

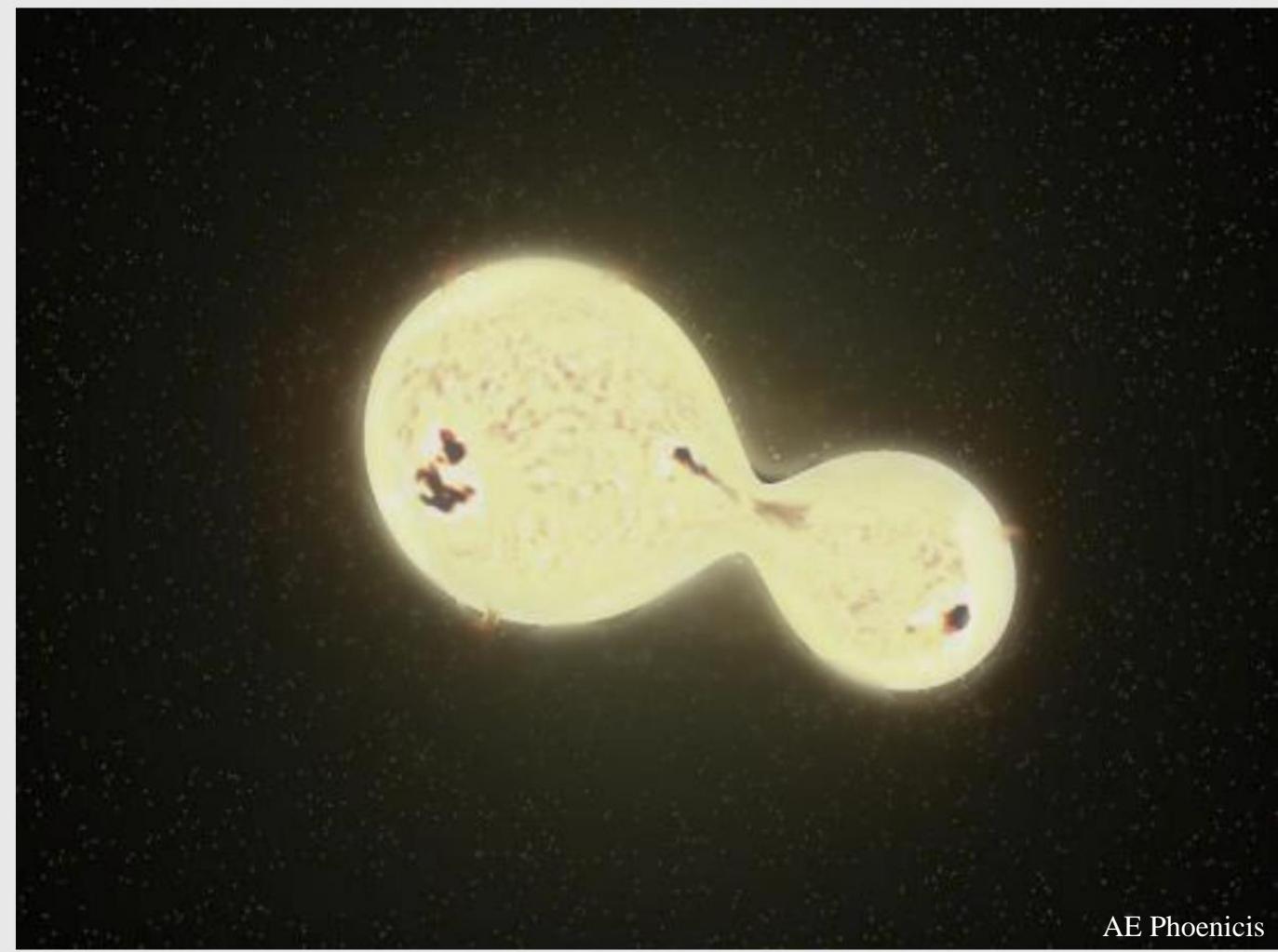
# First photometric study of five contact binary systems from Leo constellation

