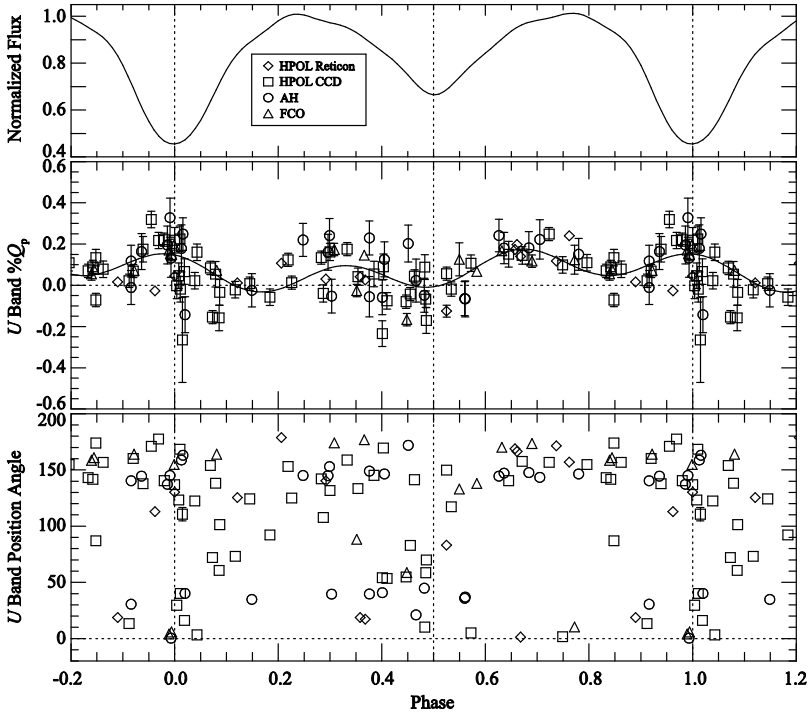
Nick Elias

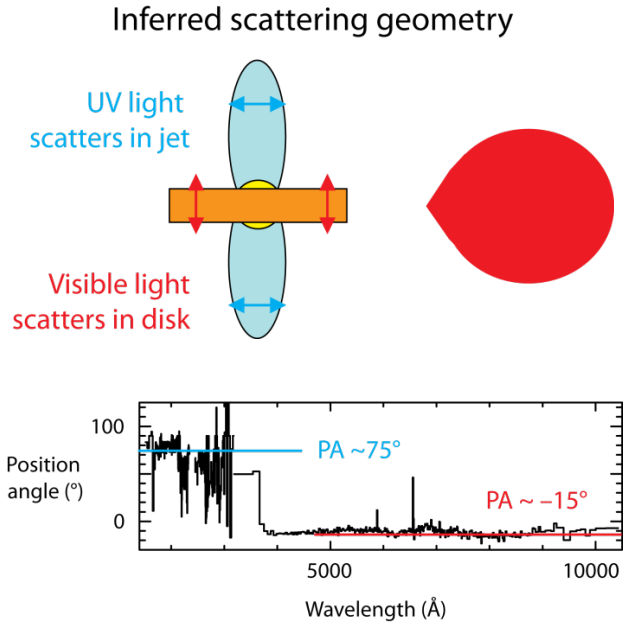
Hot Spot Simple Model Size Estimate



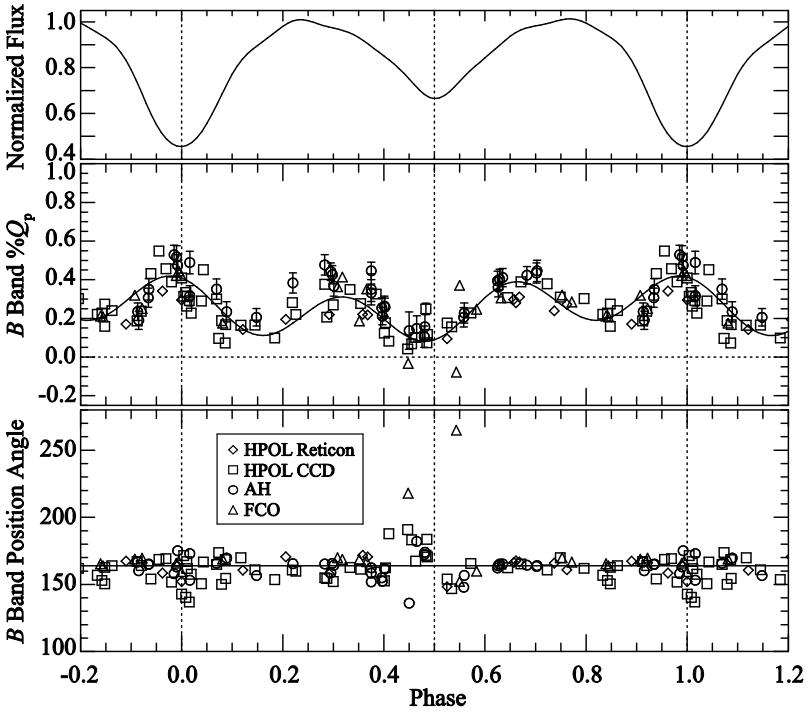
Band	q_{DC}	q_{min}	HS_{SM}
B	0.187	0.041	37
V	0.179	0.081	23
R	0.171	0.074	24
I	0.140	0.076	19

U Band

