First determination of the system parameters in five contact binaries

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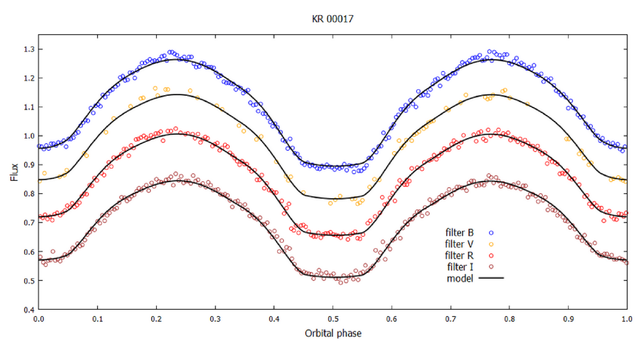
Background

The Henryk Jordan Youth Center in cooperation with the Jagiellonian University in Krakow holds the extracurricular classes aimed at the high school students. The Astronomy Section, since 2017, is organizing individual yearly projects in which student can utilize the theoretical and practical knowledge gathered during the course. In past three years high school students were using the original photometry data to study selected close binaries. In parallel to the national and international competitions, the student's studies on close binaries started to be used in publications and International Baccalaureate theses. Out of this group, a selected few students comprised a core of observational program which first results are shown here.

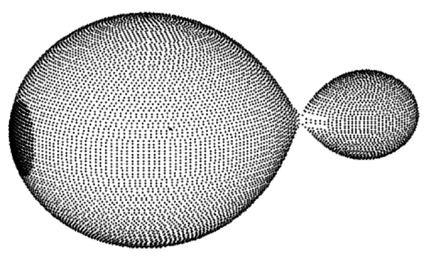
Project overview

The studies in this program are focused around the photometry of eclipsing close binary stars. A complete solution of the physical properties of contact binaries based on the light curve numerical modeling is exposing students to a full spectrum of physical and mathematical background.

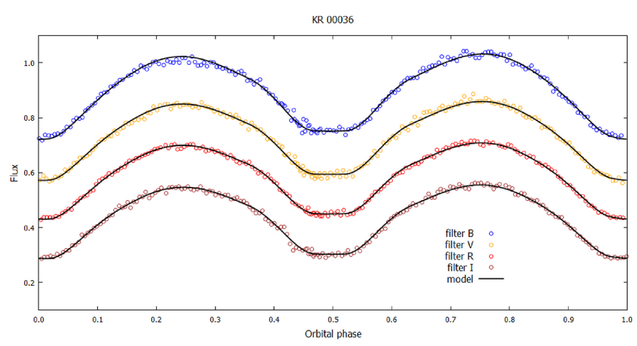
The objects come from the preselected list of suspected contact binary stars (KR - Krakow Register, http://bade.space/ew/), supplemented with several Roche geometry solving and plotting programs (Debski and Walczak, 2022). The photometry is taken mainly with the 50-cm Cassegrain telescope at the Krakow Observatory. The multi-filter light curve numerical modeling is conducted with a modified Wilson-Devinney code (Wilson and Devinney, 1971; Zola, Kolonko, and Szczech, 1997; Debski, 2022). Here we report first results of the physical parameters determination for five contact binaries, none of which were studied earlier.



