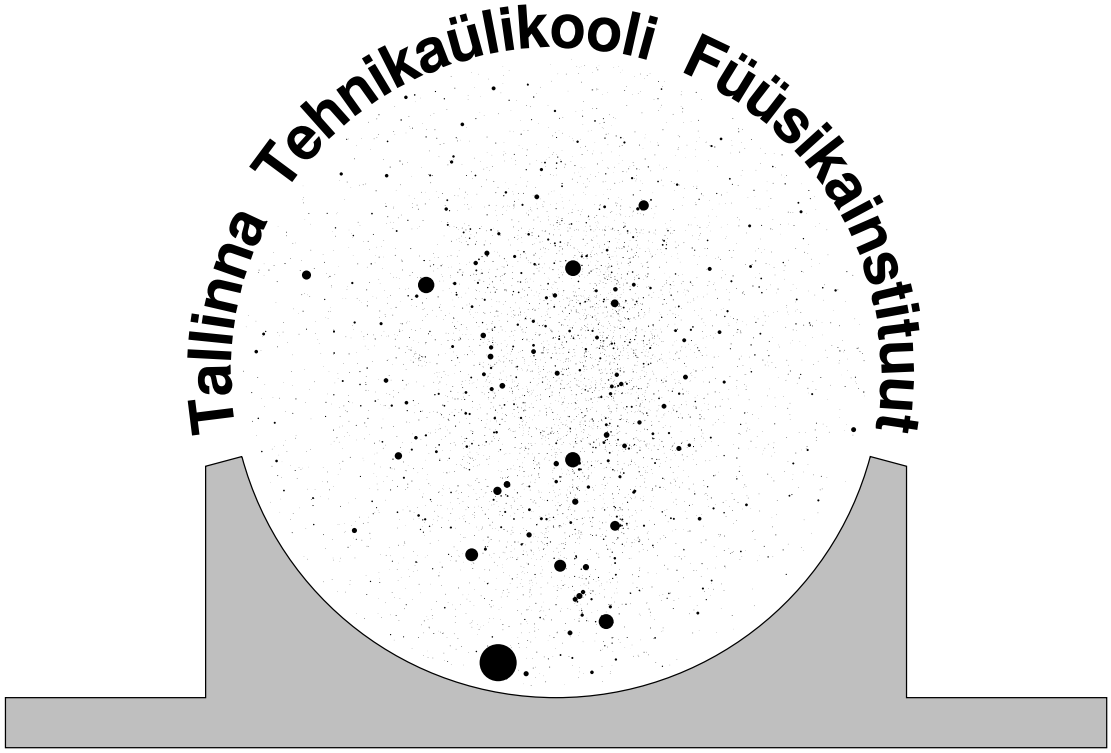

TALLINNA TÄHETORN
TALLINN OBSERVATORY

III

Number 2

2004

Tallinna Tähetorn
Tallinn Observatory

TALLINNA TEHNIKAÜLIKOOL
FÜÜSIKAINSTITUUT
TALLINNA TÄHETORN

TALLINN UNIVERSITY OF TECHNOLOGY
INSTITUTE OF PHYSICS
TALLINN OBSERVATORY

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CCD Photometry experiments at Tallinn Observatory

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The first observations in classical UBVR photoelectric photometry at Tallinn Observatory started at the end of 1966 (Kalv and Veismann (1984)). These observations continued until 1999. After that we started CCD photoelectric photometry with camera SBIG ST-7 (manufactured by Santa Barbara Group). First project was supernova search from galactic clusters. But it was not successful, because the main telescope AZT–14 field is 2 arcminutes and maximum magnitude 16 with exposition 1 minute (V–filter).

The next project was research of rapidly variable stars. Object of one of the first observations was TZ CrB (also used in the M. Burmeister graduate thesis). It was the latest observations of Peep Kalv (honourable astronomer in our memory).

There were dome repairing at Tallinn Observatory in the summer of year 2002. It lasted until late autumn. At the same time we planned to build a robot observatory, using the Meade LX90 amateur telescope and professional camera SBIG ST–7 for research. Climatic contitions in temporary observing place did not promise good results. Dew, water crystals and winds did not promise good images.

In summer 2003 we moved experimental robot equipment to the observatory. Our main observing object (from winter to spring) was Castor C (also known as YY Gem).

One needs quite a wide field to observe variable star. With our telescopes, we can observe only visual binaries at the same time. Due to AZT–14 and Meade LX90's somewhat limited field, because comparison stars are probably far from variable star. How we can expand the field of camera? Now we try to construct special Multi–CCD Photoelectric System.

There are three ways to enlarge field: use of bigger CCDs, building CCD mosaics or finding a better solution. Only realistic approach is new Multi–CCD system. According to this we observe at the same time with two telescopes and identical cameras (first have wide and second less wide field). Physically we mount an aerophoto camera NAFA (manufactured in the Soviet Union) to the main telescope, focal length 50 cm and corresponding field 0.5 degree. For the NAFA's field there are plenty of proper comparison stars in the sky. Unfortunately we do not have two identical CCDs. Therefore we have to use self-made camera with Sony ICX027BL CCD chip as the second detector. Of course the CCD cameras must have similar properties.

Of course the idea of using two telescopes to observe variable stars and comparision stars at the same time is not new. Analogous experimental observations were carried out

in Tartu Observatory already 40 years ago. Their results were not very good (fluctuations and drifts of the channels). About twenty years ago in Vilnius University Observatory at mount Maidanak had almost same system. Optical system MTO 1000 was mounted to their main telescope. Their technique based on classical photoelectric fotometers. Now the photometers have been replaced with CCD cameras.

CCD fotomeetria Tallinna Tähetornis

UBVR klassikalised fotoelektrilised vaatlused algasid Tallinna Tähetornis 1966. aasta lõpus. Need kestsid 1999. aastani, kuni Tallinna Tähetorni hangiti esimene CCD kaamera SBIG ST–7. Esmalt üritati uue kaameraga teostada galaktikaparvede patrullvaatlusi supernoovade avastamise eesmärgil, kuid proovivaatluste järgi selgus, et teleskoobi AZT-14 küündivuse piiriks osutus umbes 16 tähesuurust 1 minutilise ekspositsiooniaja korral (V–filter). Vaateväli oli ligikaudu 2 kaareminutit. NAFA (vaateväli umbes 0.5 kraadi) korral oli sama küündivuse saavutamiseks vajalik ekspositsiooniaeg 8 minutit. Nende asjaolude tõttu osutusid supernoovade otsingud vähe lootustandvateks.

Seejärel alustati muutlike tähtede kiireloomuliste muutuste vaatlemist. Üheks esimeseks vaatlusobjektiks oli TZ CrB (kasutati M. Burmeistri bakalaureusetöös). See jäi ühtlasi viimaseks vaatlustel osalemiseks Peep Kalvile. Ka teostati EM Cep, kappa Bootis mõõtmisi, mida oli varem vaadeldud Uzbekimaal Maidanaki mäel astrokliima ekspeditsioonide käigus.

2002. aasta suvel teostati tähetorni kupli remonti, mis kestis hilissügiseni. Seoses antud tööde venimisega, rajati ajutine robotobservatoorium, kasutades SBIG ST–7. Robotvaatlusi kavatseti teostama hakata Tallinnas Mähel. Antud arendus osutus väheedukaks osaliselt asukoha valiku tõttu. Teleskoobile tekkis väga kergesti kaste ning härmatis ja vaatlusi takistasid mittesoodsad tuuled, mis loomulikult ei võimaldanud saada stabiilseid kujutisi.

2003. aasta suvel teisaldati ajutine vaatlusseade Tallinna Tähetorni rõdule. Selle käigus monteeriti observatooriumi rõdule stabiilne sammas teleskoobi aluseks. Proovivaatluste käigus teostati Castor C vaatlusseeria ajavahemikul 2004 talvest kevadeni, kasutades ära kõiki soodsaid ilmastikutingimusi.

Kuna ST–7 kaamera puhul põhiteleskoobi AZT–14 vaateväli on väike, siis ei ole võimalik registreerida nii muutlikku kui võdlustähte (välja arvatud visuaalsed kaksikud) samaaegselt. Kui aga suunata teleskoopi tähelt–tähele, nagu see on klassikalise fotoelektrilise fotomeetri kasutamise korral, kaovad ka CCD kaamera eelised. Ainsa eelisena säilib suurem tundlikkus. Paljude vaatlusprogrammi kuuluvate tähtede võrdlus- ja kontrolltähed jääksid aga NAFA vaatevälja. Väikese vaatevälja kompenseerimiseks püütakse edaspidi välja töötada nn mitmik–CCD fotomeetriline süsteem.

Vaatevälja suurendamiseks on kolm võimalust, kasutada suuremat CCD maatriksit, valmistada CCD mosaiike või kasutada mõnda muud lahendust. Esimesed kaks lahendust pole antud juhul jõukohased, sest tegemist on suhteliselt suurte summadega, mis ulatuvad kümnete tuhandete dollariteni. Kolmas võimalus kujutab endast uudsemat lahendust. Selle järgi toimuks sama taevaala üheaegne salvestamine kahe kaameraga, millest üks oleks suure, teine aga väikese vaateväljaga. Konkreetselt on kinnitatud põhiteleskoobi külge aerofotokaamera NAFA, mille fookuskaugus on 50 cm ja vastav vaateväli pool kraadi. NAFA vaatevälja jaoks leidub enamasti piisavalt palju sobiva heledusega võrdlustähti. Loodava süsteemi puuduseks on see, et lisakaamera objektiiv on ainult 10 cm läbimõõduga. Kuid see ei ole eriti tähtis vajakajäämine, sest suurde vaatevälja on võimalik leida piisavalt palju suhteliselt heledaid võrdlustähti. Kuna Tallinna Tähetornis on professionaalseteks vaatlusteks ettenähtud kaameraid üks, siis põhiteleskoobi külge tuleb monteerida isevalmistatud kaamera. Selle tehnilised näitajad on tagasihoidlikumad, sest

on kasutatud Sony ICX027BL ränimaatriks vastuvõtjat. Oluline on märkida, et põhimõtteliselt peaksid fotoelektrilised kaamerad olema identsed.

Samaaegne uuritava tähe ja võrdlustähe vaatlemine kahe erineva teleskoobiga ei ole uudne lähenemine. Nii püüti teha ka Tartu Observatooriumi kaksikteleskoobiga, kuid tollel ajal osutusid takistuseks kiireloomulise neeldumise fluktuatsioonidest ja kanalite erinevatest triividest tingitud mõõtmisvead. Seda põhjustas teleskoopide suur omavaheline kaugus. Maidanakis asuvas Vilniuse Ülikoolile kuulunud observatooriumis oli teatud mõttes samasugune lahendus, kui Tallinna Tähetornis kavandatav. Seal oli põhiteleskoobi külge monteeritud MTO 1000 fotoobjektiiv ja mõlemad olid varustatud identsete fotomeetritega. Tõravere ja Maidanaki teleskoobid olid varustatud klassikaliste fotoelektriliste fotomeetritega. Mitmik–CCD fotomeetrilise süsteemi korral on eeliseks, et vähemalt üks objekt on mõlemas kaameras sama.

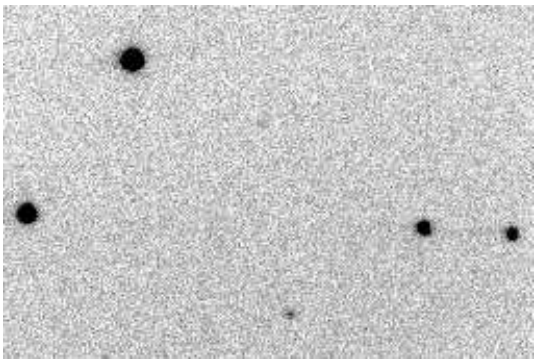

Figure 1: filter **b**, exp=5s

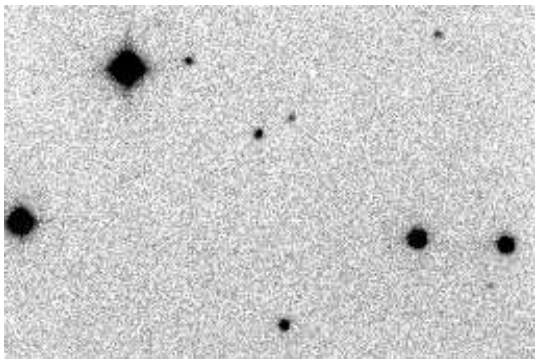

Figure 2: filter **g**, exp=5s

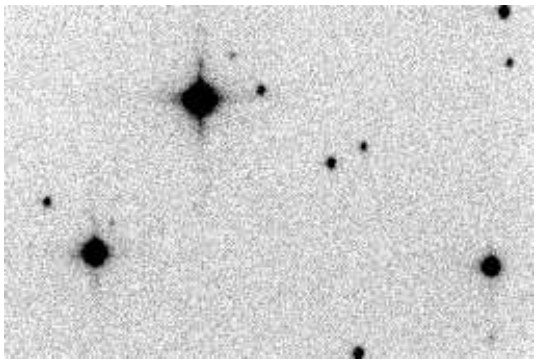

Figure 3: filter **r**, exp=5s

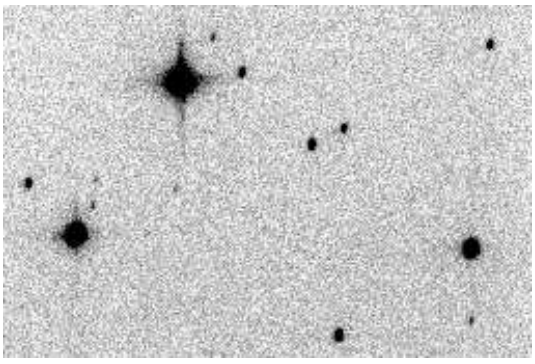

Figure 4: filter **i**, exp=5s

Observations of NGC 7160 with AZT–14 telescope and SBIG ST–7 CCD Camera.

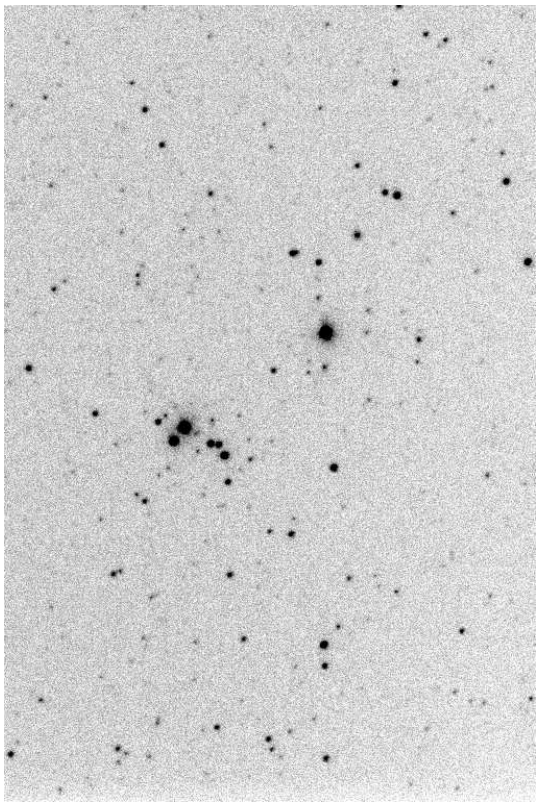

Figure 5: filter **clear**, exp=4s

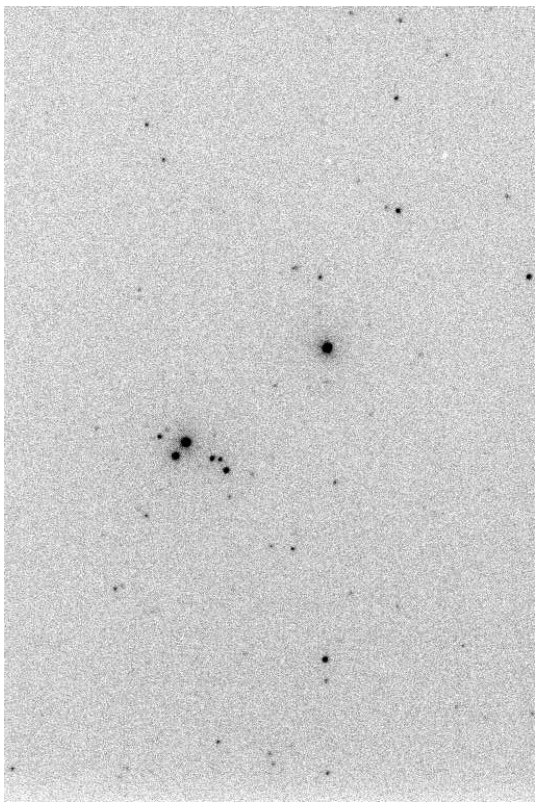

Figure 6: filter **g**, exp=10s

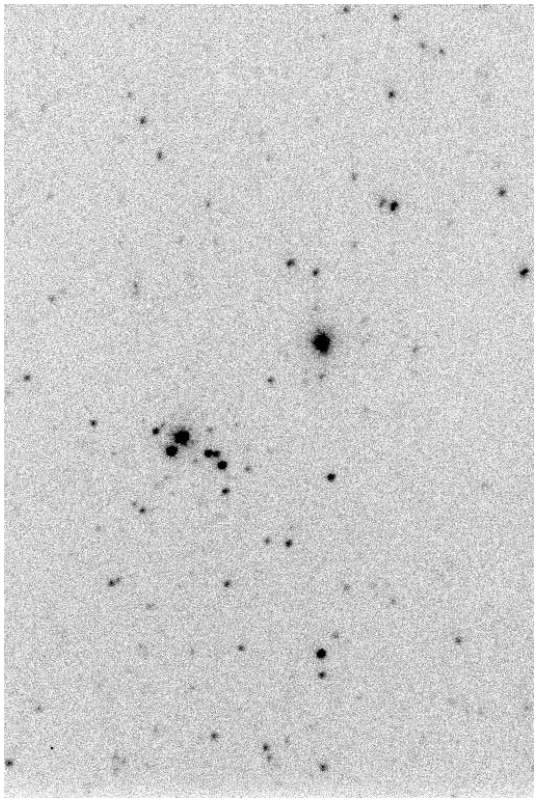

Figure 7: filter **r**, exp=10s

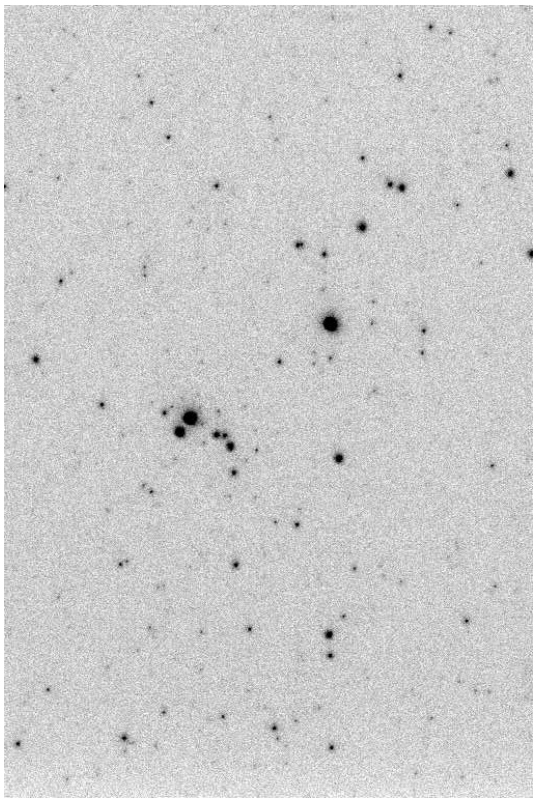

Figure 8: filter **i**, exp=9s

Observations of NGC 7160 with NAFA and SBIG ST–7 CCD Camera.