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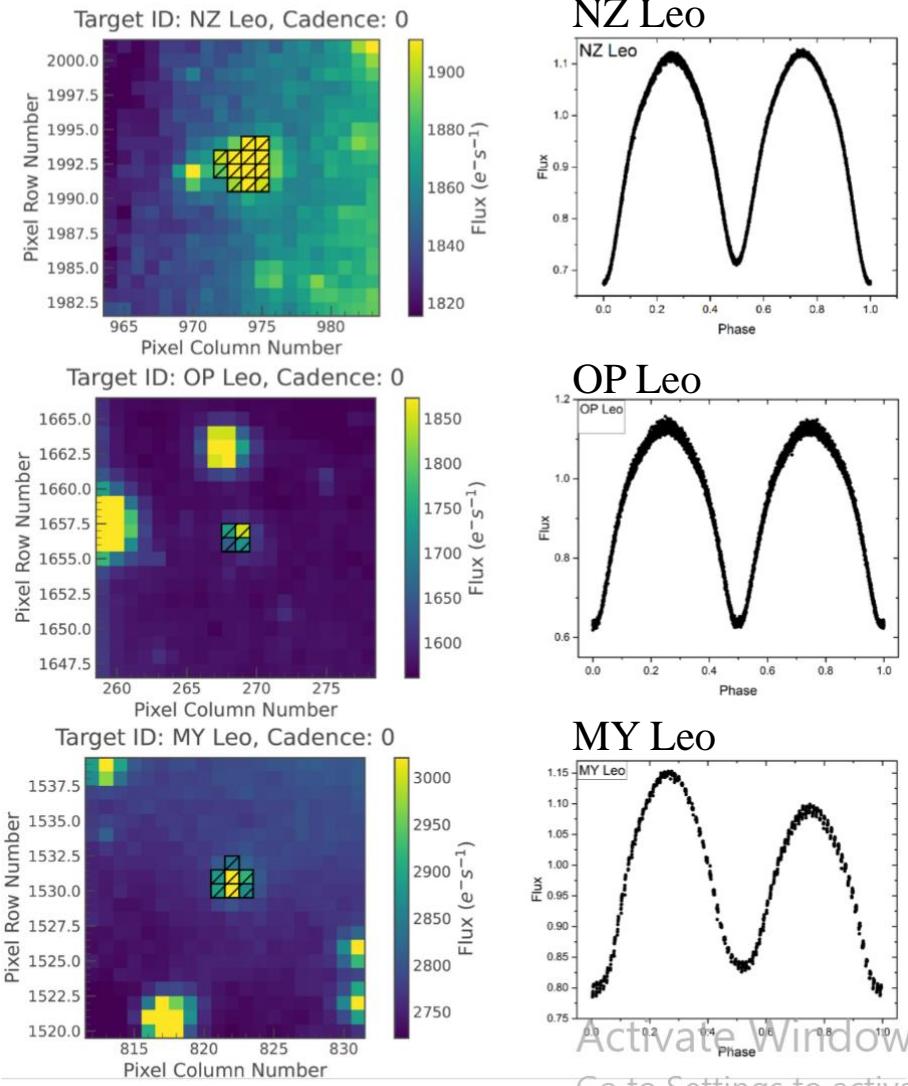
CRAQ Annual Meeting,  
May 9<sup>th</sup>, 2024