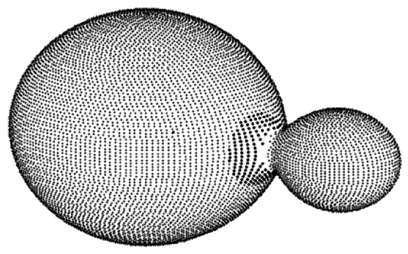
KR 00017 = GSC 4525-00721



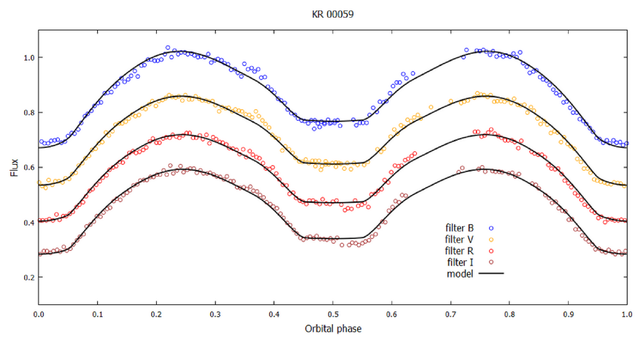
Object name:		KR 00017	
Parameter	value	Parameter	value
J2000 RA [h m s]	06 29 57.66	inclination [deg]	77(3)
J2000 DEC [deg m s]	76 42 59.7	Temperature Star 1 [K]	5750 [fixed]
Orbital period, P [d]	0.314556	Temperature Star 2 [K]	5674(16)
Distance, D [pc]	519(3)	Omega	2.0048(491)
Max brightness, m_V [V mag]	13.04(1)	mass ratio [M2/M1]	0.116(20)
Absolute magnitude, M_V [V mag]	4.17(4)	Spot longitude [deg]	179(4)
Total luminosity, L_Tot [L_Sol]	1.84(6)	Spot radius [deg]	17(1)
Semimajor axis, A [R_Sol]	2.22(13)		
Total mass, M_Tot [M_Sol]	1.40(27)		
Star 1 mass, M_1 [M_Sol]	1.33(26)		
Star 2 mass, M_2 [M_Sol]	0.16(5)		



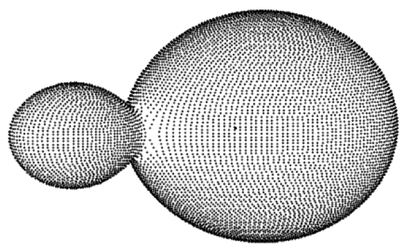
KR 00036 = GSC 3490-01506



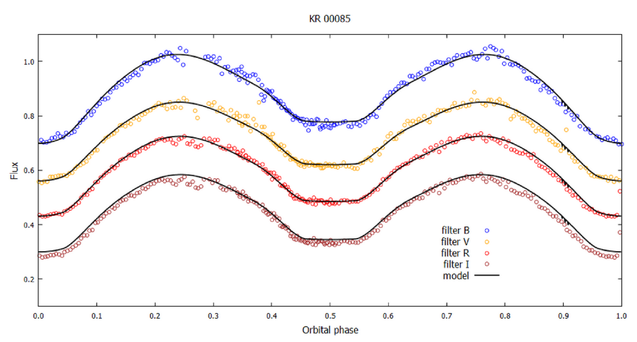
Object name:		KR 00036	
Parameter	value	Parameter	value
J2000 RA [h m s]:	15 58 54.15	inclination [deg]	76(3)
J2000 DEC [deg m s]:	46 35 49.0	Temperature Star 1 [K]	5604 [fixed]
Orbital period, P [d]	0.27203	Temperature Star 2 [K]	5643(10)
Distance, D [pc]	589(4)	Omega	2.076(49)
Max brightness, m_V [V mag]	13.37(1)	mass ratio [M2/M1]	0.153(16)
Absolute magnitude, M_V [V mag]	4.49(3)	Spot longitude [deg]	355(28)
Total luminosity, L_Tot [L_Sol]	1.37(4)	Spot radius [deg]	15(2)
Semimajor axis, A [R_Sol]	2.01(7)		
Total mass, M_Tot [M_Sol]	1.48(15)		
Star 1 mass, M_1 [M_Sol]	1.28(15)		
Star 2 mass, M_2 [M_Sol]	0.20(4)		



KR 00059 = V802 Cep



Object name:		KR 00059	
Parameter	value	Parameter	value
J2000 RA [h m s]:	02 34 25.00	inclination [deg]	86(3)
J2000 DEC [deg m s]:	79 37 39.4	Temperature Star 1 [K]	5660 [fixed]
Orbital period, P [d]	0.34698	Temperature Star 2 [K]	5305(10)
Distance, D [pc]	737(6)	Omega	2.081(55)
Max brightness, m_V [V mag]	13.19(1)	mass ratio [M2/M1]	0.162(16)
Absolute magnitude, M_V [V mag]	3.34(4)		
Total luminosity, L_Tot [L_Sol]	3.95(16)		
Semimajor axis, A [R_Sol]	3.39(21)		
Total mass, M_Tot [M_Sol]	4.35(82)		
Star 1 mass, M_1 [M_Sol]	3.75(76)		
Star 2 mass, M_2 [M_Sol]	0.61(17)		