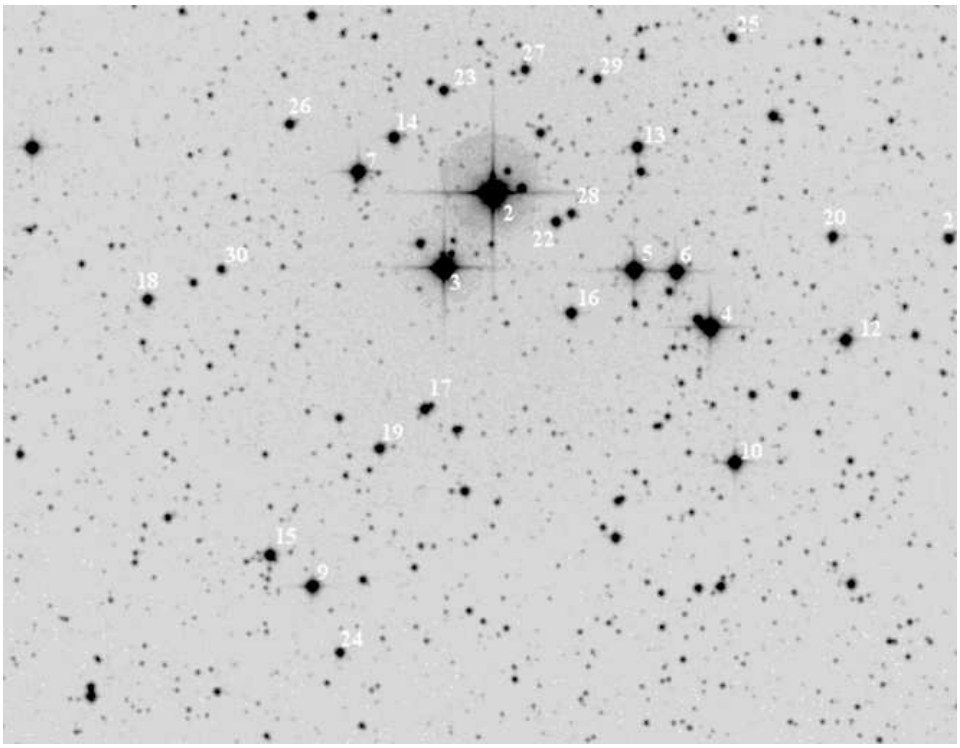

Figure 9: NGC 7160, POSS II, Optical R, DSS2.145

Star list[1]

Star	V	B–V	U–B	Star	V	B–V	U–B
				16	11.68	0.26	0.12
*2	7.04	0.26	-0.56	17	12.07	0.34	0.28
3	7.90	0.07	-0.73	18	12.14	0.34	0.42
4	8.92	0.17	-0.46	19	12.24	0.39	0.28
5	9.34	0.18	-0.49	20	12.39	0.46	0.39
6	9.83	0.23	-0.33	21	12.53	0.46	0.38
7	10.01	0.15	-0.49	22	12.53	0.68	0.40
8	10.50	0.44	0.02	23	12.66	0.46	0.27
9	10.81	0.28	-0.11	24	12.81	0.47	0.24
10	11.11	1.45	1.39	25	13.02	0.57	0.51
11	11.18	0.30	0.13	26	13.09	0.91	:0.44
12	11.41	0.55	0.09	27	:13.37	0.81	0.30
13	11.48	0.29	0.06	28	13.47	0.74	0.35
14	11.52	0.36	0.23	29	:13.49	1.02	:0.41
15	11.64	0.55	0.46	30	14.48	1.53	0.74

[1]PUBLICATIONS of THE UNITED STATES NAVAL OBSERVATORY
Second Series, Vol. XVII–Part VII, Washington, 1961, p. 474

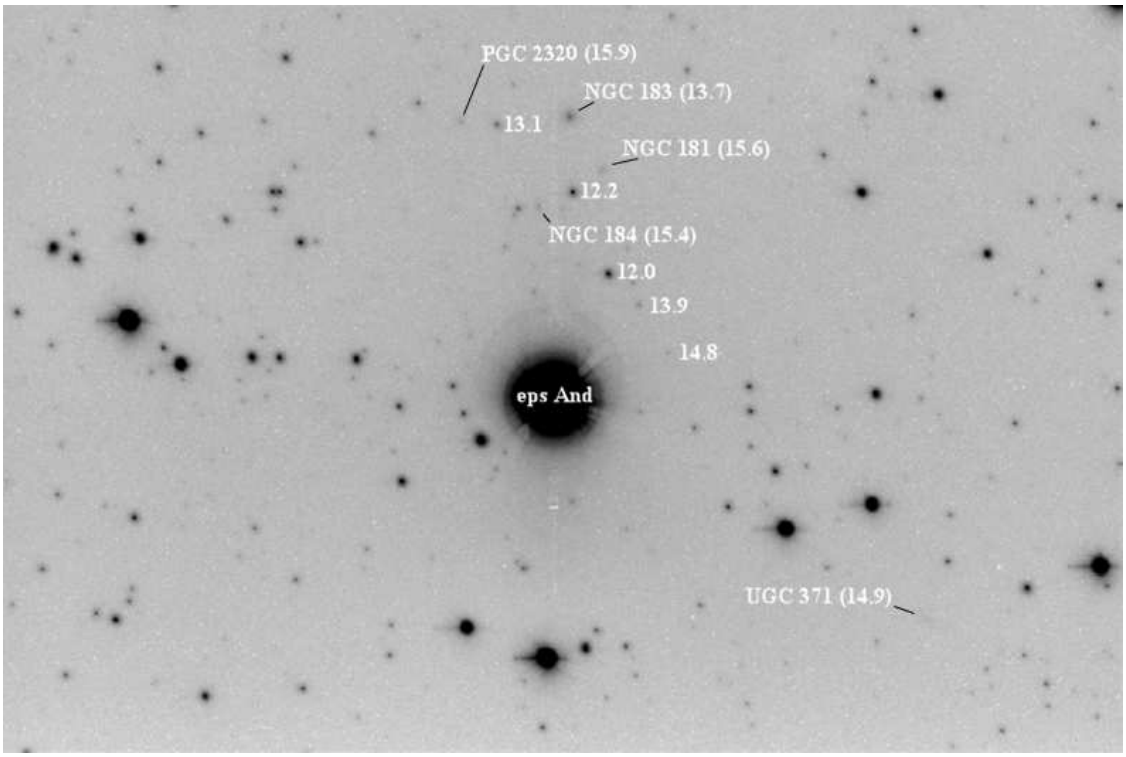

Figure 10: filter **clear**, exp=480s, 8 sept 2000, NAFA

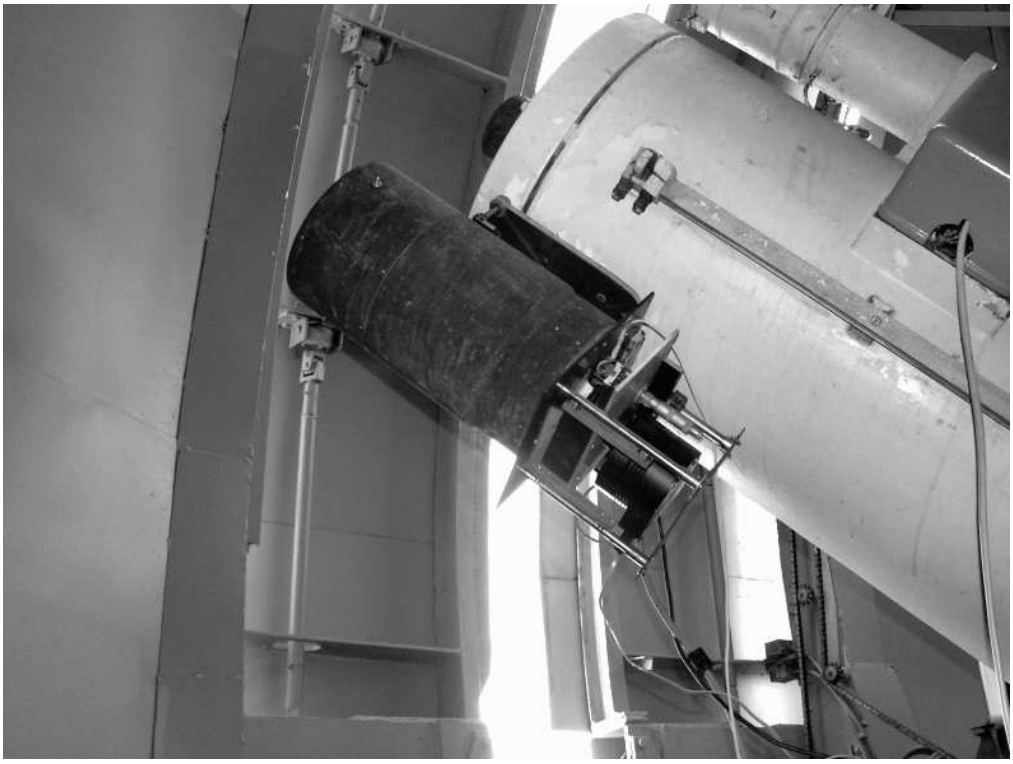

Figure 11: NAFA attatched to AZT–14 telescope

YY Gem

Table 1. YY Gem

JD Hel. 2453000+	Δi	JD Hel. 2453000+	Δi
78.26077	-2.159	78.48503	-2.128
78.26466	-2.101	78.48690	-2.112
78.26818	-2.075	78.48945	-2.206
78.27741	-2.205	78.51168	-2.189
78.31939	-2.291	78.51457	-2.116
78.32370	-2.272	78.51810	-2.084
78.32694	-2.284	78.52152	-2.163
78.33019	-2.336	78.52524	-2.140
78.33426	-2.310	78.52814	-2.199
78.34321	-2.210	78.53195	-2.144
78.36254	-2.289	78.53552	-2.156
78.36460	-2.215	78.53914	-2.161
78.42062	-2.239	78.54260	-2.164
78.42585	-2.274	78.54602	-2.227
78.42768	-2.198	78.54837	-2.280
78.43130	-2.251	78.59579	-1.664
78.43503	-2.199	78.59801	-1.747
78.43823	-2.196	78.60165	-1.829
78.44193	-2.249	78.60489	-1.897
78.44521	-2.173	78.60840	-1.856
78.44749	-2.255	78.61185	-2.005
78.45968	-2.246	78.61445	-1.931
78.46272	-2.185	78.61883	-2.057
78.46597	-2.284	78.62312	-2.045
78.46966	-2.175	78.62544	-2.164
78.47285	-2.204	78.62977	-2.222
78.47562	-2.413	78.63271	-2.242
78.48123	-2.309		

Table 2. YY Gem

JD Hel. 2453000+	Δi	JD Hel. 2453000+	Δi
96.41894	-2.075	96.49832	-1.757
96.43041	-2.118	96.50305	-1.715
96.43247	-2.050	96.50453	-1.607
96.44086	-2.118	96.50930	-1.604
96.44318	-2.055	96.51545	-1.550
96.45057	-2.066	96.51893	-1.483
96.45226	-2.095	96.52390	-1.574
96.47828	-2.066	96.52799	-1.695
96.48040	-1.963	96.52909	-1.795
96.48867	-1.940	96.53288	-1.771
96.49042	-1.929	96.53821	-1.858
96.49560	-1.890		

Table 3. YY Gem

JD Hel. 2453000+	Δi	JD Hel. 2453000+	Δi
97.27071	-2.105	97.43718	-2.091
97.27369	-2.203	97.44068	-2.089
97.27767	-2.216	97.44432	-2.102
97.27934	-2.122	97.44718	-2.061
97.28377	-2.094	97.45073	-2.107
97.28731	-2.141	97.45445	-2.139
97.29113	-2.113	97.45757	-2.149
97.29468	-2.040	97.46153	-2.128
97.29762	-2.066	97.46414	-2.123
97.32368	-1.597	97.46814	-2.124
97.32568	-1.716	97.47185	-2.150
97.32840	-1.802	97.47496	-2.180
97.33269	-1.544	97.47836	-2.215
97.33643	-1.681	97.48227	-2.168
97.38878	-2.332	97.48448	-2.069
97.39161	-2.292	97.48951	-2.080
97.39517	-2.298	97.49209	-2.129
97.39869	-2.136	97.49579	-2.107
97.40132	-2.115	97.49929	-2.111
97.40577	-2.078	97.50268	-2.129
97.40909	-2.033	97.50625	-2.139
97.41214	-2.083	97.51020	-2.174
97.41531	-2.052	97.51325	-2.157
97.41833	-2.088	97.52010	-2.211

Table 4. YY Gem

JD Hel. 2453000+	Δi	JD Hel. 2453000+	Δi
98.32715	-1.893	98.42171	-2.022
98.33741	-1.981	98.42502	-2.029
98.34153	-2.227	98.42870	-2.033
98.34567	-2.167	98.43232	-1.989
98.34865	-1.969	98.43482	-2.080
98.35146	-2.055	98.43905	-2.012
98.36391	-1.957	98.44234	-2.102
98.36611	-2.034	98.44595	-2.036
98.36959	-2.007	98.44944	-2.036
98.37299	-2.020	98.45281	-2.020
98.37644	-1.998	98.45642	-2.041
98.37921	-1.986	98.45989	-2.004
98.39050	-2.008	98.46356	-2.109
98.39447	-2.068	98.46678	-2.104
98.39740	-2.047	98.49461	-2.078
98.40189	-2.068	98.49854	-2.123
98.40437	-2.039	98.50144	-2.090
98.40702	-1.994	98.50495	-2.057
98.41077	-2.083	98.50850	-2.057
98.41450	-2.035	98.51217	-2.018
98.41823	-2.026	98.51557	-2.083

Table 5. YY Gem

JD Hel. 2453000+	Δi	JD Hel. 2453000+	Δi
99.26795	-2.267	99.42149	-2.091
99.27129	-2.139	99.42437	-2.087
99.27460	-2.175	99.42858	-2.060
99.27948	-2.236	99.43152	-2.170
99.28244	-2.142	99.43561	-2.125
99.28616	-2.185	99.43810	-2.122
99.28824	-2.295	99.44199	-2.149
99.29244	-2.222	99.44508	-2.100
99.29655	-2.324	99.44921	-2.163
99.30076	-2.341	99.45272	-2.179
99.30249	-2.216	99.45534	-2.108
99.30597	-2.301	99.45928	-2.125
99.31027	-2.222	99.46308	-2.124
99.31186	-2.266	99.46660	-2.097
99.31624	-2.158	99.46921	-2.133
99.32179	-2.160	99.49545	-2.105
99.32334	-2.247	99.49742	-2.123
99.33074	-2.104	99.50116	-2.089
99.33829	-2.054	99.50480	-2.105
99.34126	-2.004	99.50788	-2.110
99.34458	-1.996	99.51159	-2.154
99.34827	-1.878	99.51595	-2.097
99.41122	-2.115	99.51850	-2.106
99.41412	-2.097	99.52190	-2.134
99.41642	-2.224		

Table 6. YY Gem

JD Hel. 2453000+	Δi	JD Hel. 2453000+	Δi
109.31668	-2.350	109.33765	-2.212
109.31982	-2.370	109.34067	-2.273
109.32190	-2.436	109.34516	-2.332
109.32775	-2.364	109.34734	-2.562
109.33012	-2.446	109.35213	-2.494
109.33383	-2.307	109.35530	-2.559

Table 7. YY Gem

JD Hel. 2453000+	Δi	JD Hel. 2453000+	Δi
122.32106	-2.008	122.35872	-2.072
122.32378	-2.010	122.36222	-2.070
122.32742	-2.056	122.36551	-2.068
122.33076	-2.038	122.36907	-2.100
122.33427	-2.101	122.37251	-2.121
122.33750	-2.119	122.37541	-2.138
122.34147	-2.075	122.37951	-2.149
122.34469	-2.101	122.38297	-2.087
122.34761	-2.126	122.38645	-2.119
122.35297	-2.062	122.38980	-2.204
122.35512	-2.087	122.39327	-2.117

Table 8. YY Gem

JD Hel. 2453000+	Δi	JD Hel. 2453000+	Δi
123.34959	-2.063	123.37668	-1.821
123.35237	-2.060	123.38006	-1.729
123.35583	-2.047	123.38378	-1.692
123.35935	-2.055	123.38736	-1.630
123.36277	-1.965	123.39055	-1.662
123.36620	-1.919	123.39402	-1.591
123.36971	-1.820	123.39753	-1.696
123.37326	-1.820	123.40100	-1.588

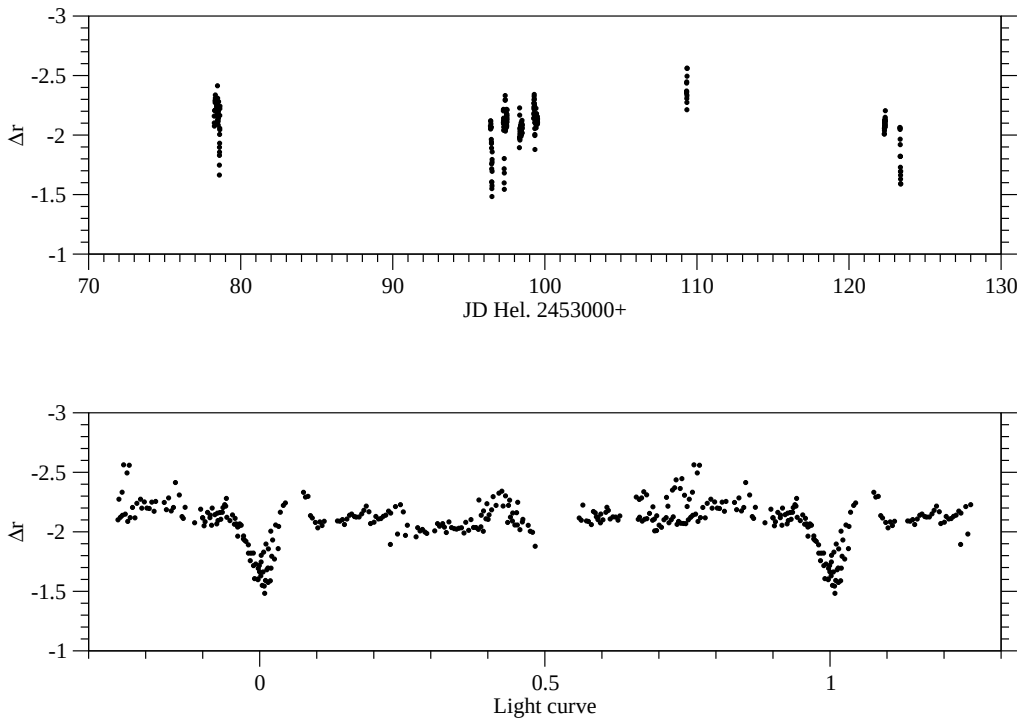

Figure 12: Light curve of YY Gem, O–C = 0d.00058184

EM Cep (Maidanak)

Table 1. EM Cep

JD Hel. 2447060+	Δ r	JD Hel. 2447060+	Δ r	JD Hel. 2447060+	Δ r	JD Hel. 2447060+	Δ r
3.2971	-0.903	3.4832	-0.797	5.3190	-0.924	6.3062	-0.771
3.3032	-0.935	3.4852	-0.814	5.3232	-0.918	6.3096	-0.752
3.3082	-0.917	3.4888	-0.802	5.3277	-0.885	6.3131	-0.736
3.3157	-0.908	3.4921	-0.787	5.3319	-0.908	6.3173	-0.772
3.3192	-0.888	3.4957	-0.820	5.3360	-0.867	6.3214	-0.773
3.3219	-0.901	3.4984	-0.785	5.3402	-0.876	6.3253	-0.795
3.3254	-0.880	3.5026	-0.821	5.3451	-0.908	6.3291	-0.793
3.3372	-0.852	4.3076	-0.823	5.3492	-0.901	6.3339	-0.793
3.3403	-0.877	4.3117	-0.821	5.3534	-0.910	6.3464	-0.788
3.3437	-0.869	4.3159	-0.834	5.3576	-0.874	6.3503	-0.832
3.3464	-0.871	4.3249	-0.840	5.3617	-0.894	6.3541	-0.820
3.3492	-0.854	4.3291	-0.830	5.3656	-0.935	6.3576	-0.816
3.3525	-0.848	4.3416	-0.832	5.3770	-0.901	6.3617	-0.821
3.3553	-0.860	4.3464	-0.855	5.3816	-0.892	6.3652	-0.849
3.3581	-0.863	4.3534	-0.853	5.3863	-0.876	6.3694	-0.846
3.3610	-0.890	4.3583	-0.857	5.3909	-0.877	6.3732	-0.846
3.3663	-0.875	4.3631	-0.846	5.3951	-0.875	6.3774	-0.830
3.3690	-0.854	4.3673	-0.911	5.3999	-0.888	6.3812	-0.851
3.3720	-0.852	4.3733	-0.879	5.4041	-0.882	6.3850	-0.852
3.3746	-0.855	4.3774	-0.883	5.4083	-0.840	6.3888	-0.865
3.3777	-0.854	4.3819	-0.890	5.4131	-0.823	6.3971	-0.876
3.3812	-0.841	4.3964	-0.878	5.4197	-0.850	6.4006	-0.879
3.3844	-0.851	4.4009	-0.902	5.4250	-0.860	6.4048	-0.891
3.3942	-0.851	4.4048	-0.902	5.4284	-0.869	6.4086	-0.876
3.3984	-0.858	4.4089	-0.899	5.4333	-0.839	6.4131	-0.888
3.4013	-0.854	4.4131	-0.895	5.4377	-0.835	6.4173	-0.872
3.4052	-0.868	4.4173	-0.887	5.4416	-0.841	6.4214	-0.887
3.4083	-0.837	4.4214	-0.902	5.4458	-0.814	6.4256	-0.892
3.4111	-0.846	4.4263	-0.916	5.4503	-0.839	6.4298	-0.904
3.4144	-0.826	4.4381	-0.890	5.4544	-0.840	6.4339	-0.896
3.4170	-0.859	4.4423	-0.926	5.4583	-0.827	6.4381	-0.897
3.4201	-0.869	4.4471	-0.944	5.4624	-0.834	6.4471	-0.905
3.4228	-0.808	4.4527	-0.898	5.4686	-0.818	6.4513	-0.892
3.4254	-0.847	4.4569	-0.920	5.4708	-0.807	6.4555	-0.898
3.4435	-0.809	4.4603	-0.923	5.4749	-0.801	6.4590	-0.905
3.4470	-0.807	4.4680	-0.912	5.4791	-0.798	6.4635	-0.906
3.4499	-0.819	4.4735	-0.895	5.4833	-0.819	6.4677	-0.912
3.4533	-0.802	4.4777	-0.922	5.4892	-0.790	6.4714	-0.899
3.4561	-0.833	4.4839	-0.918	5.4930	-0.811	6.4756	-0.898
3.4602	-0.819	4.4895	-0.885	6.2819	-0.799	6.4795	-0.891
3.4629	-0.793	4.4951	-0.894	6.2860	-0.771	6.4839	-0.893
3.4659	-0.795	5.3020	-0.908	6.2902	-0.791	6.4881	-0.926
3.4687	-0.816	5.3062	-0.944	6.2944	-0.759	6.4934	-0.912
3.4756	-0.798	5.3093	-0.932	6.2978	-0.768	6.4985	-0.913
3.4798	-0.812	5.3149	-0.913	6.3020	-0.782	6.5034	-0.900

EM Cep (Tallinn)