# Eclipsing contact binary System (W UMa binaries)



AE Phoenicis

# Observation and Data reduction



**5 Binary Stars System**

**MS Leo**

**MY Leo**

**NZ Leo**

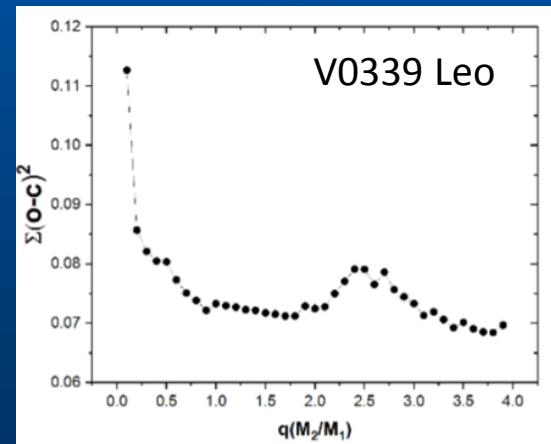
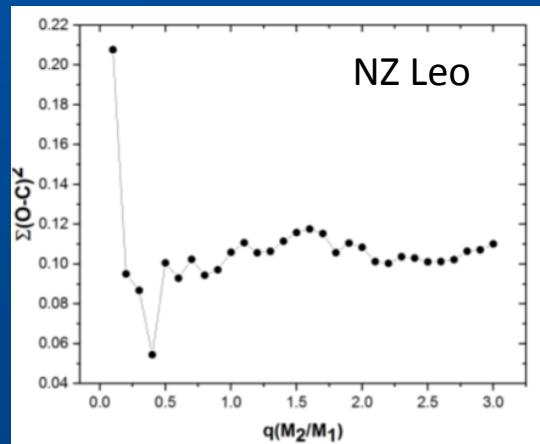
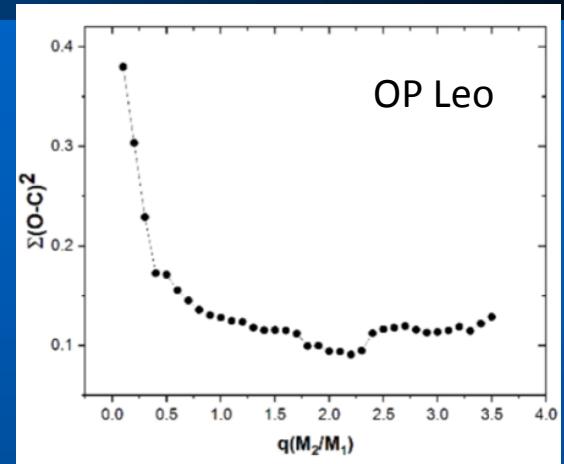
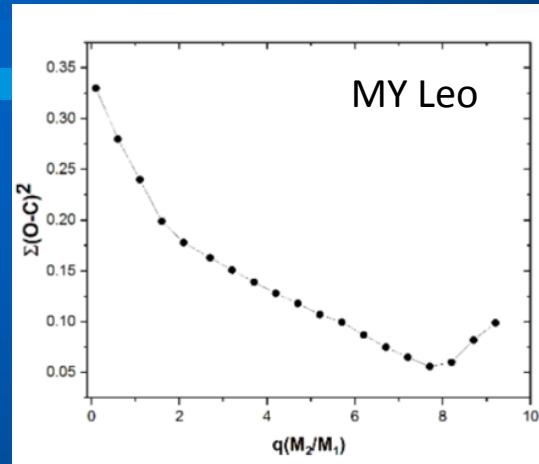
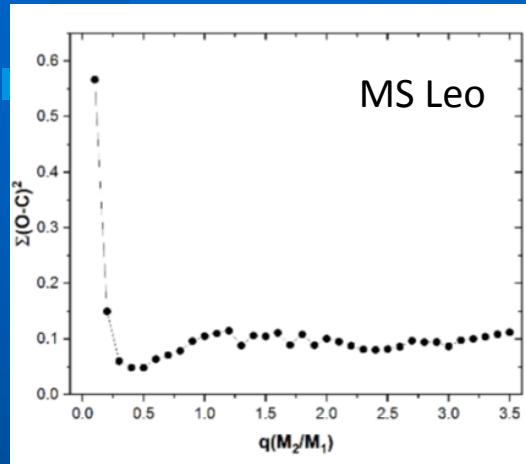
**OP Leo**