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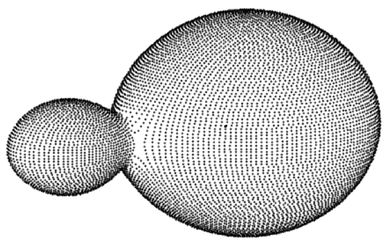
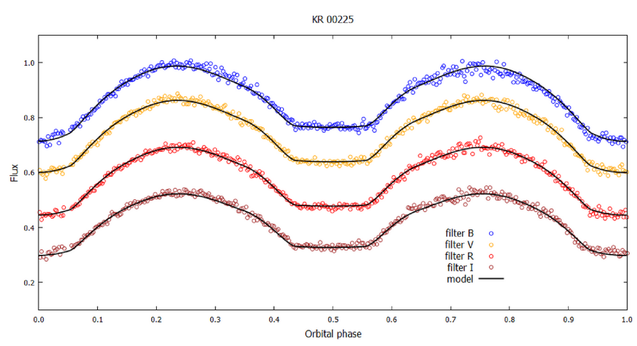


Object name:		KR 00085	
Parameter	value	Parameter	value
J2000 RA [h m s]:	06 50 47.22	inclination [deg]	79(1)
J2000 DEC [deg m s]:	73 21 32.7	Temperature Star 1 [K]	5515 [fixed]
Orbital period, P [d]	0.338555	Temperature Star 2 [K]	5263(14)
Distance, D [pc]	625(3)	Omega	1.988(6)
Max brightness, m_V [V mag]	13.10(3)	mass ratio [M2/M1]	0.132(2)
Absolute magnitude, M_V [V mag]	3.62(6)		
Total luminosity, L_Tot [L_Sol]	3.05(12)		
Semimajor axis, A [R_Sol]	2.53(9)		
Total mass, M_Tot [M_Sol]	1.89(20)		
Star 1 mass, M_1 [M_Sol]	1.67(17)		
Star 2 mass, M_2 [M_Sol]	0.22(4)		



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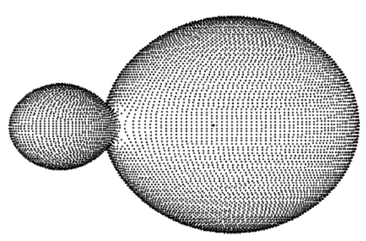

Object name:		KR 00225	
Parameter	value	Parameter	value
J2000 RA [h m s]:	20 40 03.59	inclination [deg]	89(3)
J2000 DEC [deg m s]:	63 59 34.52	Temperature Star 1 [K]	6151 [fixed]
Orbital period, P [d]	0.352281	Temperature Star 2 [K]	5998(10)
Distance, D [pc]	269(1)	Omega	1.986(43)
Max brightness, m_V [V mag]	10.70(2)	mass ratio [M2/M1]	0.120(11)
Absolute magnitude, M_V [V mag]	2.73(4)		
Total luminosity, L_Tot [L_Sol]	6.89(28)		
Semimajor axis, A [R_Sol]	5.72(23)		
Total mass, M_Tot [M_Sol]	20.3(2.4)		
Star 1 mass, M_1 [M_Sol]	18.1(2.1)		
Star 2 mass, M_2 [M_Sol]	2.2(5)		

*all modeled spots:
1) are located on the equator of the more massive star;
2) are of fixed temperature: 0.75 of host star effective temperature

References

Debski, 2022, MNRAS 516, 5003
Debski and Walczak, 2022, arXiv:2212.14085
Wilson and Devinney, 1971, ApJ 166, 605
Zola, Kolonko, and Szczech, 1997, A&A 324, 1010

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