Table 2. EM Cep

JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r
0.2955	-0.877	0.3041	-0.888	0.3184	-0.847	0.3290	-0.853
0.2957	-0.877	0.3043	-0.874	0.3186	-0.871	0.3292	-0.846
0.2959	-0.882	0.3045	-0.881	0.3188	-0.861	0.3294	-0.865
0.2961	-0.883	0.3063	-0.877	0.3190	-0.851	0.3296	-0.842
0.2963	-0.891	0.3065	-0.893	0.3192	-0.856	0.3298	-0.849
0.2965	-0.881	0.3067	-0.875	0.3194	-0.881	0.3300	-0.845
0.2967	-0.876	0.3069	-0.877	0.3195	-0.858	0.3301	-0.868
0.2969	-0.872	0.3071	-0.872	0.3197	-0.872	0.3303	-0.852
0.2971	-0.898	0.3073	-0.872	0.3199	-0.849	0.3305	-0.845
0.2972	-0.872	0.3075	-0.875	0.3201	-0.846	0.3307	-0.858
0.2974	-0.876	0.3077	-0.894	0.3203	-0.859	0.3309	-0.847
0.2976	-0.878	0.3079	-0.882	0.3205	-0.861	0.3311	-0.845
0.2978	-0.884	0.3080	-0.866	0.3207	-0.862	0.3315	-0.884
0.2980	-0.870	0.3082	-0.871	0.3209	-0.858	0.3317	-0.865
0.2982	-0.871	0.3084	-0.881	0.3211	-0.876	0.3319	-0.874
0.2984	-0.871	0.3086	-0.875	0.3213	-0.844	0.3321	-0.857
0.2986	-0.894	0.3088	-0.854	0.3214	-0.878	0.3322	-0.857
0.2988	-0.886	0.3090	-0.872	0.3216	-0.858	0.3324	-0.857
0.2990	-0.885	0.3092	-0.877	0.3218	-0.868	0.3326	-0.863
0.2991	-0.880	0.3094	-0.874	0.3220	-0.853	0.3328	-0.841
0.2993	-0.888	0.3096	-0.876	0.3222	-0.860	0.3330	-0.851
0.2995	-0.893	0.3098	-0.866	0.3224	-0.855	0.3332	-0.885
0.2997	-0.907	0.3100	-0.862	0.3226	-0.864	0.3334	-0.855
0.2999	-0.885	0.3101	-0.877	0.3228	-0.851	0.3336	-0.860
0.3001	-0.888	0.3103	-0.880	0.3230	-0.858	0.3338	-0.869
0.3003	-0.887	0.3105	-0.876	0.3232	-0.865	0.3340	-0.867
0.3005	-0.877	0.3107	-0.888	0.3234	-0.853	0.3342	-0.873
0.3007	-0.885	0.3109	-0.875	0.3235	-0.859	0.3343	-0.871
0.3009	-0.887	0.3111	-0.874	0.3237	-0.863	0.3345	-0.865
0.3011	-0.879	0.3113	-0.875	0.3239	-0.848	0.3347	-0.840
0.3012	-0.874	0.3115	-0.858	0.3241	-0.883	0.3349	-0.868
0.3014	-0.887	0.3117	-0.878	0.3243	-0.872	0.3351	-0.853
0.3016	-0.877	0.3119	-0.884	0.3245	-0.877	0.3353	-0.866
0.3018	-0.904	0.3121	-0.883	0.3247	-0.871	0.3357	-0.879
0.3020	-0.880	0.3122	-0.879	0.3249	-0.878	0.3359	-0.859
0.3022	-0.896	0.3124	-0.878	0.3251	-0.864	0.3361	-0.870
0.3024	-0.901	0.3126	-0.874	0.3253	-0.863	0.3364	-0.872
0.3026	-0.877	0.3128	-0.881	0.3255	-0.851	0.3366	-0.863
0.3028	-0.878	0.3130	-0.886	0.3256	-0.853	0.3368	-0.867
0.3030	-0.882	0.3132	-0.884	0.3258	-0.871	0.3370	-0.873
0.3032	-0.877	0.3134	-0.884	0.3260	-0.849	0.3372	-0.872
0.3033	-0.902	0.3176	-0.858	0.3262	-0.886	0.3374	-0.869
0.3035	-0.881	0.3178	-0.861	0.3264	-0.857	0.3376	-0.853
0.3037	-0.869	0.3180	-0.859	0.3266	-0.871	0.3378	-0.870
0.3039	-0.875	0.3182	-0.872	0.3270	-0.857	0.3380	-0.876

Table 2. EM Cep: continued

JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r
0.3382	-0.868	0.3578	-0.878	0.3681	-0.903	0.3784	-0.892
0.3383	-0.865	0.3580	-0.872	0.3683	-0.899	0.3786	-0.889
0.3402	-0.880	0.3581	-0.874	0.3685	-0.898	0.3788	-0.919
0.3404	-0.878	0.3583	-0.891	0.3687	-0.885	0.3790	-0.911
0.3406	-0.877	0.3585	-0.888	0.3689	-0.869	0.3792	-0.898
0.3408	-0.881	0.3587	-0.885	0.3691	-0.901	0.3794	-0.908
0.3410	-0.861	0.3589	-0.879	0.3692	-0.884	0.3796	-0.905
0.3412	-0.854	0.3591	-0.875	0.3694	-0.883	0.3798	-0.910
0.3414	-0.881	0.3593	-0.887	0.3696	-0.895	0.3800	-0.916
0.3417	-0.870	0.3595	-0.870	0.3698	-0.879	0.3801	-0.894
0.3419	-0.871	0.3597	-0.877	0.3700	-0.894	0.3803	-0.884
0.3421	-0.853	0.3599	-0.885	0.3702	-0.894	0.3805	-0.907
0.3423	-0.882	0.3601	-0.902	0.3704	-0.881	0.3807	-0.892
0.3425	-0.849	0.3602	-0.887	0.3706	-0.902	0.3809	-0.880
0.3427	-0.869	0.3604	-0.888	0.3708	-0.885	0.3811	-0.912
0.3429	-0.853	0.3606	-0.886	0.3710	-0.917	0.3813	-0.875
0.3431	-0.854	0.3608	-0.885	0.3712	-0.882	0.3815	-0.914
0.3433	-0.841	0.3610	-0.872	0.3714	-0.881	0.3817	-0.901
0.3435	-0.882	0.3612	-0.901	0.3715	-0.890	0.3819	-0.889
0.3436	-0.859	0.3614	-0.886	0.3717	-0.907	0.3820	-0.890
0.3530	-0.868	0.3616	-0.883	0.3719	-0.891	0.3822	-0.910
0.3532	-0.848	0.3618	-0.889	0.3721	-0.888	0.3824	-0.904
0.3534	-0.866	0.3620	-0.882	0.3723	-0.903	0.3826	-0.912
0.3536	-0.860	0.3622	-0.877	0.3725	-0.890	0.3828	-0.907
0.3538	-0.856	0.3624	-0.878	0.3727	-0.894	0.3830	-0.895
0.3539	-0.881	0.3643	-0.881	0.3729	-0.881	0.3832	-0.895
0.3541	-0.871	0.3645	-0.877	0.3731	-0.897	0.3834	-0.912
0.3543	-0.878	0.3647	-0.876	0.3733	-0.914	0.3836	-0.906
0.3545	-0.881	0.3649	-0.886	0.3734	-0.896	0.3841	-0.906
0.3547	-0.897	0.3651	-0.873	0.3736	-0.907	0.3843	-0.903
0.3549	-0.882	0.3652	-0.867	0.3756	-0.896	0.3845	-0.890
0.3551	-0.867	0.3654	-0.884	0.3758	-0.887	0.3847	-0.908
0.3553	-0.884	0.3656	-0.886	0.3759	-0.884	0.3849	-0.908
0.3555	-0.865	0.3658	-0.891	0.3761	-0.906	0.3867	-0.879
0.3557	-0.871	0.3660	-0.879	0.3763	-0.898	0.3869	-0.923
0.3559	-0.853	0.3662	-0.880	0.3765	-0.877	0.3871	-0.894
0.3561	-0.876	0.3664	-0.887	0.3767	-0.898	0.3873	-0.905
0.3562	-0.870	0.3666	-0.879	0.3769	-0.894	0.3875	-0.894
0.3564	-0.874	0.3668	-0.876	0.3771	-0.883	0.3877	-0.906
0.3566	-0.871	0.3670	-0.869	0.3773	-0.894	0.3879	-0.882
0.3568	-0.876	0.3672	-0.889	0.3775	-0.906	0.3881	-0.891
0.3570	-0.883	0.3673	-0.874	0.3777	-0.912	0.3883	-0.889
0.3572	-0.870	0.3675	-0.891	0.3778	-0.902	0.3885	-0.903
0.3574	-0.885	0.3677	-0.879	0.3780	-0.896	0.3887	-0.900
0.3576	-0.878	0.3679	-0.891	0.3782	-0.900	0.3888	-0.897

Table 2. EM Cep: continued

JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r
0.3890	-0.895	0.4000	-0.916	0.4114	-0.928	0.4234	-0.912
0.3892	-0.906	0.4002	-0.898	0.4116	-0.928	0.4249	-0.942
0.3894	-0.899	0.4003	-0.904	0.4118	-0.921	0.4253	-0.924
0.3896	-0.892	0.4005	-0.919	0.4122	-0.932	0.4255	-0.947
0.3898	-0.906	0.4007	-0.915	0.4123	-0.923	0.4257	-0.928
0.3900	-0.921	0.4009	-0.911	0.4125	-0.939	0.4259	-0.953
0.3902	-0.906	0.4011	-0.908	0.4129	-0.933	0.4261	-0.944
0.3904	-0.880	0.4013	-0.906	0.4131	-0.915	0.4262	-0.948
0.3906	-0.920	0.4015	-0.907	0.4133	-0.933	0.4264	-0.954
0.3908	-0.919	0.4017	-0.904	0.4137	-0.922	0.4266	-0.936
0.3909	-0.889	0.4019	-0.925	0.4139	-0.931	0.4268	-0.934
0.3911	-0.901	0.4021	-0.937	0.4141	-0.920	0.4270	-0.965
0.3913	-0.908	0.4023	-0.922	0.4142	-0.924	0.4272	-0.971
0.3915	-0.929	0.4024	-0.909	0.4144	-0.931	0.4276	-0.947
0.3917	-0.902	0.4026	-0.925	0.4146	-0.923	0.4278	-0.959
0.3919	-0.913	0.4028	-0.918	0.4148	-0.935	0.4280	-0.943
0.3921	-0.903	0.4030	-0.912	0.4152	-0.946	0.4282	-0.946
0.3923	-0.910	0.4032	-0.917	0.4154	-0.914	0.4283	-0.951
0.3925	-0.921	0.4034	-0.920	0.4156	-0.935	0.4285	-0.946
0.3927	-0.919	0.4036	-0.912	0.4158	-0.936	0.4287	-0.940
0.3928	-0.911	0.4038	-0.915	0.4162	-0.923	0.4289	-0.963
0.3930	-0.919	0.4040	-0.924	0.4164	-0.944	0.4291	-0.983
0.3932	-0.905	0.4042	-0.926	0.4165	-0.947	0.4293	-0.970
0.3934	-0.894	0.4044	-0.952	0.4167	-0.926	0.4295	-0.965
0.3936	-0.912	0.4045	-0.926	0.4169	-0.934	0.4297	-0.960
0.3938	-0.922	0.4047	-0.933	0.4171	-0.923	0.4299	-0.935
0.3940	-0.923	0.4049	-0.935	0.4173	-0.945	0.4301	-0.964
0.3942	-0.919	0.4051	-0.924	0.4175	-0.949	0.4306	-0.950
0.3944	-0.940	0.4053	-0.932	0.4177	-0.960	0.4310	-0.950
0.3946	-0.924	0.4055	-0.932	0.4179	-0.936	0.4331	-0.947
0.3948	-0.910	0.4057	-0.933	0.4181	-0.942	0.4333	-0.957
0.3950	-0.918	0.4059	-0.930	0.4183	-0.935	0.4335	-0.957
0.3953	-0.909	0.4061	-0.926	0.4184	-0.938	0.4337	-0.949
0.3955	-0.924	0.4063	-0.933	0.4186	-0.945	0.4339	-0.945
0.3957	-0.926	0.4064	-0.938	0.4188	-0.918	0.4341	-0.943
0.3959	-0.917	0.4066	-0.940	0.4190	-0.936	0.4343	-0.948
0.3961	-0.902	0.4068	-0.924	0.4192	-0.933	0.4344	-0.958
0.3984	-0.911	0.4070	-0.937	0.4194	-0.956	0.4346	-0.940
0.3986	-0.915	0.4072	-0.943	0.4196	-0.938	0.4348	-0.923
0.3988	-0.940	0.4074	-0.934	0.4198	-0.952	0.4350	-0.945
0.3990	-0.915	0.4076	-0.939	0.4219	-0.939	0.4352	-0.945
0.3992	-0.915	0.4104	-0.930	0.4221	-0.928	0.4354	-0.956
0.3994	-0.926	0.4106	-0.937	0.4222	-0.932	0.4356	-0.944
0.3996	-0.899	0.4108	-0.929	0.4224	-0.918	0.4358	-0.945
0.3998	-0.892	0.4110	-0.928	0.4232	-0.959	0.4360	-0.958

Table 2. EM Cep: continued

JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r
0.4362	-0.944	0.4462	-0.952	0.4617	-0.973	0.4728	-0.975
0.4364	-0.959	0.4464	-0.957	0.4619	-0.983	0.4730	-0.988
0.4365	-0.945	0.4466	-0.970	0.4621	-0.989	0.4732	-0.984
0.4367	-0.942	0.4468	-0.967	0.4623	-0.988	0.4734	-0.965
0.4369	-0.954	0.4470	-0.956	0.4625	-0.966	0.4736	-0.962
0.4371	-0.949	0.4472	-0.974	0.4626	-0.971	0.4738	-0.988
0.4373	-0.951	0.4473	-0.950	0.4628	-0.965	0.4740	-0.974
0.4375	-0.945	0.4475	-0.956	0.4630	-0.978	0.4742	-0.975
0.4377	-0.938	0.4477	-0.946	0.4632	-0.977	0.4744	-0.984
0.4379	-0.935	0.4479	-0.962	0.4634	-0.976	0.4746	-0.971
0.4381	-0.949	0.4481	-0.965	0.4636	-0.998	0.4748	-0.987
0.4383	-0.960	0.4483	-0.958	0.4638	-0.971	0.4749	-0.976
0.4384	-0.953	0.4485	-0.957	0.4640	-0.987	0.4751	-0.976
0.4386	-0.964	0.4494	-0.976	0.4642	-0.978	0.4753	-0.986
0.4388	-0.951	0.4498	-0.942	0.4644	-0.992	0.4755	-0.975
0.4390	-0.955	0.4500	-0.969	0.4646	-0.984	0.4757	-0.984
0.4392	-0.947	0.4502	-0.970	0.4647	-0.982	0.4759	-0.987
0.4394	-0.945	0.4506	-0.940	0.4649	-0.983	0.4761	-0.976
0.4396	-0.957	0.4510	-0.956	0.4677	-0.964	0.4763	-0.980
0.4398	-0.957	0.4512	-0.970	0.4679	-0.980	0.4765	-0.985
0.4400	-0.941	0.4513	-0.982	0.4681	-0.954	0.4767	-0.974
0.4402	-0.952	0.4515	-0.968	0.4683	-0.971	0.4769	-0.995
0.4404	-0.956	0.4517	-0.976	0.4685	-0.969	0.4770	-0.977
0.4405	-0.963	0.4519	-0.980	0.4686	-0.976	0.4792	-0.980
0.4407	-0.957	0.4521	-0.971	0.4688	-0.970	0.4794	-0.972
0.4409	-0.957	0.4525	-0.968	0.4690	-0.968	0.4796	-0.986
0.4411	-0.952	0.4529	-0.963	0.4692	-0.972	0.4798	-0.974
0.4413	-0.943	0.4531	-0.982	0.4694	-0.977	0.4799	-0.972
0.4415	-0.971	0.4533	-0.975	0.4696	-0.957	0.4801	-0.966
0.4417	-0.968	0.4534	-0.981	0.4698	-0.976	0.4803	-0.987
0.4419	-0.974	0.4556	-0.943	0.4700	-0.980	0.4805	-0.984
0.4421	-0.964	0.4590	-0.969	0.4702	-0.970	0.4807	-0.974
0.4423	-0.974	0.4592	-0.970	0.4704	-0.968	0.4809	-0.987
0.4425	-0.944	0.4594	-0.946	0.4706	-0.965	0.4811	-1.001
0.4441	-0.937	0.4596	-0.970	0.4707	-0.984	0.4813	-0.992
0.4443	-0.962	0.4598	-0.947	0.4709	-0.966	0.4815	-0.981
0.4445	-0.960	0.4600	-0.977	0.4711	-0.976	0.4817	-0.985
0.4447	-0.961	0.4602	-0.981	0.4713	-0.973	0.4819	-0.977
0.4449	-0.967	0.4604	-0.968	0.4715	-0.981	0.4820	-0.972
0.4451	-0.963	0.4606	-0.972	0.4717	-0.978	0.4822	-0.975
0.4452	-0.962	0.4607	-0.969	0.4719	-0.983	0.4824	-0.979
0.4454	-0.956	0.4609	-0.966	0.4721	-0.985	0.4826	-0.987
0.4456	-0.967	0.4611	-0.980	0.4723	-0.966	0.4828	-0.967
0.4458	-0.957	0.4613	-0.967	0.4725	-0.981	0.4830	-0.974
0.4460	-0.974	0.4615	-0.976	0.4726	-0.972	0.4832	-0.994

Table 2. EM Cep: continued

JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r
0.4834	-0.996	0.4955	-0.972	0.5059	-0.967	0.5205	-0.972
0.4836	-0.967	0.4957	-0.983	0.5061	-0.970	0.5207	-0.964
0.4838	-0.974	0.4959	-0.962	0.5063	-0.974	0.5209	-0.971
0.4840	-0.985	0.4961	-0.976	0.5065	-0.975	0.5211	-0.992
0.4841	-0.979	0.4963	-0.991	0.5067	-0.977	0.5213	-0.978
0.4843	-0.976	0.4964	-0.988	0.5069	-0.977	0.5215	-0.980
0.4845	-0.990	0.4966	-0.977	0.5071	-0.972	0.5217	-0.982
0.4847	-0.982	0.4968	-0.985	0.5073	-0.973	0.5219	-0.975
0.4849	-0.975	0.4970	-0.993	0.5075	-0.971	0.5220	-0.983
0.4851	-0.986	0.4972	-0.979	0.5077	-1.002	0.5222	-0.977
0.4853	-0.982	0.4974	-0.993	0.5079	-0.960	0.5224	-0.981
0.4855	-1.001	0.4976	-0.987	0.5080	-0.962	0.5226	-0.973
0.4857	-0.983	0.4978	-0.998	0.5082	-0.973	0.5228	-0.987
0.4859	-1.003	0.4980	-0.975	0.5084	-0.978	0.5230	-0.987
0.4861	-0.992	0.4982	-0.982	0.5086	-0.972	0.5232	-0.978
0.4862	-0.969	0.4984	-0.995	0.5088	-0.992	0.5234	-0.990
0.4864	-0.988	0.4986	-0.983	0.5092	-0.971	0.5236	-0.968
0.4866	-0.979	0.4987	-1.000	0.5096	-0.959	0.5238	-0.971
0.4868	-0.995	0.4989	-0.976	0.5098	-0.986	0.5240	-0.978
0.4874	-0.985	0.4991	-0.981	0.5100	-0.972	0.5241	-0.975
0.4876	-0.988	0.4993	-0.989	0.5109	-0.966	0.5394	-0.969
0.4878	-0.986	0.4995	-0.987	0.5111	-0.979	0.5396	-0.972
0.4880	-0.987	0.4997	-0.986	0.5113	-0.976	0.5398	-0.970
0.4881	-0.979	0.4999	-0.984	0.5115	-0.987	0.5400	-0.974
0.4883	-1.002	0.5001	-0.988	0.5117	-0.970	0.5402	-0.970
0.4885	-0.989	0.5003	-0.995	0.5119	-1.002	0.5406	-0.973
0.4918	-0.980	0.5005	-0.987	0.5120	-0.982	0.5407	-0.980
0.4921	-0.982	0.5006	-0.995	0.5122	-0.992	0.5409	-0.965
0.4923	-0.971	0.5008	-0.997	0.5124	-0.983	0.5411	-0.968
0.4924	-0.993	0.5010	-0.991	0.5126	-0.961	0.5497	-0.962
0.4926	-0.992	0.5012	-0.994	0.5148	-0.988	0.5499	-0.969
0.4928	-0.997	0.5033	-0.978	0.5150	-0.984	0.5501	-0.966
0.4930	-0.980	0.5035	-0.982	0.5152	-0.972	0.5503	-0.960
0.4932	-0.985	0.5037	-0.983	0.5154	-0.973	0.5504	-0.968
0.4934	-0.982	0.5039	-0.991	0.5156	-0.968	0.5506	-0.973
0.4936	-1.002	0.5040	-0.989	0.5157	-0.982	0.5508	-0.968
0.4938	-0.991	0.5042	-0.998	0.5159	-0.989	0.5510	-0.961
0.4940	-0.971	0.5044	-0.986	0.5161	-0.973	0.5512	-0.971
0.4942	-0.980	0.5046	-0.996	0.5163	-0.972	0.5520	-0.971
0.4943	-0.990	0.5048	-0.996	0.5165	-0.983	0.5532	-0.976
0.4945	-0.983	0.5050	-0.978	0.5196	-0.984	0.5534	-0.984
0.4947	-0.978	0.5052	-0.977	0.5198	-0.975	0.5538	-0.969
0.4949	-0.973	0.5054	-0.977	0.5200	-0.981	0.5540	-0.980
0.4951	-0.975	0.5056	-0.974	0.5201	-0.971	0.5542	-0.972
0.4953	-0.974	0.5057	-0.974	0.5203	-0.980	0.5544	-0.964

Table 2. EM Cep: continued

JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r	JD Hel. 2451976+	Δ r
0.5546	-0.970	0.5576	-0.951	0.5606	-0.962	0.5687	-0.951
0.5548	-0.966	0.5578	-0.977	0.5626	-0.974	0.5689	-0.966
0.5550	-0.974	0.5589	-0.964	0.5627	-0.973	0.5691	-0.962
0.5561	-0.983	0.5591	-0.967	0.5629	-0.982	0.5693	-0.966
0.5563	-0.967	0.5593	-0.969	0.5631	-0.968	0.5695	-0.959
0.5565	-0.969	0.5595	-0.956	0.5633	-0.971	0.5697	-0.964
0.5567	-0.974	0.5597	-0.959	0.5635	-0.970	0.5699	-0.964
0.5569	-0.966	0.5599	-0.952	0.5637	-0.972	0.5701	-0.977
0.5571	-0.970	0.5600	-0.965	0.5639	-0.971	0.5703	-0.963
0.5573	-0.962	0.5602	-0.978	0.5641	-0.963	0.5705	-0.968
0.5574	-0.973	0.5604	-0.971	0.5643	-0.964		