**V0339 Leo**

Activate Windows

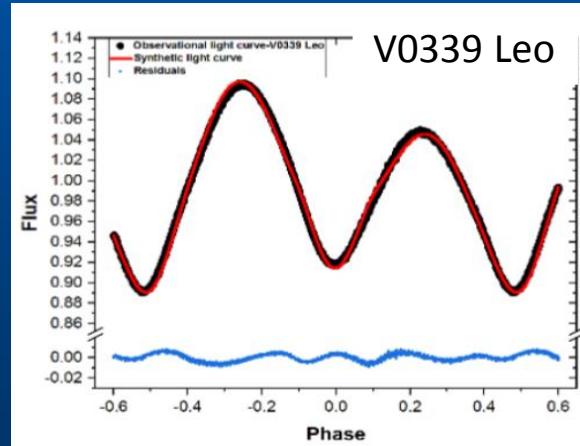
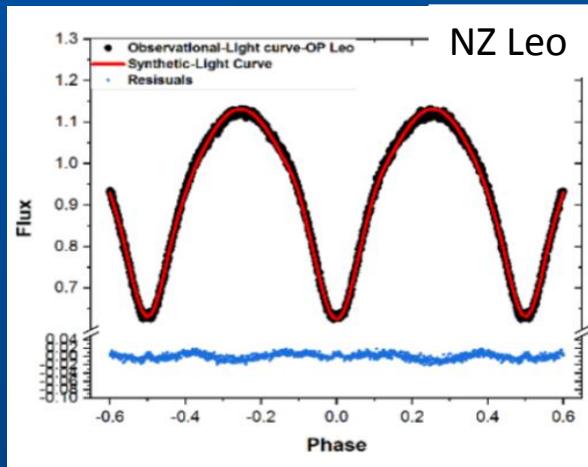
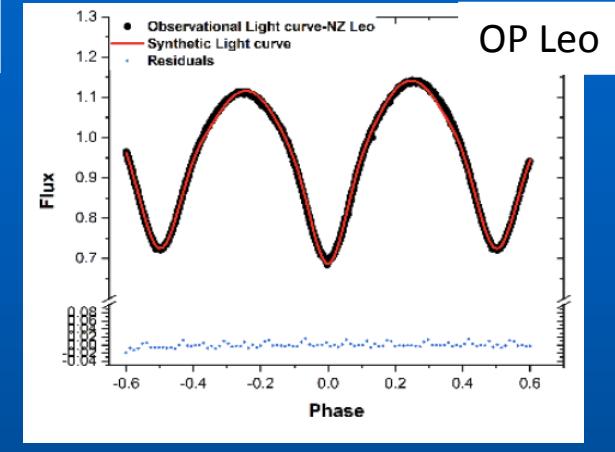
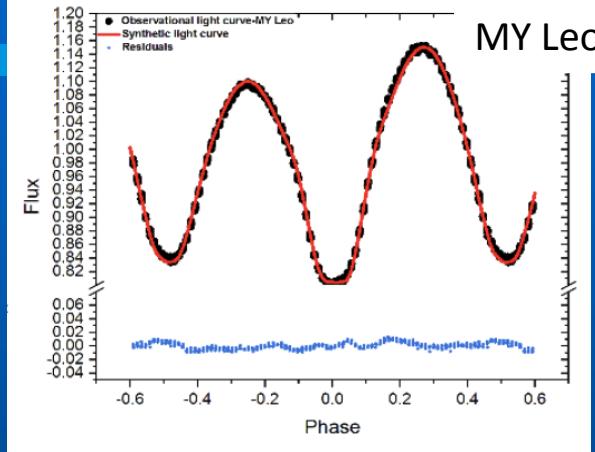
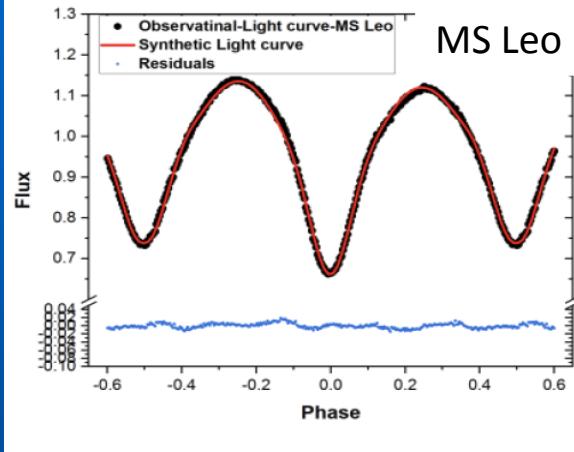
Go to Settings to activate