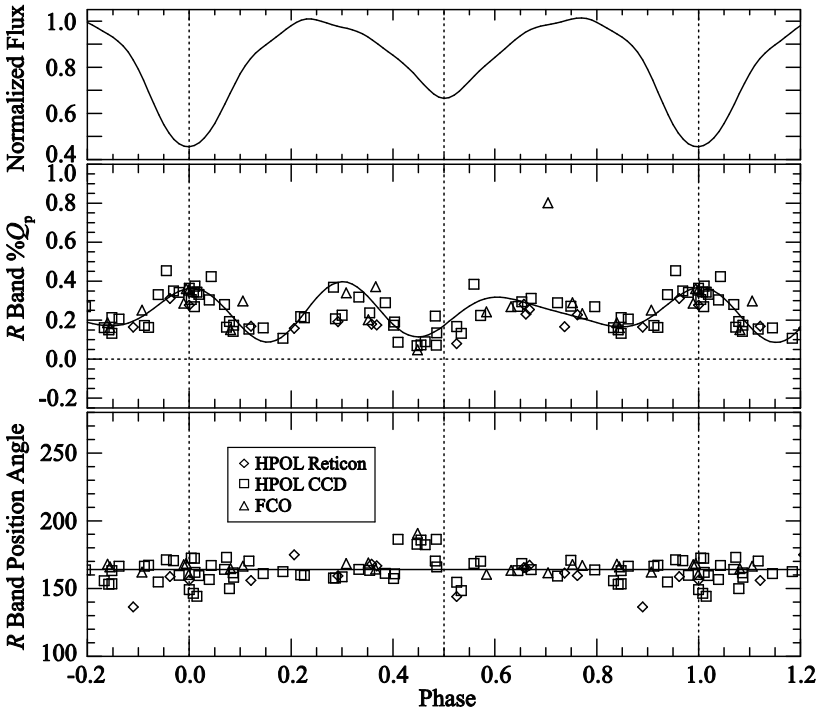

Normalized Flux
HPOL Reticon
HPOL CCD
AH
FCO
U Band %Q_p
U Band Position Angle
Phase


Inferred scattering geometry
UV light
scatters in jet
Visible light
scatters in disk
Position
angle (°)
100
0
PA ~75°
PA ~ –15°
5000
10000
Wavelength (Å)