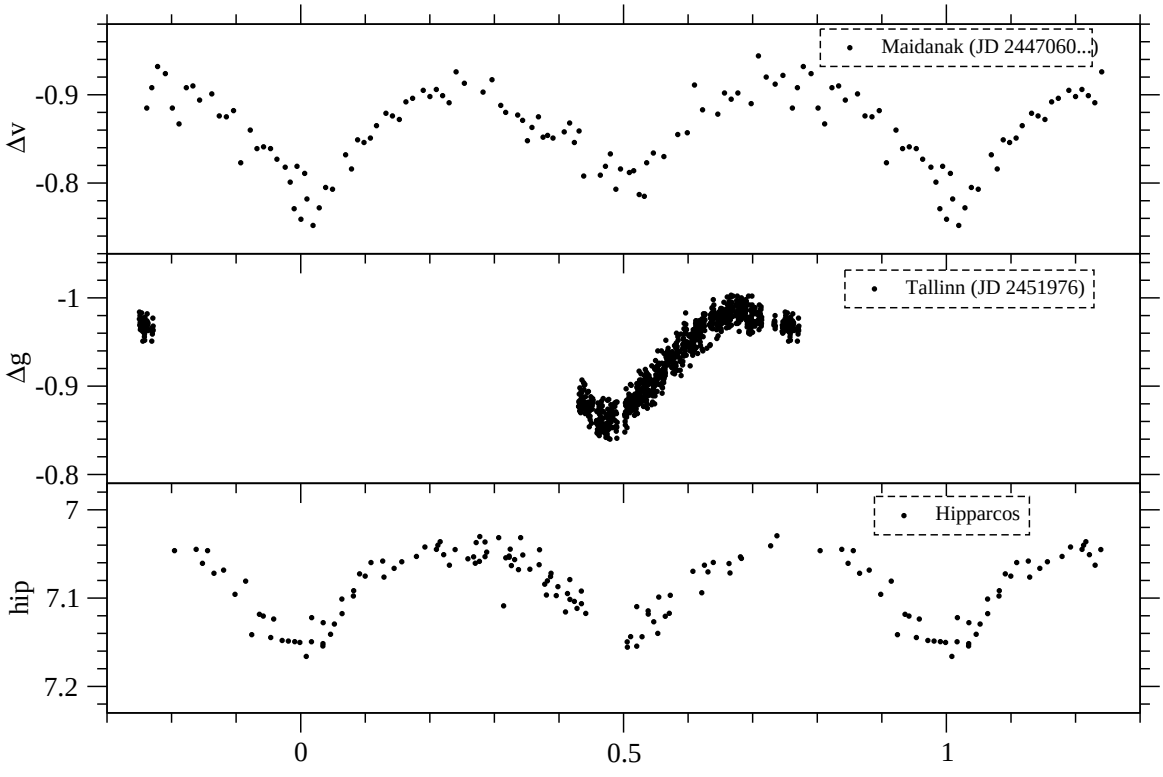

Figure 13: Light curve of EM Cep

κ^2 Boo

Table 1. κ^2 Boo

JD Hel. 2446687+	Δ v	JD Hel. 2446687+	Δ v	JD Hel. 2446687+	Δ v
0.14870	2.035	0.17030	2.087	0.18890	2.087
0.15010	1.999	0.17070	2.039	0.18910	2.055
0.15050	2.037	0.17110	2.035	0.18950	2.073
0.15110	2.007	0.17140	2.079	0.18980	2.034
0.15140	2.033	0.17170	2.050	0.19020	2.070
0.15170	1.975	0.17200	2.068	0.19050	2.052
0.15200	1.985	0.17240	2.076	0.19080	2.013
0.15230	1.950	0.17260	2.057	0.19110	1.987
0.15330	2.004	0.17290	2.086	0.19140	1.972
0.15360	2.048	0.17320	2.040	0.19170	2.044
0.15390	2.060	0.17360	2.072	0.19200	2.039
0.15410	2.010	0.17380	2.000	0.19260	2.068
0.15480	2.032	0.17410	2.051	0.19290	2.032
0.15510	1.993	0.17460	2.034	0.19330	1.963
0.15540	2.042	0.17490	2.041	0.19370	2.042
0.15550	1.981	0.17520	2.059	0.19400	2.025
0.15590	2.006	0.17550	2.030	0.19430	2.043
0.15670	2.042	0.17580	2.044	0.19460	2.041
0.15690	2.067	0.17600	2.047	0.19750	2.001
0.15720	2.056	0.17650	2.085	0.19790	2.006
0.15760	2.024	0.17680	2.046	0.19820	1.966
0.15850	2.027	0.17710	2.070	0.19850	2.060
0.15890	2.041	0.17740	2.066	0.19890	2.060
0.15920	2.024	0.17770	2.032	0.19920	2.042
0.15960	2.039	0.17810	2.066	0.19950	1.997
0.15990	2.048	0.17840	2.077	0.19980	2.035
0.16020	2.044	0.18140	2.027	0.20010	2.005
0.16060	2.029	0.18190	2.076	0.20040	2.044
0.16080	2.015	0.18230	2.078	0.20080	1.983
0.16120	2.010	0.18260	2.045	0.20110	2.051
0.16140	2.030	0.18290	2.063	0.20140	2.028
0.16170	1.995	0.18330	2.054	0.20170	1.995
0.16200	2.042	0.18360	2.043	0.20200	2.034
0.16250	2.027	0.18390	2.060	0.20230	2.042
0.16280	2.029	0.18420	2.042	0.20240	2.044
0.16610	2.075	0.18450	2.068	0.20310	2.053
0.16640	2.055	0.18480	2.031	0.20350	2.008
0.16670	2.091	0.18510	2.050	0.20380	2.059
0.16700	2.049	0.18610	2.036	0.20410	2.006
0.16730	2.076	0.18650	2.026	0.20440	1.976
0.16760	2.102	0.18710	2.012	0.20490	2.020
0.16870	2.068	0.18760	2.060	0.20540	2.012
0.16900	2.092	0.18790	2.130	0.20570	2.056
0.16970	2.082	0.18820	2.067	0.20600	2.014
0.17010	2.073	0.18850	2.062	0.20640	2.070

Table 1. κ^2 Boo: *continued*

JD Hel. 2446687+	Δ r	JD Hel. 2446687+	Δ r	JD Hel. 2446687+	Δ r
0.20680	2.017	0.21790	2.063	0.22470	2.079
0.20720	2.006	0.21820	2.061	0.22510	2.042
0.20750	1.966	0.21860	2.087	0.22530	2.040
0.20790	1.999	0.21890	2.044	0.22570	2.050
0.20820	2.018	0.21920	2.040	0.22600	2.016
0.20850	2.022	0.21950	1.983	0.22630	2.071
0.20890	1.968	0.22030	2.121	0.22660	1.974
0.20920	2.013	0.22070	2.042	0.22700	2.057
0.20980	2.025	0.22100	1.933	0.22730	2.047
0.21480	2.008	0.22140	2.035	0.22790	2.023
0.21520	2.062	0.22170	2.076	0.22830	2.060
0.21550	2.080	0.22190	2.013	0.22860	2.061
0.21590	2.036	0.22220	2.025	0.22920	2.053
0.21620	2.025	0.22240	2.049	0.22940	2.074
0.21660	2.052	0.22270	2.104	0.22970	2.067
0.21680	2.038	0.22300	2.062	0.23000	2.067
0.21710	2.017	0.22340	2.068	0.23040	2.014
0.21740	1.962	0.22380	2.032	0.23070	2.083
0.21760	2.071	0.22440	2.072		

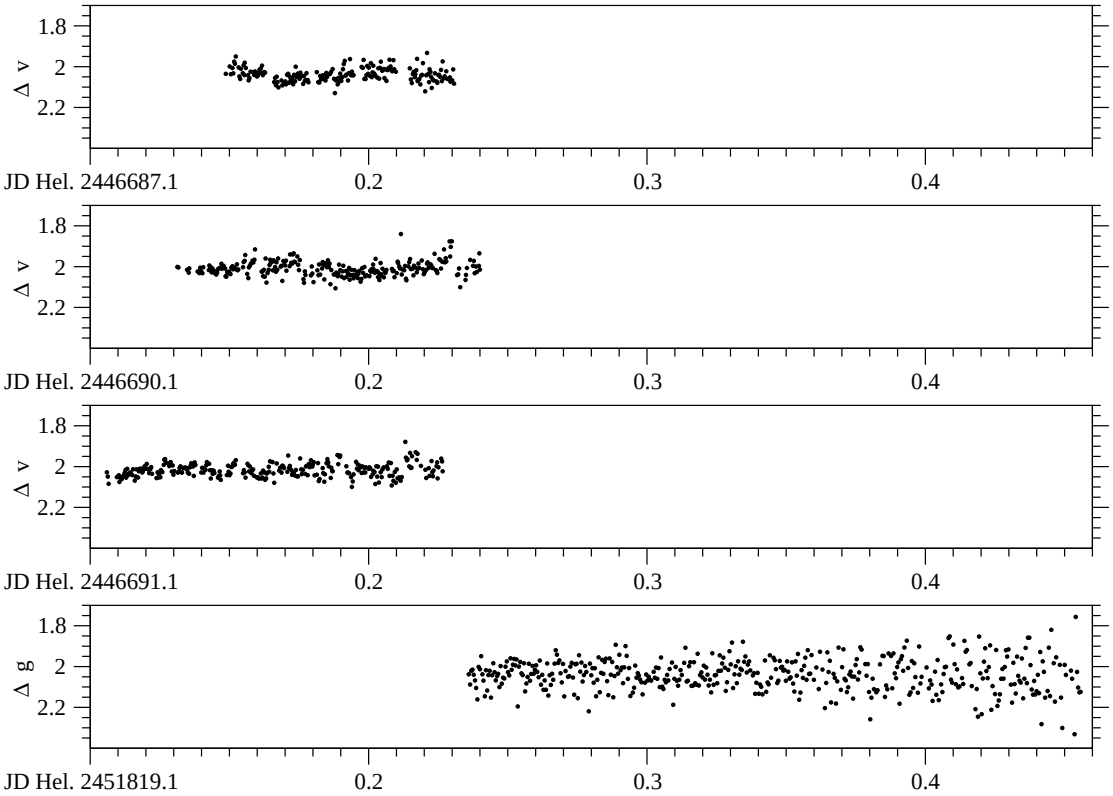

Figure 14: Light curve of κ^2 Boo

JD2446687 to JD2446691 – Maidanak h=2000m, JD2451819 – Tallinn h=100m

Table 2. κ^2 Boo

JD Hel. 2446690+	Δ r	JD Hel. 2446690+	Δ r	JD Hel. 2446690+	Δ r
0.13130	2.001	0.15270	1.988	0.17180	1.940
0.13170	2.004	0.15290	2.018	0.17220	1.981
0.13480	2.015	0.15320	2.014	0.17250	1.985
0.13540	2.029	0.15490	2.003	0.17270	1.940
0.13560	2.009	0.15510	1.977	0.17310	1.935
0.13860	2.024	0.15550	1.972	0.17330	1.976
0.13890	2.025	0.15570	1.943	0.17360	1.978
0.13920	2.032	0.15640	2.036	0.17440	1.950
0.13950	2.005	0.15680	2.056	0.17470	1.991
0.13980	2.022	0.15700	2.004	0.17500	2.017
0.14030	2.032	0.15740	1.995	0.17530	1.968
0.14060	2.003	0.15770	1.986	0.17660	2.062
0.14260	2.017	0.15830	1.971	0.17680	2.079
0.14280	1.994	0.15860	1.980	0.17710	2.023
0.14310	2.003	0.15900	1.966	0.17730	2.041
0.14330	2.003	0.15920	1.915	0.17930	2.043
0.14360	2.028	0.16160	2.024	0.17960	1.999
0.14390	2.009	0.16190	2.023	0.17980	2.034
0.14410	2.021	0.16210	2.047	0.18020	2.076
0.14440	2.020	0.16240	2.016	0.18160	2.018
0.14480	2.033	0.16270	2.049	0.18200	2.042
0.14500	2.023	0.16300	1.960	0.18220	1.989
0.14530	2.038	0.16330	2.078	0.18260	2.039
0.14560	2.029	0.16370	2.031	0.18330	2.009
0.14600	2.010	0.16410	2.016	0.18350	1.978
0.14640	2.007	0.16440	1.992	0.18370	1.990
0.14660	2.008	0.16460	1.966	0.18410	2.063
0.14690	2.006	0.16490	1.981	0.18460	1.984
0.14710	1.986	0.16560	2.018	0.18480	1.997
0.14740	2.010	0.16580	1.969	0.18510	2.003
0.14770	2.002	0.16610	1.974	0.18540	1.969
0.14790	1.996	0.16640	2.002	0.18570	2.002
0.14860	2.047	0.16670	2.025	0.18600	1.985
0.14890	2.049	0.16690	1.979	0.18630	2.086
0.14920	2.028	0.16720	2.015	0.18660	2.017
0.14850	2.009	0.16750	1.960	0.18750	2.038
0.14990	2.024	0.16840	2.000	0.18780	2.038
0.15010	2.034	0.16870	1.996	0.18810	2.106
0.15040	2.036	0.16900	2.070	0.18840	2.029
0.15070	2.005	0.16940	1.973	0.18890	2.047
0.15110	1.998	0.16970	1.978	0.18910	2.033
0.15130	2.013	0.17000	1.994	0.18940	1.990
0.15160	2.009	0.17030	1.971	0.18980	2.017
0.15200	2.006	0.17050	2.020	0.19030	2.049
0.15240	2.012	0.17160	1.998	0.19060	2.023

Table 2. κ^2 Boo: *continued*

JD Hel. 2446690+	Δ r	JD Hel. 2446690+	Δ r	JD Hel. 2446690+	Δ r
0.19090	1.996	0.20470	2.046	0.22120	1.979
0.19120	2.056	0.20500	2.010	0.22160	2.005
0.19180	2.021	0.20550	2.052	0.22220	1.989
0.19210	2.050	0.20580	2.027	0.22250	1.995
0.19230	2.023	0.20610	2.030	0.22280	2.006
0.19270	2.036	0.20640	2.016	0.22310	2.007
0.19300	2.006	0.20840	2.011	0.22370	1.937
0.19320	2.064	0.20870	2.022	0.22420	2.017
0.19350	2.041	0.20900	2.020	0.22450	2.022
0.19380	2.016	0.20930	2.052	0.22470	2.031
0.19440	2.041	0.21010	2.032	0.22540	1.963
0.19460	2.057	0.21040	1.975	0.22580	1.968
0.19490	2.017	0.21060	1.982	0.22600	2.010
0.19520	2.044	0.21100	1.999	0.22650	1.977
0.19580	2.028	0.21130	2.009	0.22710	1.915
0.19610	2.056	0.21160	1.840	0.22740	1.979
0.19630	2.035	0.21190	2.039	0.22770	1.959
0.19670	2.021	0.21210	2.013	0.22790	1.975
0.19710	2.074	0.21280	2.017	0.22910	1.877
0.19740	2.061	0.21310	1.997	0.22930	1.950
0.19770	2.007	0.21340	2.059	0.22950	1.904
0.19800	2.031	0.21360	2.067	0.22990	1.876
0.19850	2.002	0.21430	1.999	0.23180	2.041
0.19880	2.048	0.21460	1.978	0.23220	2.038
0.19900	2.043	0.21490	1.962	0.23250	2.009
0.19940	2.043	0.21520	2.012	0.23290	2.101
0.20030	2.047	0.21580	2.010	0.23480	2.065
0.20060	2.020	0.21610	2.043	0.23500	2.041
0.20090	2.025	0.21630	1.996	0.23530	2.007
0.20110	2.013	0.21660	2.003	0.23650	1.967
0.20160	1.990	0.21730	2.028	0.23750	1.996
0.20180	2.013	0.21760	2.010	0.23780	1.972
0.20220	2.030	0.21790	1.985	0.23810	2.032
0.20250	1.962	0.21820	2.007	0.23850	1.999
0.20310	2.022	0.21910	1.970	0.23890	2.025
0.20340	2.051	0.21950	2.013	0.23960	1.997
0.20370	2.032	0.21980	2.037	0.23980	1.935
0.20390	2.066	0.22010	2.029	0.24000	2.015
0.20430	1.982	0.22070	2.016		

Table 3. κ^2 Boo

JD Hel. 2446691+	Δ r	JD Hel. 2446691+	Δ r	JD Hel. 2446691+	Δ r
0.10600	2.028	0.12520	2.052	0.14370	2.018
0.10630	2.049	0.12540	2.017	0.14400	2.035
0.10660	2.084	0.12570	2.026	0.14430	2.019
0.10960	2.052	0.12590	2.027	0.14460	2.031
0.11000	2.048	0.12640	1.992	0.14590	2.054
0.11030	2.042	0.12660	1.966	0.14620	2.045
0.11050	2.075	0.12690	1.964	0.14650	2.024
0.11080	2.055	0.12720	1.980	0.14670	2.043
0.11110	2.055	0.12810	1.986	0.14690	2.065
0.11130	2.062	0.12840	1.998	0.14910	2.041
0.11150	2.052	0.12870	1.981	0.14950	1.995
0.11210	2.042	0.12890	1.978	0.14970	2.025
0.11240	2.030	0.12930	2.025	0.15000	2.042
0.11270	2.016	0.12960	1.994	0.15040	2.034
0.11290	2.054	0.12990	2.040	0.15070	2.002
0.11330	2.011	0.13020	2.022	0.15100	2.000
0.11350	2.043	0.13150	2.029	0.15130	1.987
0.11380	2.035	0.13180	2.025	0.15170	1.981
0.11410	2.035	0.13210	2.007	0.15200	1.991
0.11450	2.028	0.13240	1.999	0.15230	1.969
0.11480	2.037	0.13280	2.029	0.15490	2.033
0.11510	2.041	0.13300	2.029	0.15520	2.018
0.11540	2.013	0.13340	2.006	0.15550	2.028
0.11600	2.069	0.13360	2.008	0.15580	2.054
0.11630	2.049	0.13420	2.004	0.15650	1.986
0.11660	2.014	0.13450	2.008	0.15680	1.993
0.11670	2.051	0.13480	2.015	0.15710	2.023
0.11720	2.054	0.13510	2.030	0.15740	2.000
0.11750	2.023	0.13550	2.035	0.15790	2.032
0.11770	2.011	0.13580	2.004	0.15820	2.017
0.11810	2.010	0.13610	1.995	0.15850	2.014
0.11870	2.029	0.13630	1.983	0.15880	2.045
0.11890	2.023	0.13690	2.000	0.15980	2.052
0.11920	2.013	0.13720	2.046	0.16000	2.054
0.11950	1.999	0.13750	1.979	0.16030	2.053
0.12000	2.010	0.13780	1.992	0.16060	2.059
0.12030	1.987	0.13990	2.029	0.16130	2.033
0.12060	2.011	0.14020	2.006	0.16150	2.058
0.12090	2.015	0.14050	2.007	0.16190	2.054
0.12120	2.032	0.14070	2.029	0.16210	2.019
0.12160	2.013	0.14120	2.013	0.16260	2.029
0.12190	2.002	0.14140	2.016	0.16280	2.065
0.12220	2.035	0.14170	1.993	0.16320	2.058
0.12380	2.056	0.14190	1.978	0.16340	2.034
0.12420	2.028	0.14270	1.986	0.16380	2.029
0.12450	2.053	0.14300	2.018	0.16410	2.001
0.12470	2.039	0.14330	2.058	0.16430	2.025

Table 3. κ^2 Boo: *continued*

JD Hel. 2446691+	Δ r	JD Hel. 2446691+	Δ r	JD Hel. 2446691+	Δ r
0.16460	1.974	0.18490	1.983	0.20500	2.013
0.16550	1.978	0.18520	1.963	0.20540	2.004
0.16580	2.034	0.18550	1.979	0.20660	1.999
0.16610	2.079	0.18570	1.998	0.20690	2.011
0.16700	1.985	0.18640	2.055	0.20720	1.980
0.16790	2.019	0.18660	2.006	0.20750	2.045
0.16820	2.005	0.18690	2.021	0.20800	1.983
0.16870	2.030	0.18710	2.023	0.20830	2.092
0.16900	1.995	0.18880	1.943	0.20860	2.045
0.16930	1.998	0.18910	1.988	0.20890	2.070
0.16960	2.007	0.18930	1.947	0.20940	2.026
0.17080	2.026	0.18960	1.953	0.20980	2.079
0.17110	1.946	0.18980	1.946	0.21010	2.014
0.17140	2.007	0.19200	1.998	0.21040	2.057
0.17170	1.997	0.19240	2.029	0.21090	2.053
0.17220	2.015	0.19260	2.030	0.21120	2.064
0.17250	2.040	0.19300	2.032	0.21150	2.069
0.17280	2.029	0.19370	2.051	0.21190	2.052
0.17310	2.031	0.19400	2.099	0.21320	1.879
0.17370	2.045	0.19430	2.073	0.21340	1.956
0.17390	2.017	0.19460	2.038	0.21380	1.969
0.17430	2.048	0.19550	1.976	0.21400	1.964
0.17460	2.048	0.19580	2.010	0.21460	1.999
0.17540	1.960	0.19610	1.989	0.21490	1.933
0.17580	2.013	0.19640	2.018	0.21520	2.007
0.17600	2.037	0.19690	1.996	0.21540	2.005
0.17640	2.015	0.19720	2.003	0.21560	1.949
0.17720	2.035	0.19750	2.031	0.21690	1.930
0.17750	1.999	0.19780	1.999	0.21730	1.967
0.17780	1.997	0.19810	2.029	0.21760	1.937
0.17810	2.042	0.19850	2.007	0.21880	1.996
0.17850	1.987	0.19880	2.029	0.22040	2.016
0.17880	2.002	0.19900	2.003	0.22070	2.056
0.17910	1.990	0.20000	2.011	0.22160	2.008
0.17930	1.969	0.20030	2.004	0.22190	2.045
0.17980	2.000	0.20060	2.009	0.22260	1.973
0.18000	1.989	0.20090	2.051	0.22290	2.027
0.18030	1.979	0.20150	2.037	0.22310	2.048
0.18060	2.043	0.20170	2.021	0.22330	2.019
0.18140	2.040	0.20210	2.027	0.22440	1.998
0.18180	1.983	0.20240	2.085	0.22460	1.979
0.18210	2.071	0.20280	1.999	0.22480	2.058
0.18240	2.061	0.20310	2.049	0.22510	2.003
0.18350	2.007	0.20340	2.000	0.22610	1.961
0.18370	2.032	0.20370	2.078	0.22640	1.974
0.18410	2.074	0.20430	2.028	0.22660	2.023
0.18430	2.038	0.20470	2.051		