# Q-search to determine the mass ratio (Wilson-Devinney)



Summary: The obtained MASS RATIO of each system from the  $q$ -search.

# Light Curve Solution



## Legend

- Observational light curve (black circle)
- Synthetic light curve (red line)
- Residuals (blue circle)

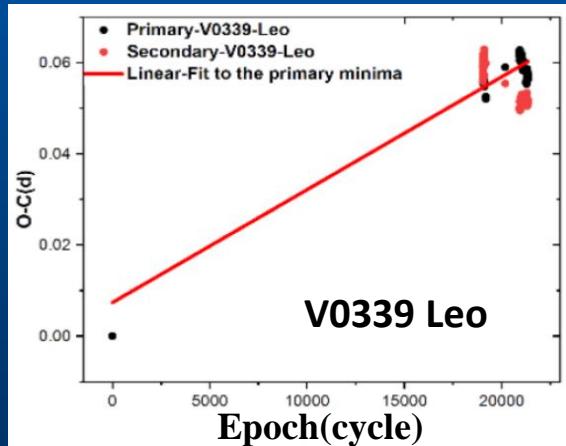
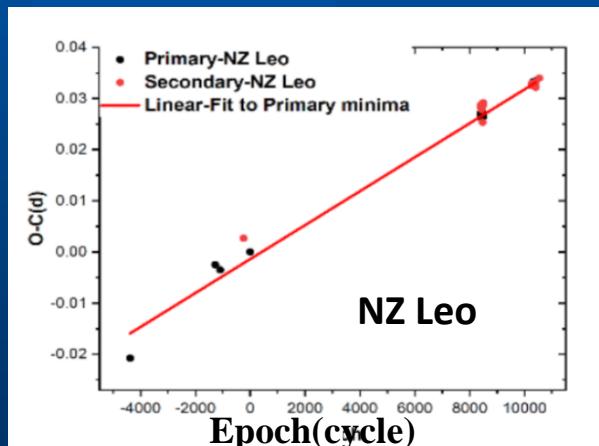
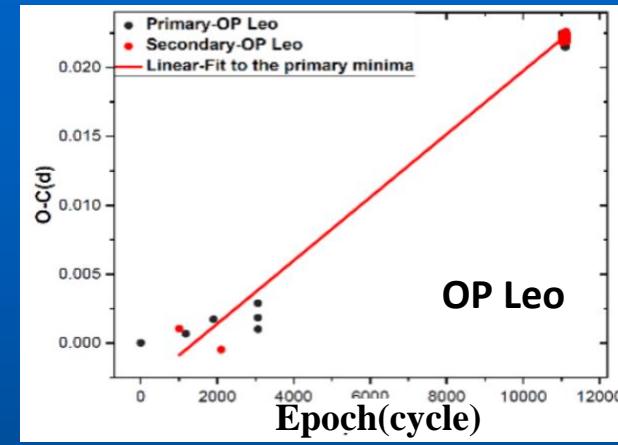
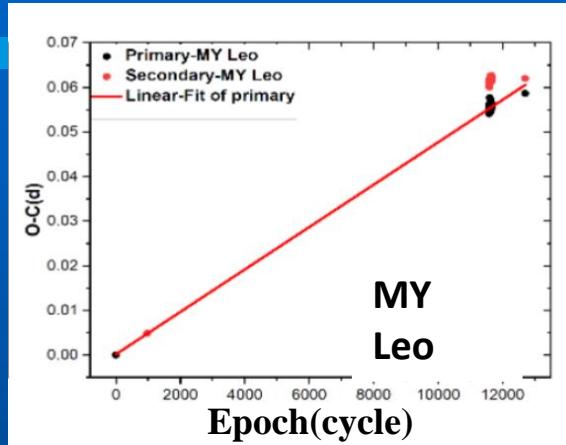
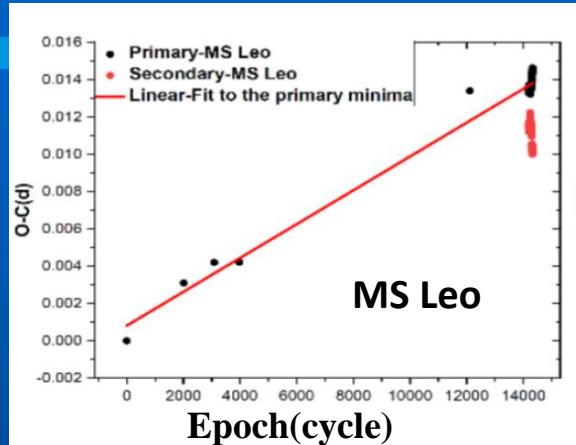
Summary: Light curve analysis of the 5 studied binary star