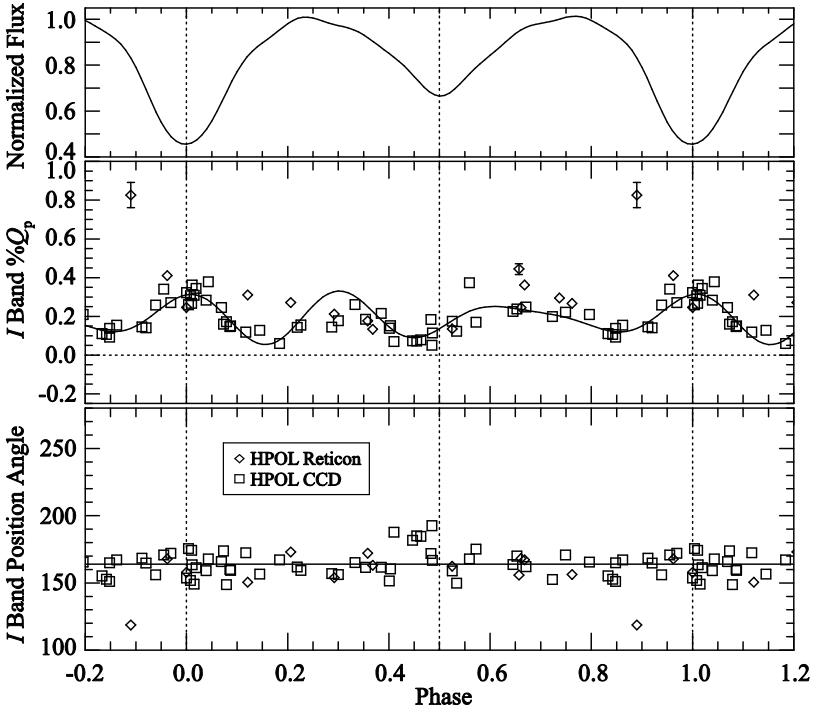
B Band


Normalized Flux
1.0
0.8
0.6
0.4
B Band %Q_p
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
B Band Position Angle
250
200
150
100
HPOL Reticon
HPOL CCD
AH
FCO
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Phase

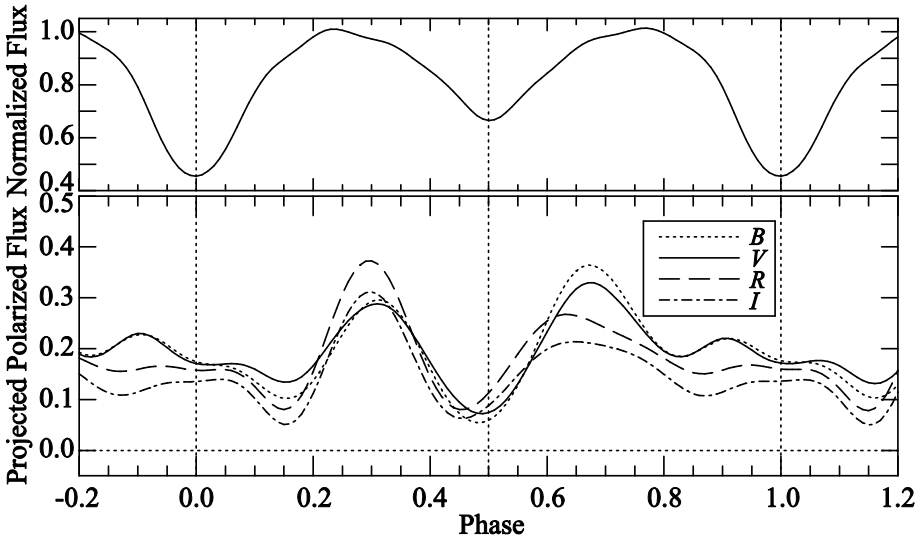
R Band


Normalized Flux
R Band %Q_p
R Band Position Angle
HPOL Reticon
HPOL CCD
FCO
Phase

I Band


Normalized Flux
1.0
0.8
0.6
0.4
I Band %Q_p
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
I Band Position Angle
250
200
150
100
HPOL Reticon
HPOL CCD
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Phase

Projected Polarized Flux



V Band Polarization and $\%U_p$