Table 4. κ^2 Boo

JD Hel. 2451819+	Δ r	JD Hel. 2451819+	Δ r	JD Hel. 2451819+	Δ r
0.23598	2.038	0.25579	1.984	0.27602	2.025
0.23646	2.088	0.25624	2.122	0.27645	1.980
0.23689	2.020	0.25667	2.083	0.27687	2.073
0.23734	2.015	0.25711	2.051	0.27733	2.042
0.23775	2.040	0.25755	1.986	0.27777	1.997
0.23822	2.068	0.25799	2.070	0.27819	2.026
0.23863	2.105	0.25841	2.036	0.27909	2.219
0.23907	2.161	0.25887	1.997	0.27951	1.986
0.23953	2.002	0.25931	2.034	0.27997	2.043
0.24001	2.013	0.25975	2.016	0.28039	2.008
0.24043	1.949	0.26019	1.993	0.28084	2.079
0.24088	2.038	0.26061	2.026	0.28127	2.008
0.24128	2.069	0.26106	2.052	0.28172	2.146
0.24174	2.146	0.26149	1.971	0.28216	2.065
0.24216	2.018	0.26193	2.089	0.28262	1.955
0.24260	2.117	0.26237	2.041	0.28304	2.126
0.24304	2.042	0.26281	2.114	0.28352	2.031
0.24350	2.021	0.26324	2.068	0.28391	1.967
0.24398	2.152	0.26370	2.114	0.28435	2.036
0.24436	2.043	0.26416	1.985	0.28479	1.977
0.24480	1.984	0.26458	2.142	0.28523	1.961
0.24524	2.027	0.26505	2.042	0.28567	2.072
0.24568	2.068	0.26546	2.090	0.28611	2.140
0.24615	2.046	0.26590	2.035	0.28655	1.960
0.24655	2.035	0.26633	2.065	0.28700	2.040
0.24700	2.101	0.26678	1.986	0.28747	1.977
0.24742	1.998	0.26720	1.920	0.28789	2.150
0.24786	2.084	0.26766	1.942	0.28831	2.046
0.24831	2.055	0.26809	1.982	0.28875	1.893
0.24875	2.058	0.26853	1.970	0.28919	2.003
0.24920	2.000	0.26896	2.033	0.28963	2.035
0.24963	1.975	0.26941	2.078	0.29007	1.942
0.25008	2.028	0.26984	1.987	0.29051	2.018
0.25052	2.043	0.27030	2.146	0.29096	2.005
0.25095	1.960	0.27074	2.022	0.29138	2.081
0.25138	2.016	0.27162	2.050	0.29183	2.004
0.25184	1.991	0.27206	2.047	0.29228	1.900
0.25226	1.962	0.27249	2.000	0.29270	1.947
0.25270	1.994	0.27297	1.982	0.29315	2.060
0.25314	1.965	0.27339	2.054	0.29358	2.007
0.25358	2.195	0.27385	2.138	0.29402	2.144
0.25400	2.000	0.27425	1.989	0.29493	2.128
0.25448	1.977	0.27470	1.986	0.29536	2.104
0.25490	2.033	0.27514	2.155	0.29578	1.995
0.25534	2.042	0.27559	1.945	0.29622	2.055

Table 4. κ^2 Boo: *continued*

JD Hel. 2451819+	Δ r	JD Hel. 2451819+	Δ r	JD Hel. 2451819+	Δ r
0.29667	2.032	0.31818	1.938	0.33843	2.033
0.29709	2.044	0.31865	2.093	0.33889	2.134
0.29752	2.064	0.31909	2.042	0.33929	2.079
0.29799	2.077	0.31954	2.028	0.33975	2.031
0.29843	2.136	0.31997	2.053	0.34019	2.133
0.29929	2.079	0.32042	1.996	0.34061	2.088
0.29973	2.039	0.32084	2.064	0.34104	2.099
0.30019	2.068	0.32127	2.005	0.34149	2.136
0.30061	2.050	0.32172	2.040	0.34238	1.970
0.30104	2.065	0.32215	2.093	0.34282	2.124
0.30149	2.069	0.32262	2.064	0.34329	2.078
0.30238	2.026	0.32304	2.127	0.34369	2.087
0.30281	2.055	0.32347	1.935	0.34414	1.945
0.30326	2.005	0.32390	2.089	0.34458	2.055
0.30369	2.060	0.32436	2.043	0.34546	1.957
0.30414	2.007	0.32480	2.041	0.34590	1.969
0.30458	2.101	0.32525	2.082	0.34633	2.012
0.30502	1.956	0.32567	2.021	0.34678	2.080
0.30546	2.099	0.32613	1.945	0.34722	2.069
0.30588	2.110	0.32656	2.020	0.34767	1.972
0.30634	2.065	0.32700	1.985	0.34810	2.005
0.30677	2.077	0.32744	1.956	0.34854	2.001
0.30721	2.041	0.32793	2.005	0.34900	2.020
0.30767	2.068	0.32831	2.119	0.34943	2.017
0.30811	2.012	0.32875	2.077	0.34987	2.070
0.30897	1.980	0.32919	2.016	0.35032	1.974
0.30941	2.187	0.32963	1.925	0.35073	2.026
0.30984	2.060	0.33008	1.989	0.35120	2.059
0.31028	2.002	0.33051	1.882	0.35161	2.053
0.31073	2.070	0.33095	2.105	0.35206	1.979
0.31117	2.094	0.33144	2.038	0.35250	2.083
0.31160	2.064	0.33185	1.999	0.35294	2.123
0.31206	2.018	0.33228	2.081	0.35336	1.974
0.31250	2.041	0.33271	1.974	0.35381	2.045
0.31337	1.982	0.33315	2.040	0.35424	1.938
0.31381	1.908	0.33359	2.010	0.35469	2.163
0.31425	2.073	0.33404	2.017	0.35512	2.128
0.31468	2.069	0.33447	1.878	0.35554	2.017
0.31512	1.998	0.33491	1.977	0.35601	2.056
0.31556	1.979	0.33534	1.950	0.35645	1.997
0.31601	2.095	0.33583	2.029	0.35688	1.956
0.31645	2.094	0.33624	1.990	0.35733	2.065
0.31689	1.979	0.33668	1.975	0.35775	1.920
0.31733	2.082	0.33711	2.019	0.35822	2.036
0.31775	2.088	0.33802	2.043	0.35865	2.035

Table 4. κ^2 Boo: *continued*

JD Hel. 2451819+	Δ r	JD Hel. 2451819+	Δ r	JD Hel. 2451819+	Δ r
0.35910	1.944	0.38369	1.989	0.40829	1.860
0.35995	2.065	0.38458	1.947	0.40874	1.852
0.36084	2.005	0.38502	1.949	0.40919	2.065
0.36170	2.110	0.38547	2.149	0.40959	2.079
0.36215	1.928	0.38589	2.093	0.41005	1.892
0.36303	2.015	0.38634	2.111	0.41049	1.988
0.36391	2.203	0.38678	1.936	0.41093	2.087
0.36436	2.080	0.38766	1.948	0.41137	2.014
0.36479	1.930	0.38810	2.106	0.41181	2.102
0.36522	2.027	0.38853	1.936	0.41225	2.097
0.36567	1.972	0.38897	2.033	0.41315	2.056
0.36612	2.176	0.38947	2.057	0.41359	2.085
0.36700	2.036	0.38986	2.002	0.41403	1.874
0.36744	2.056	0.39032	1.980	0.41446	1.927
0.36789	2.181	0.39073	2.182	0.41491	1.919
0.36834	2.073	0.39119	1.964	0.41579	1.989
0.36881	1.907	0.39159	1.949	0.41623	1.983
0.36964	2.114	0.39203	2.021	0.41667	2.095
0.37008	2.003	0.39247	1.907	0.41799	2.209
0.37058	1.915	0.39334	1.873	0.41843	2.110
0.37097	2.060	0.39380	2.007	0.41887	2.245
0.37139	2.068	0.39424	2.138	0.41929	1.853
0.37182	2.125	0.39468	2.126	0.41975	2.033
0.37227	2.101	0.39514	1.973	0.42021	2.234
0.37270	2.039	0.39557	2.105	0.42062	2.058
0.37315	2.024	0.39600	1.984	0.42104	1.976
0.37359	2.049	0.39642	2.051	0.42149	1.910
0.37403	2.157	0.39731	2.128	0.42192	2.022
0.37446	2.049	0.39775	1.902	0.42236	2.057
0.37491	1.992	0.39821	2.083	0.42281	2.002
0.37534	1.964	0.39863	2.050	0.42325	1.896
0.37578	2.064	0.40041	2.004	0.42369	2.212
0.37622	2.029	0.40126	2.107	0.42413	2.096
0.37664	1.905	0.40171	2.068	0.42501	2.135
0.37709	1.917	0.40221	2.088	0.42544	1.919
0.37843	1.988	0.40259	2.168	0.42588	2.193
0.37888	2.045	0.40348	2.025	0.42634	2.166
0.37931	1.988	0.40392	2.138	0.42676	2.136
0.37976	2.124	0.40439	1.968	0.42722	2.060
0.38019	2.259	0.40479	2.165	0.42765	2.012
0.38061	2.153	0.40567	2.087	0.42808	2.059
0.38106	2.059	0.40610	2.125	0.42851	2.002
0.38152	2.111	0.40654	2.036	0.42895	1.920
0.38237	2.126	0.40697	2.003	0.42937	1.951
0.38281	2.116	0.40741	2.001	0.42984	1.916

Table 4. κ^2 Boo: *continued*

JD Hel. 2451819+	Δ r	JD Hel. 2451819+	Δ r	JD Hel. 2451819+	Δ r
0.43072	2.089	0.43819	2.113	0.44653	2.172
0.43116	2.177	0.43865	2.138	0.44699	1.955
0.43160	1.981	0.43907	2.070	0.44830	1.992
0.43205	2.086	0.43951	2.137	0.44873	2.152
0.43247	2.132	0.43993	2.121	0.44918	2.301
0.43292	1.951	0.44039	2.040	0.45005	1.992
0.43334	2.045	0.44082	2.130	0.45049	2.041
0.43381	2.069	0.44126	1.928	0.45230	2.020
0.43425	2.079	0.44170	2.282	0.45270	2.059
0.43466	1.960	0.44215	1.975	0.45360	2.332
0.43512	2.156	0.44257	2.026	0.45402	1.756
0.43557	2.059	0.44302	2.153	0.45447	2.026
0.43601	1.909	0.44390	2.120	0.45487	2.103
0.43646	2.081	0.44435	1.907	0.45532	2.127
0.43686	1.859	0.44477	2.145	0.45576	2.124
0.43734	1.859	0.44522	1.820		

Figure 15: Front side of binary telescope

TZ CrB

Table 1. TZ CrB

JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r
9.28155	0.894	10.27987	0.837	10.40751	0.896
9.28479	0.887	10.28275	0.801	10.41040	0.909
9.28767	0.898	10.28683	0.826	10.41318	0.897
9.29048	0.893	10.29002	0.835	10.41795	0.872
9.29345	0.902	10.29281	0.820	10.42200	0.895
9.29723	0.884	10.29326	0.828	10.42315	0.927
9.30066	0.876	10.29608	0.802	10.42398	0.904
9.30434	0.889	10.30057	0.857	10.42630	0.878
9.30715	0.896	10.30227	0.875	10.42940	0.900
9.31022	0.895	10.30598	0.855	10.43258	0.904
9.31322	0.897	10.30894	0.831	10.43636	0.873
9.31656	0.894	10.31330	0.834	10.44003	0.884
9.31932	0.895	10.31347	0.844	10.44025	0.882
9.32210	0.888	10.31350	0.886	10.44375	0.882
9.32599	0.893	10.31737	0.816	10.44720	0.876
9.32932	0.876	10.32155	0.834	10.44999	0.905
9.33298	0.896	10.32513	0.870	10.45297	0.913
9.33619	0.895	10.32801	0.834	10.45565	0.918
9.33932	0.912	10.33199	0.831	10.45903	0.907
9.34210	0.906	10.33239	0.822	14.26982	0.905
9.34519	0.888	10.33537	0.799	14.27203	0.894
9.34876	0.887	10.33906	0.828	14.27421	0.897
9.35274	0.888	10.34155	0.867	14.27677	0.925
9.35654	0.877	10.34443	0.855	14.27905	0.931
9.35987	0.904	10.34762	0.886	14.28125	0.938
9.36263	0.873	10.35076	0.854	14.28345	0.934
9.36542	0.884	10.35428	0.819	14.28564	0.888
9.36830	0.874	10.36592	0.839	14.28785	0.912
9.37175	0.891	10.36842	0.852	14.29005	0.906
9.37486	0.902	10.37090	0.824	14.29223	0.918
9.37762	0.901	10.37338	0.852	14.29451	0.899
9.38039	0.877	10.37346	0.845	14.29777	0.893
9.38351	0.884	10.37587	0.871	14.30059	0.920
9.38683	0.864	10.37875	0.828	14.30279	0.906
9.39117	0.877	10.38134	0.882	14.30499	0.896
9.39449	0.874	10.38383	0.878	14.30718	0.899
9.39772	0.875	10.38632	0.853	14.30940	0.913
10.25729	0.881	10.38672	0.882	14.31158	0.903
10.26146	0.815	10.38910	0.885	14.31420	0.901
10.26415	0.882	10.39300	0.914	24.22239	0.881
10.26703	0.822	10.39676	0.879	24.22315	0.905
10.27071	0.796	10.40055	0.884	24.22389	0.894
10.27440	0.817	10.40393	0.887	24.22476	0.883
10.27702	0.813	10.40442	0.868	24.22554	0.903
10.27737	0.813	10.40523	0.879	24.22629	0.883

Table 1. TZ CrB: *continued*

JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r
24.22705	0.916	24.26432	0.879	24.30484	0.891
24.22780	0.882	24.26550	0.877	24.30577	0.884
24.22867	0.871	24.26652	0.900	24.30697	0.863
24.22956	0.890	24.26764	0.894	24.30823	0.878
24.23036	0.893	24.26893	0.881	24.30926	0.866
24.23122	0.902	24.26973	0.888	24.31019	0.875
24.23201	0.889	24.27049	0.917	24.31124	0.891
24.23277	0.905	24.27125	0.914	24.31220	0.874
24.23351	0.896	24.27199	0.894	24.31304	0.870
24.23427	0.886	24.27291	0.884	24.31420	0.870
24.23517	0.885	24.27376	0.891	24.31502	0.880
24.23591	0.906	24.27450	0.896	24.31594	0.883
24.23667	0.883	24.27536	0.903	27.19736	0.931
24.23743	0.889	24.27618	0.892	27.19855	0.916
24.23816	0.874	24.27709	0.890	27.19978	0.914
24.23891	0.894	24.27796	0.895	27.20090	0.930
24.23969	0.910	24.27872	0.867	27.20183	0.922
24.24043	0.903	24.27955	0.898	27.20261	0.939
24.24118	0.888	24.28052	0.894	27.20336	0.928
24.24191	0.894	24.28127	0.904	27.20473	0.925
24.24267	0.895	24.28206	0.896	27.20596	0.938
24.24342	0.897	24.28293	0.883	27.20729	0.941
24.24418	0.906	24.28369	0.883	27.20855	0.926
24.24495	0.887	24.28463	0.879	27.20937	0.943
24.24570	0.893	24.28552	0.870	27.21012	0.954
24.24659	0.871	24.28638	0.892	27.21123	0.928
24.24732	0.895	24.28717	0.896	27.21248	0.948
24.24807	0.895	24.28831	0.892	27.21353	0.944
24.24883	0.880	24.28908	0.890	27.21434	0.948
24.24957	0.900	24.29007	0.891	27.21541	0.927
24.25068	0.902	24.29139	0.898	27.21652	0.960
24.25159	0.880	24.29250	0.878	27.21752	0.918
24.25246	0.892	24.29331	0.885	27.21839	0.939
24.25319	0.885	24.29421	0.877	27.21935	0.951
24.25400	0.897	24.29506	0.905	27.22058	0.915
24.25493	0.900	24.29588	0.880	27.22182	0.936
24.25581	0.892	24.29706	0.881	27.22296	0.909
24.25683	0.876	24.29796	0.903	27.22381	0.937
24.25772	0.901	24.29889	0.888	27.22468	0.937
24.25853	0.899	24.29986	0.895	27.22566	0.948
24.25967	0.897	24.30073	0.890	27.22678	0.939
24.26057	0.890	24.30166	0.871	27.22800	0.928
24.26148	0.891	24.30246	0.875	27.22891	0.945
24.26246	0.874	24.30322	0.889	27.22981	0.934
24.26334	0.897	24.30406	0.901	27.23087	0.957

Table 1. TZ CrB: *continued*

JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r
27.23225	0.953	27.27401	0.922	27.31277	0.961
27.23312	0.905	27.27476	0.969	27.31377	0.936
27.23396	0.939	27.27566	0.945	27.31460	0.956
27.23480	0.930	27.27641	0.926	27.31541	0.937
27.23591	0.942	27.27718	0.946	27.31659	0.943
27.23681	0.913	27.27793	0.940	27.31804	0.979
27.23775	0.943	27.27887	0.949	27.31898	0.942
27.23859	0.923	27.27958	0.950	27.32017	0.951
27.23958	0.929	27.28035	0.966	27.32106	0.961
27.24034	0.951	27.28105	0.941	27.32207	0.965
27.24124	0.927	27.28181	0.974	27.32295	0.926
27.24214	0.939	27.28256	0.952	27.32393	0.953
27.24320	0.928	27.28358	0.946	27.32512	0.973
27.24413	0.954	27.28437	0.934	27.32608	0.965
27.24512	0.937	27.28511	0.917	27.32715	0.926
27.24619	0.936	27.28601	0.927	27.32833	0.945
27.24716	0.942	27.28678	0.962	27.32913	0.969
27.24816	0.915	27.28764	0.944	27.33022	0.918
27.24906	0.931	27.28861	0.946	27.33124	0.942
27.24980	0.939	27.28954	0.927	27.33226	0.948
27.25093	0.935	27.29039	0.945	27.33312	0.945
27.25195	0.944	27.29119	0.957	27.33422	0.946
27.25282	0.928	27.29219	0.961	27.33557	0.938
27.25356	0.968	27.29306	0.939	27.33647	0.958
27.25477	0.935	27.29383	0.969	27.33765	0.928
27.25600	0.949	27.29467	0.940	27.33902	0.961
27.25690	0.947	27.29548	0.940	27.34063	0.960
27.25783	0.936	27.29638	0.930	27.34187	0.960
27.25883	0.938	27.29720	0.957	27.34300	0.942
27.25973	0.937	27.29825	0.943	27.34405	0.951
27.26072	0.939	27.29925	0.920	27.34516	0.966
27.26153	0.937	27.30015	0.968	33.24070	0.935
27.26243	0.945	27.30105	0.926	33.24191	0.928
27.26318	0.955	27.30195	0.937	33.24290	0.948
27.26394	0.945	27.30271	0.954	33.24376	0.931
27.26469	0.942	27.30353	0.939	33.24517	0.943
27.26568	0.940	27.30451	0.948	33.24620	0.921
27.26679	0.950	27.30537	0.907	33.24744	0.937
27.26767	0.956	27.30631	0.951	33.24891	0.932
27.26887	0.927	27.30737	0.922	33.25068	0.916
27.26986	0.918	27.30811	0.950	33.25228	0.918
27.27073	0.969	27.30917	0.920	33.25328	0.922
27.27161	0.934	27.30995	0.940	33.25419	0.898
27.27237	0.943	27.31081	0.917	33.25505	0.926
27.27327	0.927	27.31163	0.955	33.25551	0.925

Table 1. TZ CrB: *continued*

JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r
36.17146	0.897	36.21421	0.882	36.25978	0.879
36.17239	0.909	36.21513	0.919	36.26102	0.886
36.17332	0.898	36.21606	0.912	36.26215	0.922
36.17424	0.917	36.21697	0.892	36.26339	0.900
36.17517	0.926	36.21790	0.915	36.26459	0.882
36.17609	0.919	36.21894	0.913	36.26596	0.932
36.17700	0.924	36.21994	0.894	36.26718	0.902
36.17794	0.914	36.22086	0.896	36.26826	0.928
36.17887	0.930	36.22180	0.897	36.26917	0.893
36.17979	0.940	36.22279	0.910	36.27010	0.892
36.18072	0.915	36.22383	0.933	36.27103	0.901
36.18163	0.894	36.22483	0.928	36.27215	0.909
36.18264	0.919	36.22586	0.913	36.27308	0.892
36.18386	0.906	36.22701	0.923	36.27399	0.899
36.18479	0.907	36.22809	0.906	36.27510	0.929
36.18571	0.882	36.22913	0.921	36.27618	0.906
36.18664	0.922	36.23012	0.914	36.27713	0.876
36.18755	0.909	36.23105	0.919	36.27805	0.902
36.18848	0.902	36.23210	0.912	36.27898	0.925
36.18941	0.913	36.23310	0.915	36.28009	0.886
36.19070	0.927	36.23405	0.912	36.28117	0.878
36.19164	0.911	36.23535	0.919	36.28231	0.902
36.19256	0.920	36.23660	0.944	36.28324	0.917
36.19349	0.914	36.23761	0.890	36.28418	0.894
36.19442	0.889	36.23864	0.924	36.28509	0.917
36.19533	0.900	36.23957	0.924	36.28612	0.888
36.19626	0.900	36.24049	0.879	36.28735	0.924
36.19719	0.908	36.24145	0.929	36.28861	0.912
36.19811	0.926	36.24282	0.910	36.28953	0.890
36.19903	0.903	36.24400	0.902	36.29056	0.922
36.19996	0.898	36.24504	0.876	36.29193	0.899
36.20089	0.928	36.24605	0.918	36.29311	0.941
36.20182	0.927	36.24697	0.888	36.29449	0.907
36.20274	0.931	36.24805	0.922	36.29600	0.965
36.20366	0.899	36.24919	0.914	36.29692	0.908
36.20459	0.904	36.25011	0.914	36.29793	0.930
36.20552	0.919	36.25104	0.931	36.29948	0.887
36.20651	0.947	36.25197	0.912	36.30100	0.936
36.20755	0.935	36.25289	0.920	36.30200	0.959
36.20847	0.937	36.25407	0.911	36.30315	0.937
36.20939	0.924	36.25511	0.879	36.30442	0.906
36.21047	0.893	36.25603	0.912	36.30619	0.944
36.21143	0.908	36.25696	0.908	36.30782	0.942
36.21235	0.923	36.25789	0.877	36.30925	0.926
36.21329	0.904	36.25881	0.893	36.31025	0.942