# Light Curve Solutions

Parameter	MS Leo	MY Leo	NZ Leo	OP Leo	V0339 Leo
$T_1(K)$	5068	5140	5811	6149	5594
$T_2(K)$	4789(30)	4745(4)	5560(6)	6063(45)	5761(39)
$i^\circ$	79.51(70)	75.14(15)	76.52(56)	81.48(45)	57.86(42)
$q = M_2/M_1$	0.379(32)	7.499(22)	0.438(6)	2.18(10)	3.787(47)
$f$	0.184(25)	0.645(15)	0.218(15)	0.252(9)	0.1870(27)
$\Omega_1 = \Omega_2$	2.602(50)	11.759(254)	2.697(13)	5.352(80)	7.522(97)
$l_1/l_{tot}$	0.753(24)	0.201(3)	0.709(14)	0.351(16)	0.210(12)
$l_2/l_{tot}$	0.247(23)	0.798(4)	0.291(16)	0.649(16)	0.789(13)
$r_1(mean)$	0.476(6)	0.251(1)	0.466(2)	0.329(2)	0.279(2)
$r_2(mean)$	0.309(7)	0.579(1)	0.323(2)	0.228(2)	0.507(2)
Phase shift	-0.003	0.009	-0.0004	-0.0002	-0.002
Col.(deg)	75	77	65		95
Long.(deg)	270	99	110		70
Rad.(deg)	9	32	15		22
$T_{spot}/T_{star}$	0.68	0.77	0.84		0.80
Component	Primary	Primary	Primary		Secondary

Summary: The parameters calculated from the light curve solution for the systems

# Orbital Period Variations



## Legend

- All Primary (black circle)
- Linear Fit (red line)
- Secondary Minima (red circle)

# Orbital Period Changes

System	Reference ephemeris
MS Leo	$2454566.57877 + 0.349592 \times E$ (Heinze et al. 2018; Diethelm 2010)
MY Leo	$2454939.59179(9) + 0.341684 \times E$ (Diethelm 2010; Heinze et al. 2018)
NZ Leo	$2456039.65508(6) + 0.339951 \times E$ (Heinze et al. 2018; Diethelm 2012)
OP Leo	$2455209.85499 + 0.391930 \times E$ (Diethelm 2010; Heinze et al. 2018)
V0339 Leo	$2452629.17073 + 0.329512 \times E$ (VSX)

System	New ephemeris
MS Leo	$2459526.60339(9) + 0.3495929(1) \times E$
MY Leo	$2458899.42174(15) + 0.3416887(5) \times E$
NZ Leo	$2458899.69004(10) + 0.3399543(1) \times E$
OP Leo	$2459526.59423(17) + 0.3919322(2) \times E$
V0339 Leo	$2458899.50987(11) + 0.329514(1) \times E$

# Absolute Parameters

$$M_{V(system)} = V - 5 \log(d) + 5 - A_V$$

$$(1) \quad R = \left( \frac{L}{4\pi\sigma T^4} \right)^{1/2} \quad (5)$$

$$M_{V(1,2)} - M_{V(tot)} = -2.5 \log\left(\frac{l_{(1,2)}}{l_{(tot)}}\right)$$

$$(2) \quad a = \frac{R}{r} \quad (6)$$

$$M_{bol} = M_V + BC$$

$$(3) \quad \frac{a^3}{G(M_1 + M_2)} = \frac{P^2}{4\pi^2} \quad (7)$$

$$M_{bol} - M_{bol_\odot} = -2.5 \log\left(\frac{L}{L_\odot}\right)$$

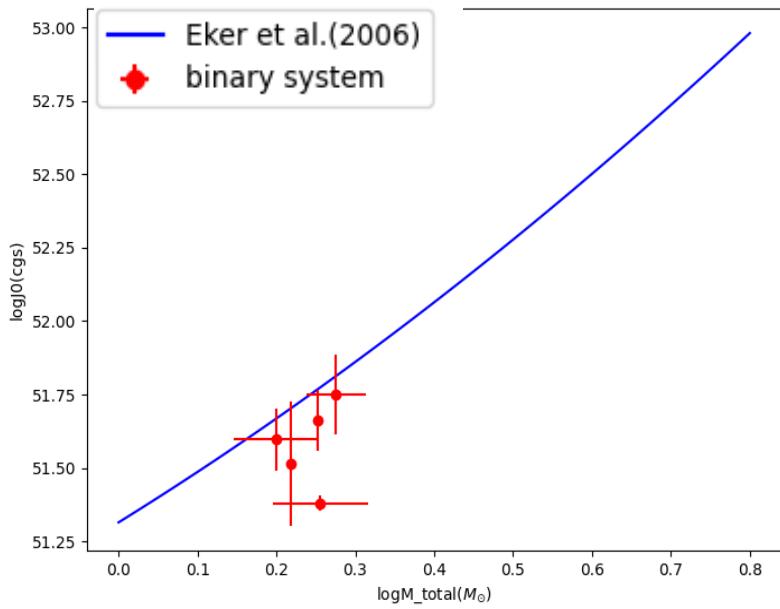
$$(4) \quad g = g_\odot \left( \frac{M}{R^2} \right) \quad (8)$$