Table 1. TZ CrB: *continued*

JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r	JD Hel. 2451800+	Δ r
36.31121	0.938	38.23146	0.906	38.28254	0.941
36.31236	0.927	38.23388	0.907	38.28463	0.937
36.31362	0.911	38.23515	0.903	38.28854	0.939
36.31495	0.932	38.23641	0.918	38.29222	0.896
36.31628	0.945	38.23801	0.929	38.29558	0.921
36.31847	0.870	38.23991	0.885	38.29821	0.902
36.31968	0.939	38.24120	0.931	38.30057	0.914
36.32116	0.908	38.24326	0.901	38.30309	0.945
36.32220	0.911	38.24540	0.875	38.30518	0.908
36.32346	0.904	38.24704	0.872	38.30698	0.927
36.32665	0.951	38.24812	0.904	38.30967	0.900
36.32994	0.914	38.25029	0.880	38.31189	0.922
36.33139	0.916	38.25127	0.915	38.31344	0.878
36.33332	0.925	38.25242	0.894	38.31511	0.948
36.33583	0.880	38.25373	0.909	38.31659	0.905
36.33831	0.949	38.25526	0.916	38.31850	0.900
36.34001	0.938	38.25731	0.905	38.32013	0.937
36.34241	0.878	38.25983	0.901	38.32311	0.910
36.34449	0.882	38.26158	0.905	38.32587	0.916
36.34786	0.948	38.26421	0.935	38.32724	0.896
36.34990	0.938	38.26757	0.913	38.32927	0.920
38.21856	0.889	38.27113	0.899	38.33151	0.920
38.22117	0.924	38.27412	0.906	38.33331	0.924
38.22414	0.917	38.27643	0.909	38.33554	0.909
38.22641	0.896	38.27821	0.939	38.33704	0.901
38.22863	0.882	38.27939	0.886	38.33892	0.920

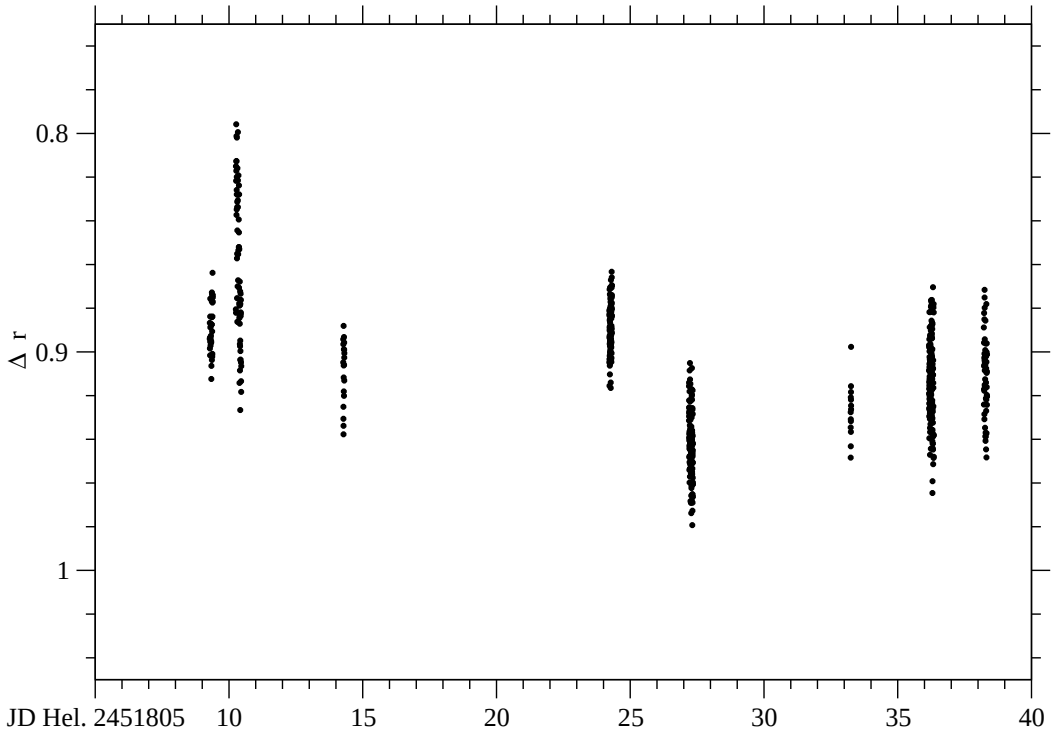

Figure 16: Light curve of TZ CrB

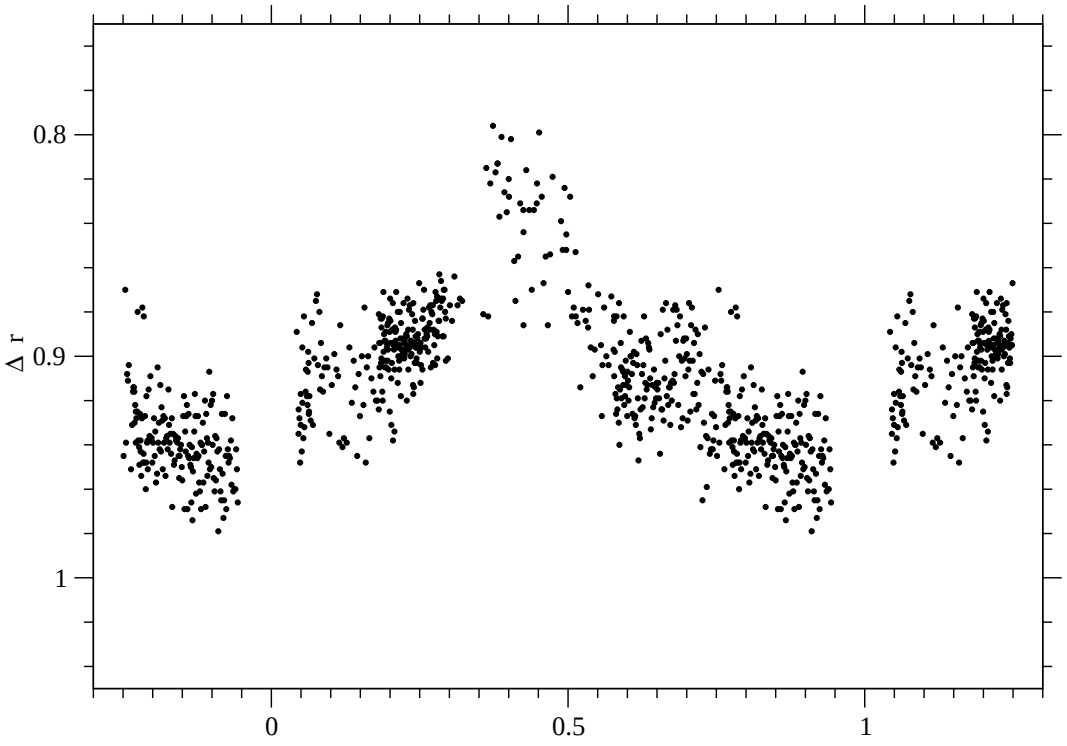

Figure 17: Light curve of TZ CrB, p=$0^{\mathrm{d}}.83$

Temporary Robotic Observatory

Figure 18: Temporary Observatory Ground Zero

Figure 19: Temporary Observatory – no comments 1

Figure 20: Temporary Observatory – no comments 2

Figure 21: Temporary Observatory – no comments 3

Figure 22: Temporary Observatory – no comments 4

Figure 23: Temporary Observatory – no comments 5

Figure 24: Temporary Observatory – no comments 6

Figure 25: Dome reconstruction

Figure 26: Temporary Observatory moved

Figure 27: The self–made camera – inside view 1

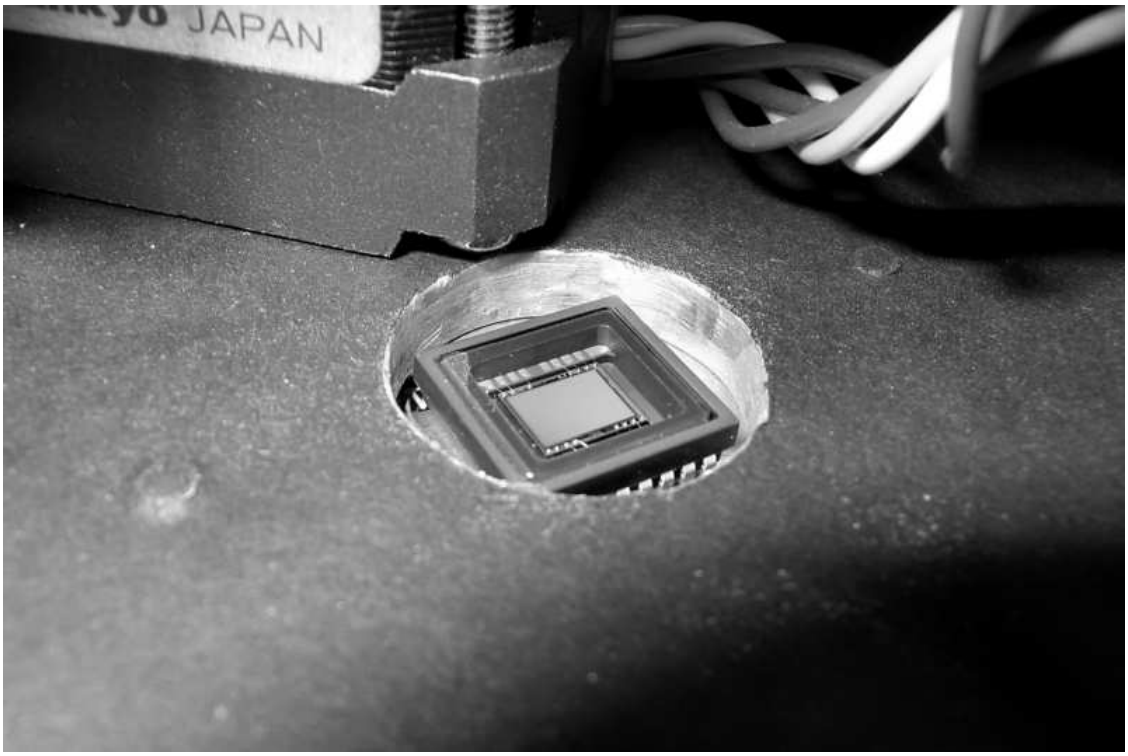

Figure 28: The self–made camera – inside view 2

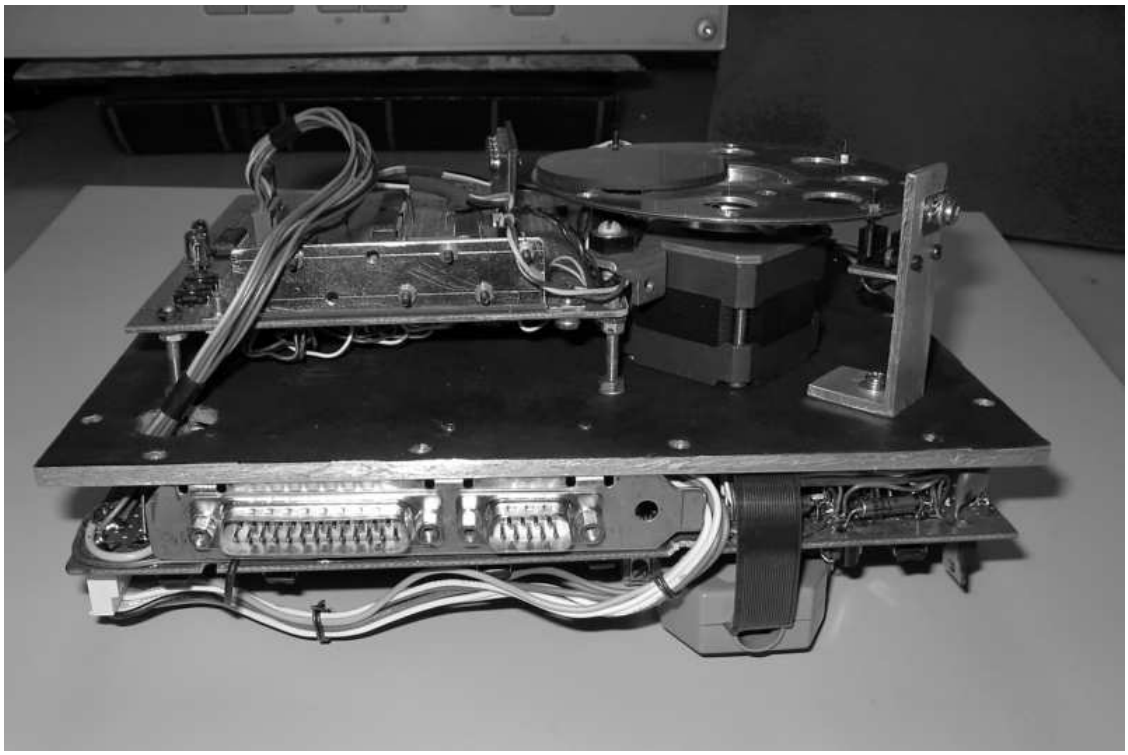

Figure 29: The self–made camera – inside view 3

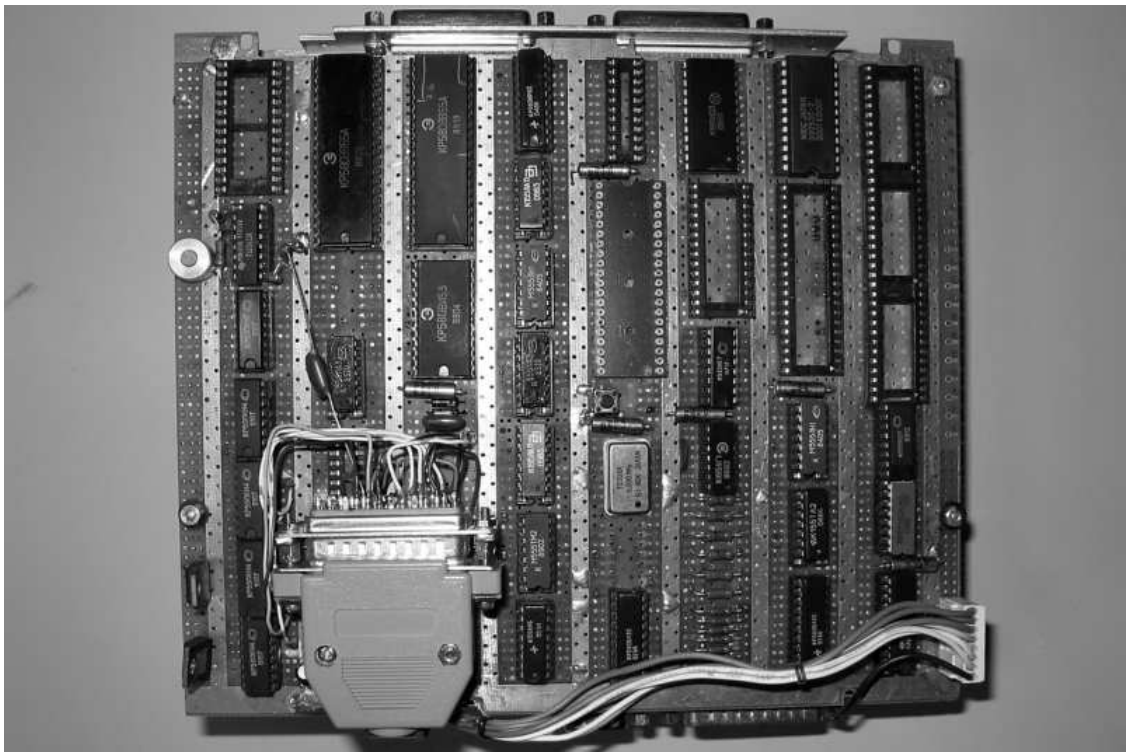

Figure 30: The self–made camera – inside view 4

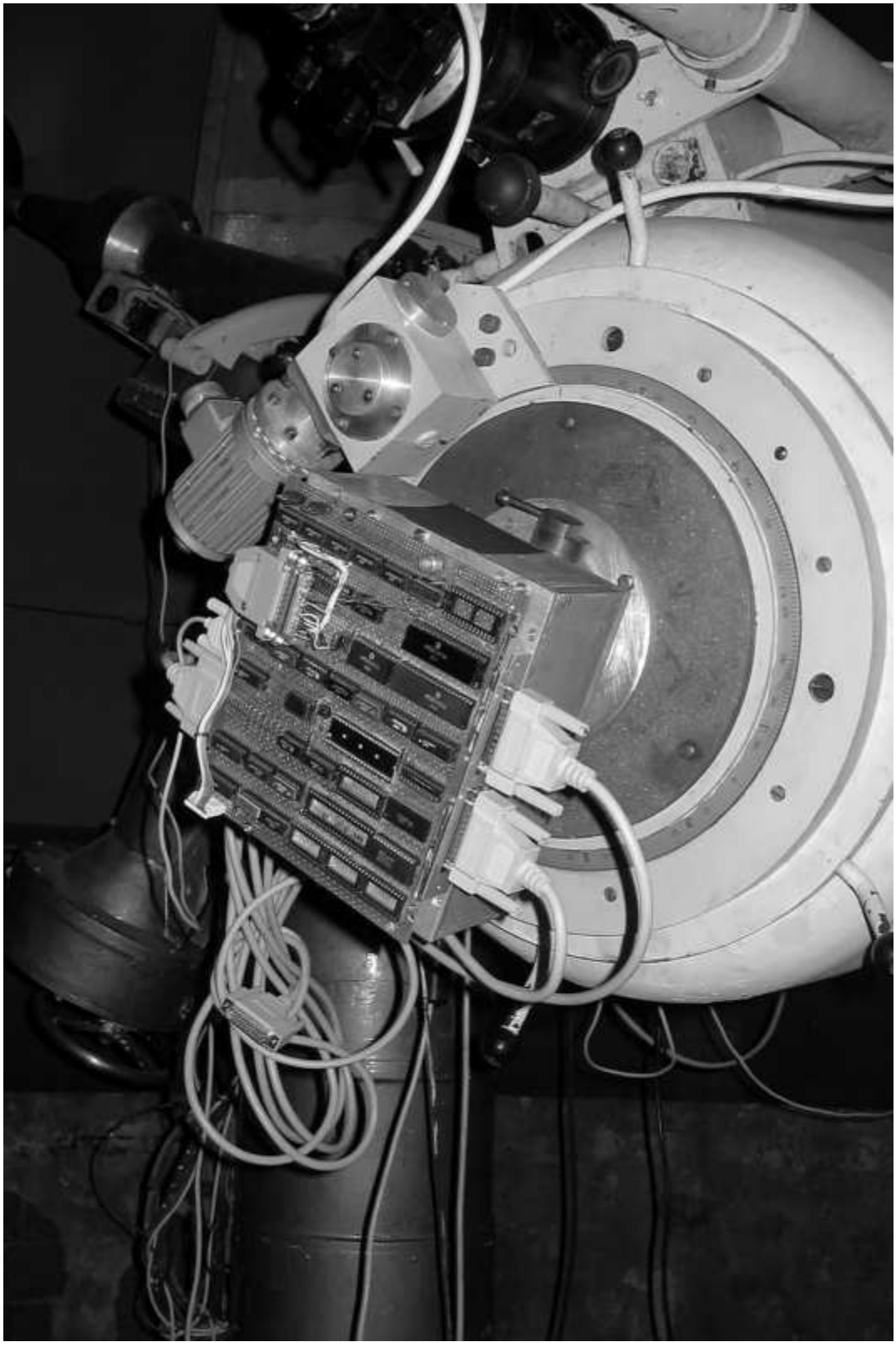

Figure 31: Self–made camera mounted to the main telescope (view 1)

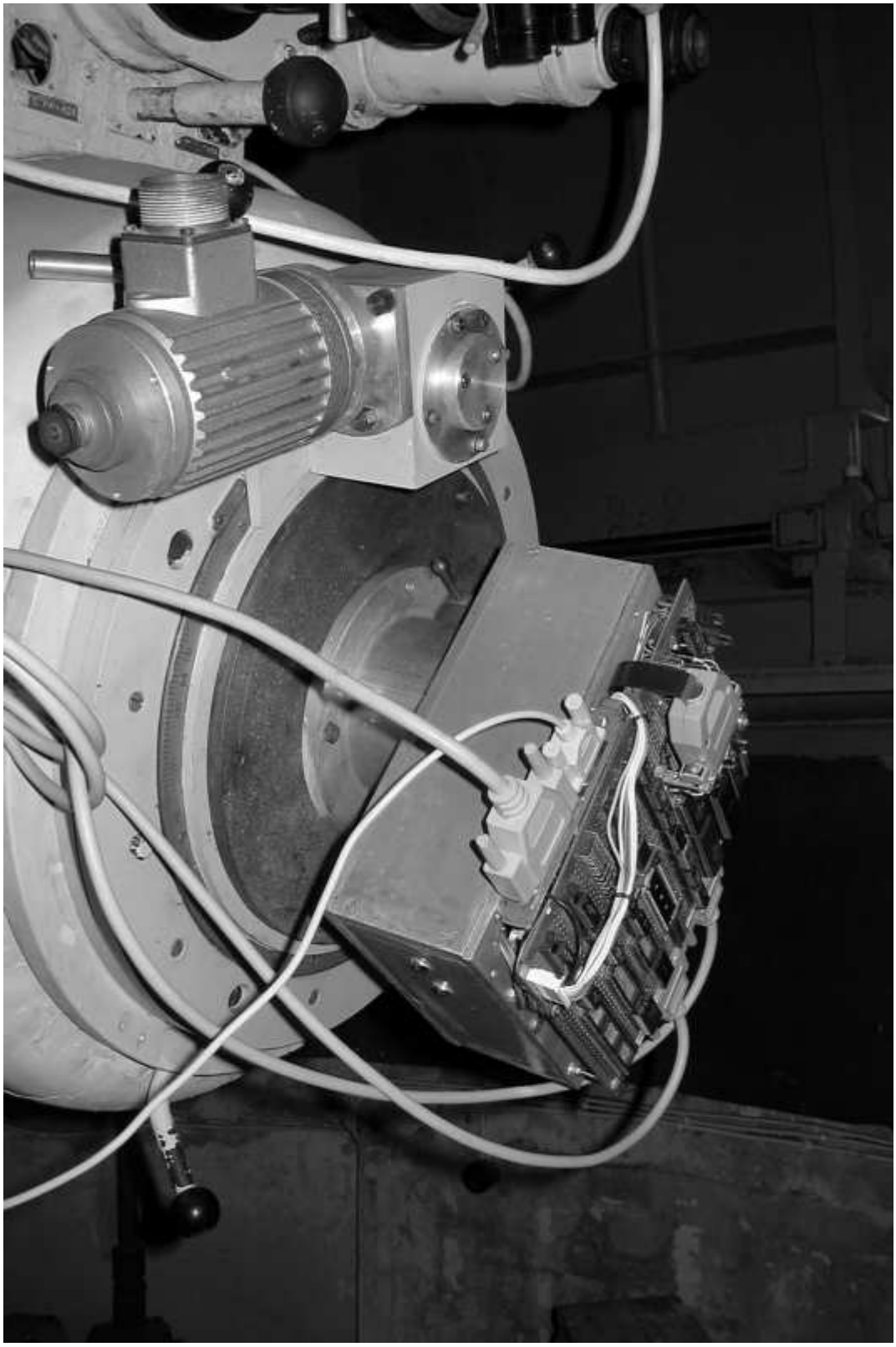

Figure 32: Self–made camera mounted to the main telescope (view 2)

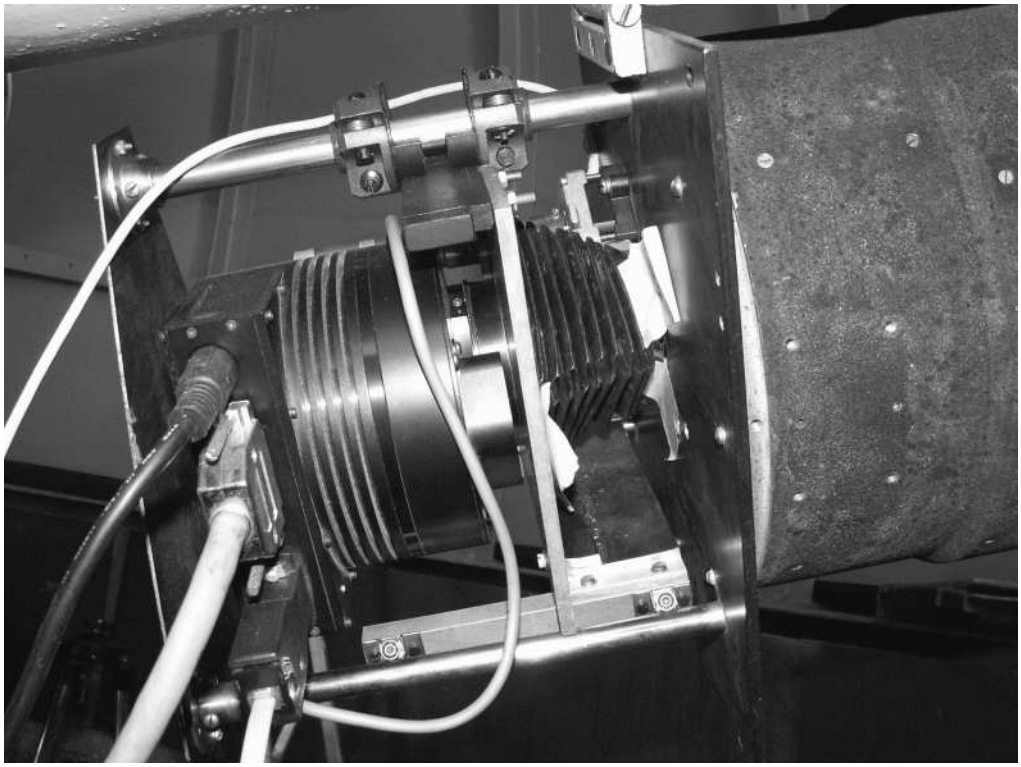

Figure 33: Remote focuser of the SBIG ST–7 CCD camera (view 1)

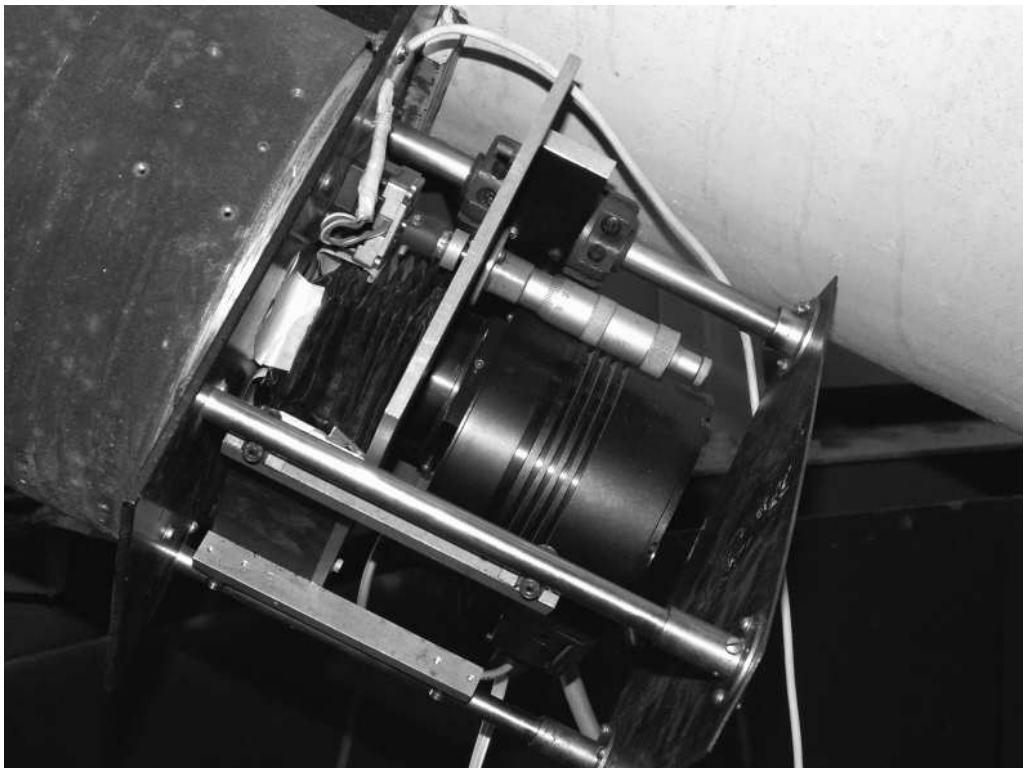

Figure 34: Remote focuser of the SBIG ST–7 CCD camera (view 2)

Reference

Kalv, P., Veismann, U., Photoelectric photometry in Estonia. Advances in photoelectric photometry, 1984, Vol. 2, p. 119 – 133

Observations of X Persei and 6 other Be Stars.

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Measurements were made within the international framework of photometric observations of bright Be stars in 1981–1996. All observations are transformed into the Johnson's standard system . The mean-square-root error of observations (normal points, one per night) are within ±0.004 – ±0.006 of magnitude. The comparison and check stars used and a number of observations are as follows:

Variable		Comp.	Check	No.
X Persei	= HD 24534	GC4516	GC4548	249
10 Cas	= HD 144	HD 2626	HD 2011	5
BV Cam	= HD 32343	HD 39283	HD 34233	11
Psi 9 Aur	= HD 50658	HD 49949	HD 52860	9
CX Dra	= HD 174237	HD 173664	HD 172883	112
V2148 Cyg	= HD 201733	HD 199311	HD 199479	129
V639 Cas	= HD 225094	HD 2626	HD 2011	5

In every table the first column is J.D. Hel–2400000 and the following four columns are differential magnitudes (var–comp) Δ U, Δ B, Δ V and Δ R respectively. Observations transformed to standard system. The oservations were partly used in papers (Hall et al. (1995), Roche et al. (1997))

X Persei ja 6 Be tähe vaatlused.

On esitatud X Persei ja kuue heleda Be tähe pikaajaliste vaatluste tulemused. Mõõtmised on teisendatud standardsesse värvussüsteemi. Tabelites on toodud heliotsentrilised vaatlusmomendid ja suhtelised heledused tähesuurustes. Osaliselt on neid vaatlusi kasutatud Hall ja teiste ning Roche ja teiste artiklites. Vaatlused on soovijatele kättesaadavad tellimisel.

Table 1. X Per

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
42045.3721		0.085	−0.011	
42056.3951		0.089	−0.007	
42057.2522		0.095	−0.004	
42058.3582		0.093	−0.004	
42059.3153		0.098	0.002	
42059.4012		0.101	0.006	
42060.3495		0.085	−0.003	
42112.2373		0.097	−0.013	
42113.2325		0.095	−0.003	
42123.2475		0.092	0.004	
42449.3068		0.126	0.041	
42450.2261		0.126	0.046	
42453.2645		0.131	0.041	
42455.2182		0.128	0.050	
42468.3004		0.131	0.041	
42469.3207		0.135	0.053	
42484.2738		0.128	0.042	
42486.2878		0.126	0.031	
42492.2749		0.136	0.039	
42645.5328		0.134	0.044	
42685.3100		0.173	0.069	
42698.4050		0.130	0.058	
42705.4961		0.116	0.034	
42713.4056		0.130	0.056	
42716.4786		0.141	0.042	
42728.4089		0.126	0.035	
42734.4170		0.117	0.033	
42757.4809		0.114	0.025	
42776.4849		0.117	0.015	
42820.3155		0.084	−0.008	
42828.2923		0.087	0.014	
42831.3924		0.102	0.022	
42832.2735		0.090	0.010	
42836.3784		0.105	0.019	
42842.3209		0.102	0.030	
43030.4804		0.131	0.061	
43052.4582		0.128	0.054	
43054.4235		0.130	0.056	
43067.4563		0.124	0.050	
43068.4223		0.121	0.048	
43069.4901		0.108	0.042	
43133.3085		0.109	0.041	
43172.2671		0.113	0.055	
43189.2375		0.119	0.054	
43209.2975		0.111	0.043	
43232.2885		0.109	0.033	
43411.4711		−0.049	−0.202	

Table 1. X Per: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
43412.5524		−0.055	−0.209	
43413.4383		−0.059	−0.208	
43414.5027		−0.065	−0.209	
43425.4809		−0.057	−0.215	
43480.2993		−0.108	−0.286	
43485.4577		−0.128	−0.301	
43494.3336		−0.122	−0.282	
43500.3917		−0.141	−0.308	
43525.4293		−0.171	−0.356	
43540.2853		−0.170	−0.334	
43544.3000		−0.164	−0.324	
43561.2201		−0.137	−0.303	
43563.3075		−0.126	−0.297	
43587.3425		−0.107	−0.271	
43588.3241		−0.106	−0.267	
43604.2958		−0.099	−0.252	
43741.4996		0.033	−0.122	
43756.5076		−0.005	−0.130	
43792.3842		0.020	−0.111	
43797.5207		−0.005	−0.101	
43807.5101		0.005	−0.074	
43808.4968		0.013	−0.074	
43811.4156		0.019	−0.083	
43814.4181		0.019	−0.079	
43817.5385		0.009	−0.080	
43819.4882		0.011	−0.074	
43872.3878		0.071	−0.001	
43916.2938		0.070	−0.011	
43922.2962		0.092	0.024	
43928.2751		0.093	0.022	
43946.2538		0.102	0.022	
44124.5563	−0.138	0.062	0.046	
44140.5805	−0.173	0.064	0.055	
44142.5033	−0.150	0.074	0.056	
44176.5723	−0.156	0.080	0.037	0.009
44215.5529	−0.238	0.003	−0.026	
44236.4391	−0.289	−0.032	−0.058	
44257.3024	−0.324	−0.064	−0.101	
44282.2247	−0.392	−0.115	−0.187	
44303.2522	−0.481	−0.199	−0.304	
44305.2574	−0.478	−0.207	−0.302	
44306.2507	−0.474	−0.191	−0.308	
44312.2576	−0.471	−0.201	−0.309	
44314.2513	−0.475	−0.204	−0.316	
44316.2573	−0.495	−0.230	−0.347	
44318.2923	−0.481	−0.192	−0.329	−0.491
44323.2807	−0.474	−0.196	−0.355	−0.526

Table 1. X Per: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
44328.2954	−0.460	−0.195	−0.351	−0.519
44479.4697	−0.341	−0.093	−0.230	−0.413
44484.5164	−0.361	−0.098	−0.221	−0.393
44493.5064	−0.359	−0.103	−0.219	−0.376
44506.5059	−0.358	−0.089	−0.185	−0.339
44631.2908	−0.197	0.045	0.008	−0.074
44637.3933	−0.183	0.053	0.016	−0.067
44664.3031	−0.169	0.068	0.024	−0.050
44670.2697	−0.154	0.062	0.025	−0.047
44682.2704	−0.155	0.078	0.045	−0.043
44988.2846	−0.300	−0.058	−0.125	−0.259
44989.3436	−0.297	−0.060	−0.128	−0.257
45009.2887	−0.335	−0.122	−0.194	−0.321
45038.2517	−0.399	−0.151	−0.251	−0.421
45047.3326	−0.399	−0.150	−0.258	−0.431
45050.2624	−0.432	−0.176	−0.285	−0.441
45055.3299	−0.427	−0.173	−0.286	−0.451
45059.2626	−0.405	−0.135	−0.252	−0.386
45060.2678	−0.406	−0.148	−0.269	−0.432
45064.3331	−0.420	−0.187	−0.302	−0.461
45229.4953	−0.487	−0.287	−0.429	−0.617
45235.5808	−0.508	−0.295	−0.439	−0.638
45237.5176	−0.495	−0.282	−0.428	−0.635
45240.5431	−0.493	−0.299	−0.435	−0.630
45254.4118	−0.459	−0.252	−0.403	−0.632
45295.3004	−0.460	−0.253	−0.410	−0.611
45321.4875	−0.491	−0.257	−0.414	−0.623
45345.2640	−0.500	−0.263	−0.395	−0.604
45380.2881	−0.478	−0.237	−0.384	−0.615
45382.1962	−0.494	−0.255	−0.397	−0.607
45394.2147	−0.486	−0.241	−0.379	−0.595
45400.2240	−0.485	−0.263	−0.404	−0.631
45698.4601	−0.468	−0.198	−0.284	−0.543
45756.2142	−0.488	−0.263	−0.367	−0.576
45771.2693	−0.497	−0.254	−0.351	−0.614
45773.2875	−0.520	−0.271	−0.369	−0.631
45777.3668	−0.496	−0.212	−0.323	−0.568
45781.2940	−0.481	−0.195	−0.307	−0.563
46020.4560	−0.448	−0.162	−0.230	−0.487
46363.4177	−0.191	0.047	0.033	−0.061
46378.5735	−0.139	0.065	0.057	−0.043
46411.3617	−0.161	0.063	0.052	−0.026
46414.5014	−0.155	0.084	0.069	−0.016
46427.2181	−0.130	0.073	0.070	−0.013
46441.3387	−0.125	0.084	0.082	0.010
46464.3639	−0.150	0.082	0.075	0.002
46468.1858	−0.167	0.079	0.074	−0.010

Table 1. X Per: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
46473.3040	−0.133	0.084	0.079	0.004
46487.3622	−0.145	0.079	0.076	−0.019
46508.3488	−0.114	0.087	0.068	−0.004
46510.2731	−0.107	0.091	0.086	0.007
46817.2572	−0.446	−0.153	−0.230	−0.478
46825.1802	−0.456	−0.158	−0.243	−0.450
46830.3707	−0.435	−0.137	−0.201	−0.471
46854.2353	−0.498	−0.212	−0.283	−0.554
46868.2412	−0.489	−0.206	−0.319	−0.574
46890.3088	−0.497	−0.235	−0.381	−0.595
46893.2981	−0.490	−0.208	−0.367	−0.587
46900.3142	−0.468	−0.194	−0.375	−0.609
47025.5354	−0.444	−0.191	−0.291	−0.535
47038.4600	−0.475	−0.202	−0.307	−0.526
47060.5047	−0.505	−0.242	−0.343	−0.546
47070.4500	−0.474	−0.232	−0.321	−0.573
47081.5584	−0.510	−0.249	−0.338	−0.575
47088.4065	−0.431	−0.198	−0.301	−0.560
47098.4912	−0.509	−0.230	−0.344	−0.602
47103.5415	−0.474	−0.202	−0.312	−0.560
47109.2818	−0.469	−0.203	−0.318	−0.573
47184.2592	−0.555	−0.303	−0.394	−0.670
47187.2694	−0.555	−0.268	−0.383	−0.664
47217.3436	−0.558	−0.293	−0.430	−0.686
47241.2704	−0.560	−0.291	−0.457	−0.694
47253.2791	−0.514	−0.238	−0.422	−0.644
47412.4457	−0.438	−0.163	−0.255	−0.486
47421.5469	−0.385	−0.111	−0.171	−0.407
47432.4930	−0.425	−0.136	−0.196	−0.426
47440.5515	−0.390	−0.112	−0.175	−0.379
47448.5079	−0.385	−0.110	−0.180	−0.407
47452.3818	−0.378	−0.119	−0.171	−0.408
47455.3673	−0.339	−0.091	−0.141	−0.355
47474.3223	−0.322	−0.058	−0.101	−0.283
47475.3956	−0.341	−0.063	−0.089	−0.298
47476.4094	−0.320	−0.060	−0.096	−0.314
47497.3641	−0.293	−0.029	−0.056	−0.219
47525.2468	−0.213	0.023	−0.012	−0.115
47536.1863	−0.196	0.031	0.016	−0.096
47552.3777	−0.164	0.051	0.042	−0.046
47557.2772	−0.159	0.054	0.054	−0.032
47561.2407	−0.167	0.063	0.045	−0.032
47566.2009	−0.155	0.064	0.061	−0.061
47567.2689	−0.143	0.064	0.055	−0.064
47575.2309	−0.130	0.072	0.062	−0.035
47576.2505	−0.144	0.065	0.064	−0.036
47579.2753	−0.146	0.068	0.061	−0.003

Table 1. X Per: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
47580.2301	−0.133	0.064	0.062	−0.017
47593.3002	−0.116	0.095	0.097	0.013
47601.2589	−0.135	0.074	0.078	−0.016
47613.2867	−0.092	0.087	0.057	−0.031
47616.2710	−0.118	0.057	0.070	0.002
47621.3270	−0.090	0.087	0.081	−0.017
47768.5428	−0.121	0.100	0.093	0.011
47769.5501	−0.126	0.081	0.083	0.003
47773.5035	−0.121	0.093	0.095	0.029
47774.5834	−0.109	0.106	0.103	0.017
47775.5841	−0.108	0.108	0.098	0.042
47780.5707	−0.099	0.119	0.113	0.061
47792.5647	−0.116	0.115	0.110	0.007
47805.4555	−0.100	0.112	0.112	0.058
47806.6412	−0.106	0.115	0.106	0.037
47825.5509	−0.100	0.107	0.110	0.058
47847.3406	−0.110	0.104	0.093	0.046
47849.4889	−0.064	0.124	0.116	0.052
47851.4430	−0.081	0.119	0.109	0.051
47895.2968	−0.096	0.077	0.075	0.038
47946.2436	−0.094	0.103	0.097	0.054
47957.2544	−0.108	0.103	0.097	0.048
47959.2666	−0.089	0.113	0.110	0.061
47964.2913	−0.098	0.127	0.107	0.049
47974.3266	−0.076	0.123	0.100	0.057
47987.2844	−0.080	0.131	0.121	0.059
48130.5268	−0.106	0.112	0.115	0.058
48135.5360	−0.099	0.114	0.112	0.057
48175.6603	−0.083	0.136	0.131	0.071
48177.5733	−0.084	0.135	0.124	0.080
48186.5900	−0.093	0.126	0.118	0.076
48207.4684	−0.093	0.128	0.124	0.087
48229.4535	−0.096	0.123	0.124	0.087
48273.2223	−0.114	0.110	0.100	0.062
48296.2264	−0.084	0.124	0.112	0.078
48319.3828	−0.075	0.134	0.106	0.072
48341.2890	−0.095	0.129	0.120	0.088
48343.2874	−0.090	0.131	0.107	0.068
48346.3014	−0.091	0.138	0.109	0.064
48539.6442	−0.086	0.116	0.104	0.058
48543.5932	−0.103	0.112	0.109	0.063
48890.5916	−0.160	0.054	0.045	−0.013
48977.3313	−0.132	0.085	0.082	0.015
48990.3084	−0.129	0.091	0.087	0.023
49027.2724	−0.133	0.092	0.094	0.028
49029.2454	−0.128	0.090	0.085	0.015
49036.3224	−0.125	0.096	0.094	0.028

Table 1. X Per: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
49044.2964	−0.138	0.079	0.074	0.015
49066.2665	−0.164	0.064	0.054	0.007
49069.3022	−0.177	0.052	0.046	0.007
49631.5596	−0.550	−0.297	−0.429	−0.706
49660.4555	−0.547	−0.315	−0.453	−0.718
50114.2986	−0.257	−0.015	−0.016	−0.132
50154.3294	−0.250	0.009	−0.006	−0.121
50156.2582	−0.193	0.037	0.027	−0.100
50161.2669	−0.203	0.025	0.022	−0.081
50163.2805	−0.199	0.031	0.017	−0.072
50166.2786	−0.193	0.039	0.021	−0.076
50177.3011	−0.155	0.086	0.054	−0.046
50179.3013	−0.164	0.076	0.040	−0.049
50182.3040	−0.173	0.063	0.033	−0.061