# Absolute Parameters

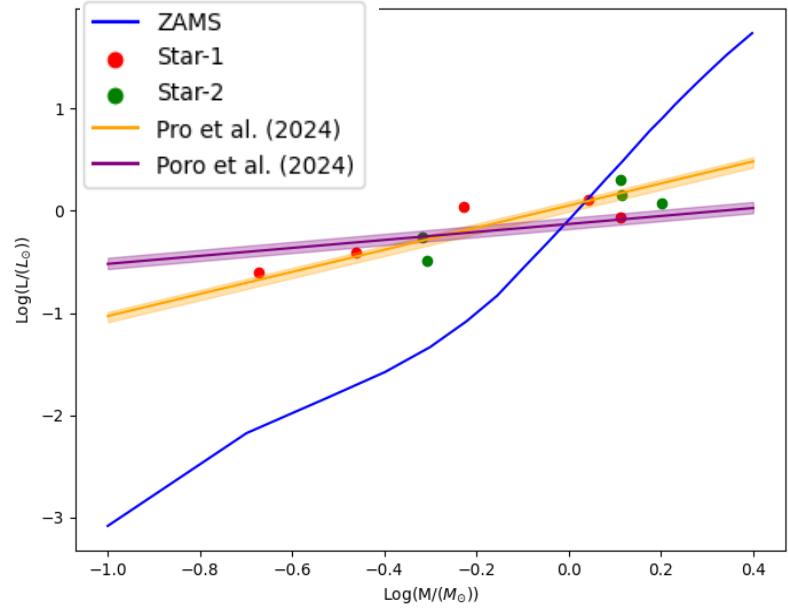
Parameter	MS Leo	MY Leo	NZ Leo	OP Leo	V0339 Leo
$M_1(M_\odot)$	1.298(53)	0.212(46)	1.101(154)	0.593(237)	0.345(73)
$M_2(M_\odot)$	0.492(37)	1.590(10)	0.482(107)	1.294(93)	1.306(539)
$R_1(R_\odot)$	1.205(46)	0.628(60)	1.112(165)	0.915(103)	0.661(58)
$R_2(R_\odot)$	0.735(35)	1.150(30)	0.729(121)	1.287(51)	1.190(160)
$L_1(L_\odot)$	0.866(28)	0.248(89)	1.274(391)	1.082(124)	0.386(42)
$L_2(L_\odot)$	0.322(19)	1.169(53)	0.547(209)	2.019(32)	1.409(220)
$M_{bol1}(mag)$	4.906(116)	6.263(36)	4.487(331)	4.664(160)	5.781(189)
$M_{bol2}(mag)$	5.981(99)	4.579(73)	5.404(329)	3.987(103)	4.377(203)
$\log(g)_1(cgs)$	4.388(114)	4.168(38)	4.394(63)	4.287(147)	4.334(202)
$\log(g)_2(cgs)$	3.966(110)	4.579(21)	4.394(44)	4.330(124)	4.402(208)
$a(R_\odot)$	2.533(70)	2.500(24)	2.387(350)	2.783(144)	2.371(248)
$J_0$	51.662(103)	51.379(26)	51.597(107)	51.751(137)	51.514(211)
$BC_1$	-0.277(15)	-0.248(11)	-0.074(10)	-0.026(14)	-0.116(6)
$BC_2$	-0.413(15)	-0.439(7)	-0.124(11)	-0.036(17)	-0.083(9)
$A_V$	"0.085(1)"	0.049(5)	0.112(16)	0.104(1)	0.044(1)

# Results

## Orbital Angular Momentum & Total Mass of the Binary System



## The Position of the Stars in the Diagram M-L



## Conclusions

- All of the systems are contact binaries
- The position of the contact binaries are in good agreement with the empirical relationship M-L

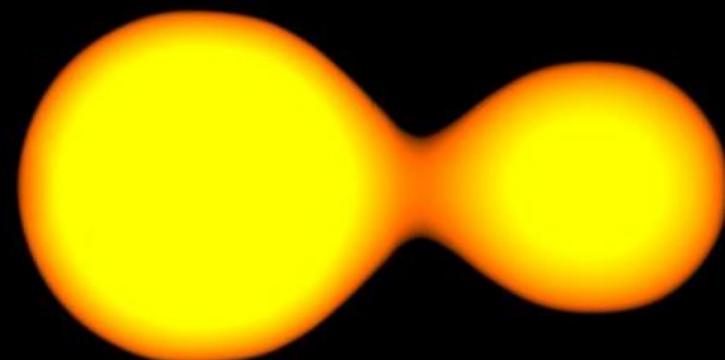
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# Thank You

Dr. Lorne Nelson Lab

Somayeh Soomandar



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# QUESTIONS?