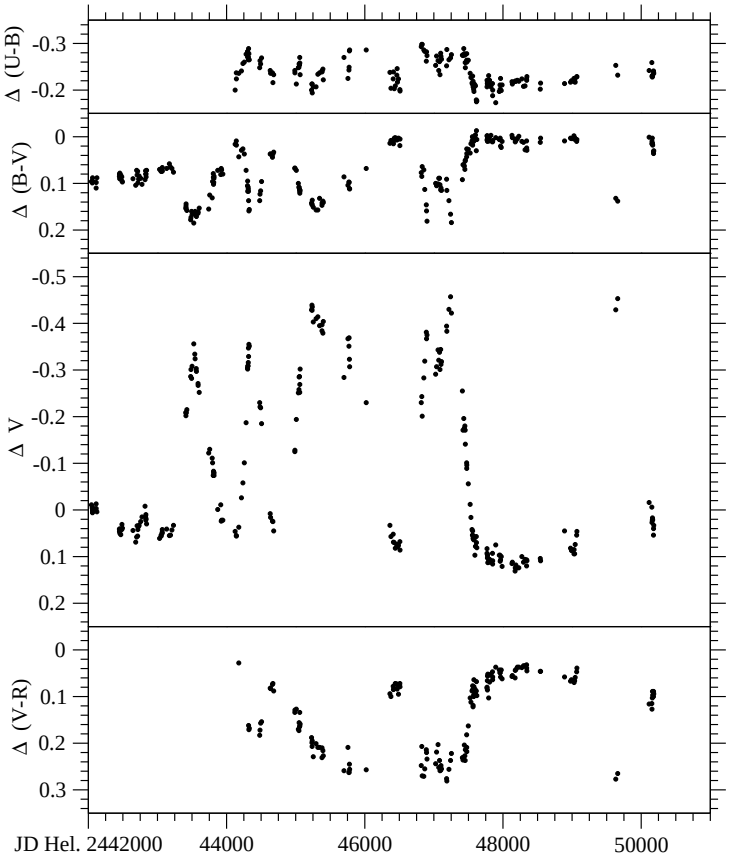

Figure 1: Color curve of X Per

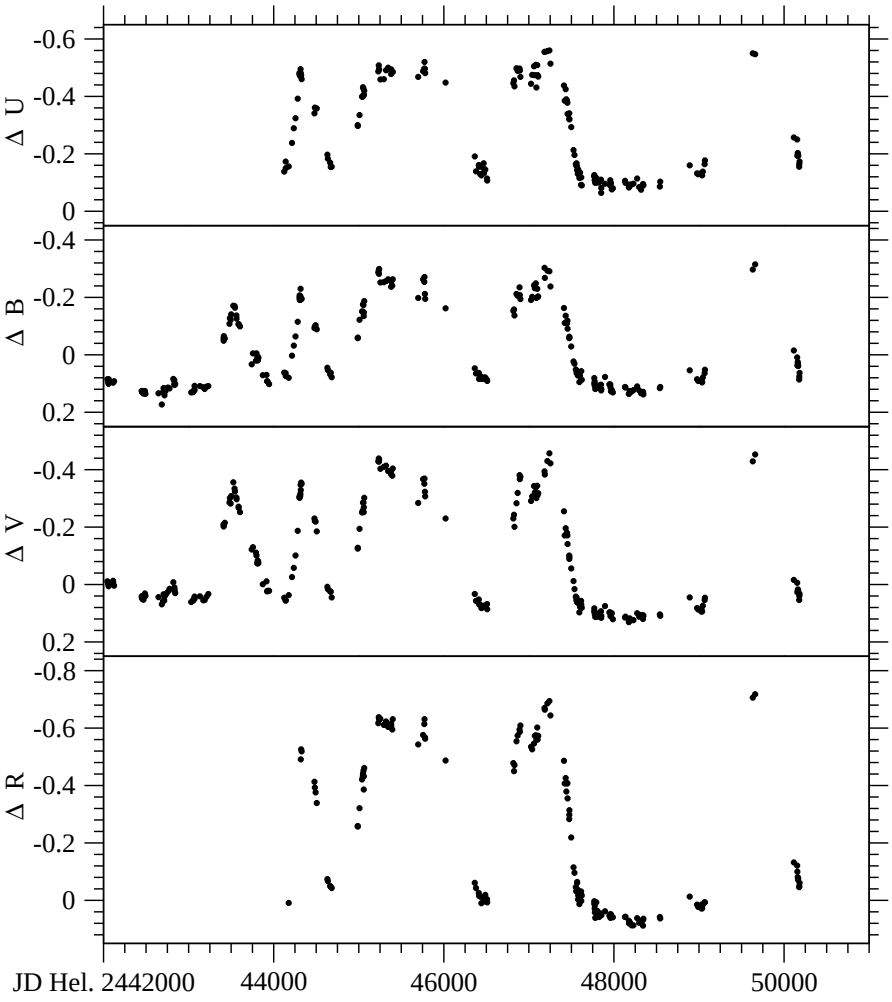

Figure 2: Light curve of X Per

Table 2. 10 Cas

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
44696.3885	-0.213	-0.380	-0.371	-0.337
44721.3612	-0.215	-0.357	-0.370	-0.308
44737.3863	-0.267	-0.400	-0.386	-0.336
44741.4191	-0.317	-0.433	-0.399	-0.374
45773.4793	-0.283	-0.416	-0.382	-0.346

Table 3. 11 Cam

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
44682.4164	-0.752	-0.103	0.076	0.056
44687.4385	-0.814	-0.128	0.057	0.040
44702.4313	-0.791	-0.088	0.075	0.050
44721.4250	-0.807	-0.101	0.081	0.066
44735.3889	-0.747	-0.072	0.094	0.053
44743.4165	-0.772	-0.096	0.058	0.067
45084.3684	-0.785	-0.118	0.083	0.027
45771.4117	-0.831	-0.037	0.224	0.159
45774.5042	-0.816	-0.028	0.227	0.158
45785.4593	-0.825	-0.029	0.221	0.180
45792.4608	-0.807	-0.015	0.240	0.181

Table 4. 9 Aur

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
44691.4694	-1.241	-0.758	-0.417	-0.217
44720.3997	-1.238	-0.744	-0.411	-0.213
44733.3972	-1.203	-0.705	-0.373	-0.190
44739.3942	-1.247	-0.722	-0.410	-0.224
45085.3545	-1.167	-0.704	-0.358	-0.188
45771.4736	-1.299	-0.766	-0.404	-0.162
45778.5330	-1.317	-0.736	-0.387	-0.148
45835.4373	-1.289	-0.746	-0.392	-0.187
46202.4074	-1.147	-0.639	-0.294	-0.096

Table 5. V639 Cas

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
44696.4003	0.423	0.590	0.331	0.060
44721.3733	0.410	0.584	0.344	0.060
44737.3968	0.417	0.594	0.330	0.070
44741.4396	0.379	0.567	0.313	0.052
45773.4949	0.327	0.548	0.313	-0.004

Table 6. CX Dra

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
44721.5354	−1.290	−0.538	−0.313	−0.261
44739.4910	−1.370	−0.573	−0.376	−0.369
44741.4917	−1.360	−0.585	−0.389	−0.372
44743.4658	−1.346	−0.568	−0.359	−0.354
44745.4022	−1.324	−0.563	−0.336	−0.326
44747.4012	−1.314	−0.541	−0.321	−0.294
44749.4305	−1.285	−0.538	−0.359	−0.354
44753.3978	−1.273	−0.521	−0.308	−0.262
45082.5468	−1.362	−0.599	−0.408	−0.414
45237.4551	−1.138	−0.457	−0.221	−0.148
45262.3809	−1.335	−0.574	−0.375	−0.328
45295.3576	−1.402	−0.600	−0.396	−0.381
45772.5538	−1.518	−0.647	−0.373	−0.369
45773.5663	−1.556	−0.672	−0.403	−0.398
45774.6089	−1.596	−0.656	−0.396	−0.394
45777.5534	−1.565	−0.655	−0.385	−0.391
45778.5882	−1.561	−0.623	−0.343	−0.331
45784.5518	−1.494	−0.611	−0.333	−0.320
45810.5489	−1.501	−0.629	−0.350	−0.326
45834.4619	−1.644	−0.718	−0.453	−0.460
46166.5188	−1.455	−0.586	−0.275	−0.239
46184.5236	−1.405	−0.570	−0.273	−0.212
46201.4865	−1.384	−0.552	−0.245	−0.183
46204.3940	−1.346	−0.549	−0.259	−0.173
46212.4069	−1.350	−0.537	−0.241	−0.209
46213.4088	−1.322	−0.515	−0.224	−0.153
46214.3944	−1.339	−0.532	−0.232	−0.171
46215.4141	−1.372	−0.540	−0.246	−0.198
46218.4088	−1.413	−0.565	−0.273	−0.225
46219.4074	−1.430	−0.573	−0.283	−0.249
46220.4053	−1.418	−0.564	−0.262	−0.207
46314.4667	−1.575	−0.665	−0.376	−0.364
46363.2641	−1.477	−0.615	−0.326	−0.311
46508.5552	−1.538	−0.633	−0.340	−0.336
46510.5068	−1.538	−0.639	−0.371	−0.390
46555.5103	−1.526	−0.629	−0.338	−0.338
46558.4714	−1.571	−0.667	−0.393	−0.410
46559.5108	−1.559	−0.657	−0.388	−0.393
46569.3991	−1.584	−0.696	−0.421	−0.389
46658.4057	−1.478	−0.611	−0.319	−0.278
46906.4718	−1.334	−0.534	−0.238	−0.139
47082.3709	−1.377	−0.568	−0.304	−0.290
47088.2840	−1.475	−0.646	−0.360	−0.356
47091.3298	−1.435	−0.598	−0.324	−0.286
47098.4018	−1.396	−0.579	−0.292	−0.252
47301.3752	−1.375	−0.603	−0.313	−0.269
47307.4739	−1.462	−0.602	−0.330	−0.321

Table 6. CX Dra: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
47308.4068	−1.489	−0.607	−0.325	−0.287
47309.4615	−1.508	−0.618	−0.334	−0.314
47310.4564	−1.458	−0.576	−0.313	−0.277
47311.4559	−1.460	−0.565	−0.281	−0.254
47413.4172	−1.482	−0.611	−0.306	−0.260
47421.4003	−1.354	−0.546	−0.256	−0.186
47432.3844	−1.422	−0.598	−0.292	−0.256
47439.3829	−1.407	−0.566	−0.270	−0.236
47440.3700	−1.417	−0.593	−0.300	−0.257
47451.3411	−1.285	−0.520	−0.228	−0.156
47497.2200	−1.317	−0.561	−0.257	−0.189
47593.5482	−1.291	−0.498	−0.208	−0.107
47613.5373	−1.312	−0.533	−0.233	−0.154
47615.5623	−1.353	−0.585	−0.289	−0.224
47616.4972	−1.394	−0.563	−0.274	−0.214
47617.5228	−1.415	−0.562	−0.269	−0.214
47621.5013	−1.461	−0.608	−0.313	−0.305
47641.4562	−1.496	−0.619	−0.329	−0.316
47648.4340	−1.487	−0.619	−0.328	−0.309
47653.4909	−1.412	−0.579	−0.272	−0.205
47654.3548	−1.379	−0.573	−0.271	−0.222
47657.3668	−1.399	−0.591	−0.297	−0.251
47658.4603	−1.434	−0.592	−0.305	−0.282
47662.4019	−1.430	−0.592	−0.299	−0.278
47665.3696	−1.441	−0.609	−0.330	−0.303
47667.3769	−1.437	−0.607	−0.308	−0.276
47668.4911	−1.451	−0.606	−0.318	−0.277
47671.4773	−1.420	−0.588	−0.296	−0.254
47672.4210	−1.407	−0.572	−0.270	−0.242
47674.3896	−1.342	−0.543	−0.239	−0.161
47675.4739	−1.404	−0.584	−0.290	−0.221
47677.4568	−1.461	−0.610	−0.301	−0.250
47734.4641	−1.431	−0.578	−0.281	−0.219
47746.3662	−1.264	−0.537	−0.227	−0.168
47752.3616	−1.361	−0.561	−0.254	−0.203
47768.4924	−1.496	−0.624	−0.343	−0.325
47769.4252	−1.514	−0.636	−0.344	−0.338
47770.3919	−1.504	−0.628	−0.337	−0.308
47771.4308	−1.457	−0.594	−0.310	−0.290
47773.4286	−1.401	−0.563	−0.262	−0.212
47774.5163	−1.409	−0.576	−0.282	−0.242
47775.3917	−1.470	−0.614	−0.312	−0.292
47777.3656	−1.533	−0.643	−0.342	−0.316
47780.4548	−1.497	−0.626	−0.335	−0.302
47791.3556	−1.463	−0.613	−0.320	−0.300
47792.4026	−1.460	−0.603	−0.305	−0.289
47793.2967	−1.435	−0.595	−0.290	−0.289

Table 6. CX Dra: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
47805.5032	−1.498	−0.640	−0.376	−0.368
47806.4491	−1.483	−0.612	−0.350	−0.324
47809.2307	−1.532	−0.711	−0.420	−0.410
47814.2837	−1.497	−0.645	−0.332	−0.300
47981.5891	−1.398	−0.574	−0.260	−0.207
47999.5710	−1.583	−0.714	−0.443	−0.417
48002.5627	−1.505	−0.641	−0.361	−0.354
48014.3295	−1.335	−0.568	−0.282	−0.204
48016.5304	−1.462	−0.605	−0.318	−0.298
48017.3592	−1.369	−0.611	−0.305	−0.252
48023.5151	−1.556	−0.678	−0.391	−0.389
48116.4382	−1.403	−0.569	−0.264	−0.211
48136.3402	−1.370	−0.499	−0.215	−0.175
48137.3522	−1.289	−0.542	−0.244	−0.197
48176.4295	−1.292	−0.503	−0.199	−0.096
48186.2407	−1.358	−0.571	−0.268	−0.196
48194.3350	−1.340	−0.548	−0.260	−0.215
48230.2501	−1.309	−0.533	−0.227	−0.155

Table 7. HD201733

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
44737.4957	−0.827	−0.193	0.047	0.143
44747.4635	−0.790	−0.159	0.058	0.148
45229.4323	−0.871	−0.253	0.005	0.111
45772.6059	−0.981	−0.330	−0.026	0.107
45777.5977	−0.990	−0.332	−0.028	0.082
45785.5952	−0.996	−0.327	−0.022	0.097
45834.4932	−1.057	−0.331	−0.034	0.083
46193.4901	−1.040	−0.344	−0.038	0.071
46204.4758	−1.062	−0.353	−0.046	0.079
46212.4743	−1.074	−0.362	−0.056	0.063
46213.4521	−1.044	−0.330	−0.025	0.094
46214.4600	−1.045	−0.347	−0.039	0.066
46218.4434	−1.074	−0.372	−0.055	0.072
46219.4410	−1.081	−0.368	−0.051	0.078
46220.4514	−1.091	−0.375	−0.064	0.076
46314.5297	−1.060	−0.371	−0.056	0.082
46363.3068	−1.078	−0.369	−0.040	0.096
46507.6241	−1.075	−0.363	−0.049	0.081
46510.5952	−1.113	−0.348	−0.057	0.065
46555.4721	−1.086	−0.370	−0.057	0.062
46558.5071	−1.117	−0.379	−0.058	0.062
46559.4750	−1.081	−0.347	−0.043	0.079

Table 7. HD201733: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
46658.4386	−1.084	−0.386	−0.059	0.065
46906.5392	−1.109	−0.381	−0.077	0.040
47082.3983	−1.097	−0.367	−0.058	0.097
47088.3188	−1.107	−0.367	−0.066	0.056
47091.3762	−1.127	−0.384	−0.069	0.059
47098.4496	−1.165	−0.376	−0.054	0.061
47300.4737	−1.150	−0.404	−0.079	0.038
47301.4734	−1.186	−0.403	−0.083	0.023
47307.4097	−1.136	−0.373	−0.058	0.057
47308.4732	−1.136	−0.377	−0.070	0.057
47309.4012	−1.153	−0.365	−0.071	0.049
47310.3964	−1.157	−0.368	−0.067	0.067
47311.3969	−1.140	−0.361	−0.071	0.071
47413.4661	−1.155	−0.412	−0.078	0.069
47414.4498	−1.144	−0.402	−0.070	0.070
47421.4753	−1.142	−0.409	−0.072	0.057
47432.4297	−1.133	−0.410	−0.082	0.062
47440.4425	−1.135	−0.399	−0.065	0.077
47451.3668	−1.131	−0.409	−0.071	0.061
47615.6202	−1.132	−0.384	−0.077	0.059
47616.5392	−1.151	−0.407	−0.088	0.058
47621.5239	−1.169	−0.410	−0.102	0.039
47641.4946	−1.136	−0.402	−0.086	0.068
47648.4739	−1.155	−0.415	−0.096	0.065
47653.4679	−1.192	−0.436	−0.113	0.032
47654.4713	−1.188	−0.416	−0.086	0.050
47655.4570	−1.168	−0.423	−0.094	0.028
47657.4664	−1.186	−0.415	−0.100	0.041
47662.4866	−1.155	−0.409	−0.082	0.053
47664.4610	−1.171	−0.419	−0.095	0.049
47665.4770	−1.154	−0.409	−0.087	0.044
47667.4839	−1.161	−0.415	−0.083	0.050
47668.4721	−1.159	−0.406	−0.089	0.053
47671.4016	−1.146	−0.404	−0.085	0.051
47672.4603	−1.164	−0.416	−0.097	0.055
47674.4598	−1.154	−0.418	−0.083	0.056
47677.4071	−1.099	−0.399	−0.090	0.070
47734.4049	−1.134	−0.401	−0.069	0.079
47735.4725	−1.137	−0.393	−0.069	0.076
47746.3958	−1.148	−0.406	−0.074	0.060
47752.3799	−1.170	−0.432	−0.084	0.058
47762.4611	−1.175	−0.430	−0.090	0.040
47768.5139	−1.146	−0.410	−0.076	0.068
47769.4765	−1.156	−0.409	−0.072	0.063
47770.4354	−1.126	−0.381	−0.056	0.076
47771.4785	−1.160	−0.424	−0.088	0.054
47773.4689	−1.164	−0.416	−0.085	0.052

Table 7. HD201733: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
47774.5386	−1.135	−0.401	−0.065	0.069
47775.4268	−1.154	−0.423	−0.082	0.067
47780.4918	−1.145	−0.408	−0.071	0.064
47791.3679	−1.076	−0.335	−0.008	0.113
47792.4252	−1.066	−0.330	−0.008	0.112
47793.3215	−1.080	−0.357	−0.040	0.101
47805.5482	−1.122	−0.376	−0.062	0.081
47806.4892	−1.108	−0.377	−0.046	0.086
47809.2610	−1.103	−0.390	−0.052	0.098
47825.4424	−1.104	−0.358	−0.029	0.082
47999.5585	−1.162	−0.397	−0.091	0.036
48002.5496	−1.158	−0.403	−0.076	0.104
48016.4482	−1.142	−0.400	−0.085	0.036
48017.5134	−1.163	−0.408	−0.091	0.053
48023.4955	−1.162	−0.419	−0.089	0.065
48117.3744	−1.137	−0.420	−0.082	0.054
48135.4774	−1.162	−0.418	−0.091	0.042
48136.4991	−1.172	−0.415	−0.083	0.054
48175.4871	−1.138	−0.407	−0.070	0.070
48176.4845	−1.173	−0.415	−0.084	0.044
48186.3300	−1.140	−0.418	−0.084	0.045
48230.3141	−1.142	−0.408	−0.068	0.067
48384.4834	−1.161	−0.410	−0.088	0.059
48386.5131	−1.147	−0.410	−0.082	0.072
48391.4851	−1.150	−0.410	−0.080	0.044
48394.4882	−1.171	−0.424	−0.100	0.022
48407.4748	−1.144	−0.423	−0.107	0.051
48408.4733	−1.146	−0.418	−0.098	0.055
48757.4867	−1.034	−0.332	−0.015	0.122
48761.4780	−1.039	−0.325	−0.019	0.103
48762.4800	−1.038	−0.328	−0.018	0.098
48765.4793	−0.881	−0.217	0.074	0.191
48766.4706	−0.964	−0.287	0.018	0.151
48767.4610	−0.989	−0.310	−0.009	0.139
48768.4480	−0.945	−0.229	0.066	0.170
48769.4482	−0.968	−0.256	0.038	0.143
48771.4529	−1.028	−0.319	−0.018	0.091
48772.4452	−0.943	−0.242	0.100	0.171
48773.4437	−1.006	−0.295	0.011	0.130
48890.3237	−1.062	−0.360	−0.042	0.126
48936.3563	−1.045	−0.349	−0.036	0.102
48977.2130	−1.086	−0.398	−0.086	0.066
48990.2484	−1.103	−0.350	−0.047	0.061
49066.5591	−1.083	−0.379	−0.054	0.096
49089.5338	−1.099	−0.379	−0.075	0.096
49091.5516	−0.973	−0.288	−0.003	0.147
49098.5068	−1.001	−0.378	−0.093	0.026

Table 7. HD201733: *continued*

JD Hel. 2400000+	Δ U	Δ B	Δ V	Δ R
49103.5075	−1.067	−0.347	−0.043	0.086
49107.5238	−1.097	−0.379	−0.054	0.080
49112.5252	−0.893	−0.184	0.097	0.209
49114.5054	−0.939	−0.230	0.053	0.175
49118.3996	−1.001	−0.276	0.012	0.119
49119.5001	−1.014	−0.305	−0.006	0.116
49125.4062	−1.007	−0.330	−0.020	0.080
49127.3925	−1.017	−0.308	−0.008	0.134
49497.4538	−1.151	−0.401	−0.087	0.082
49500.4517	−1.132	−0.403	−0.070	0.074
49505.4498	−1.150	−0.413	−0.092	0.079
50177.5914	−1.098	−0.377	−0.074	0.050
50181.5652	−1.078	−0.350	−0.047	0.078

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