

UZ Comae Berenices¹ (UZ Com)

Period Verification & Distance Estimation

(Team M35)

Team Details

- Team Name - M35
- Topic - Period Verification and Distance Estimation for UZ Com
- Team Members -

Name	Roll Number	Contribution
Neilabh Banzal	170010014	30%
Poorvi R Hebbar	170050094	30%
Deo Pranav Sunil	170040012	30%
Prathamesh Pratap More	170010016	10%

Goals

UZ Com (Class RRab)

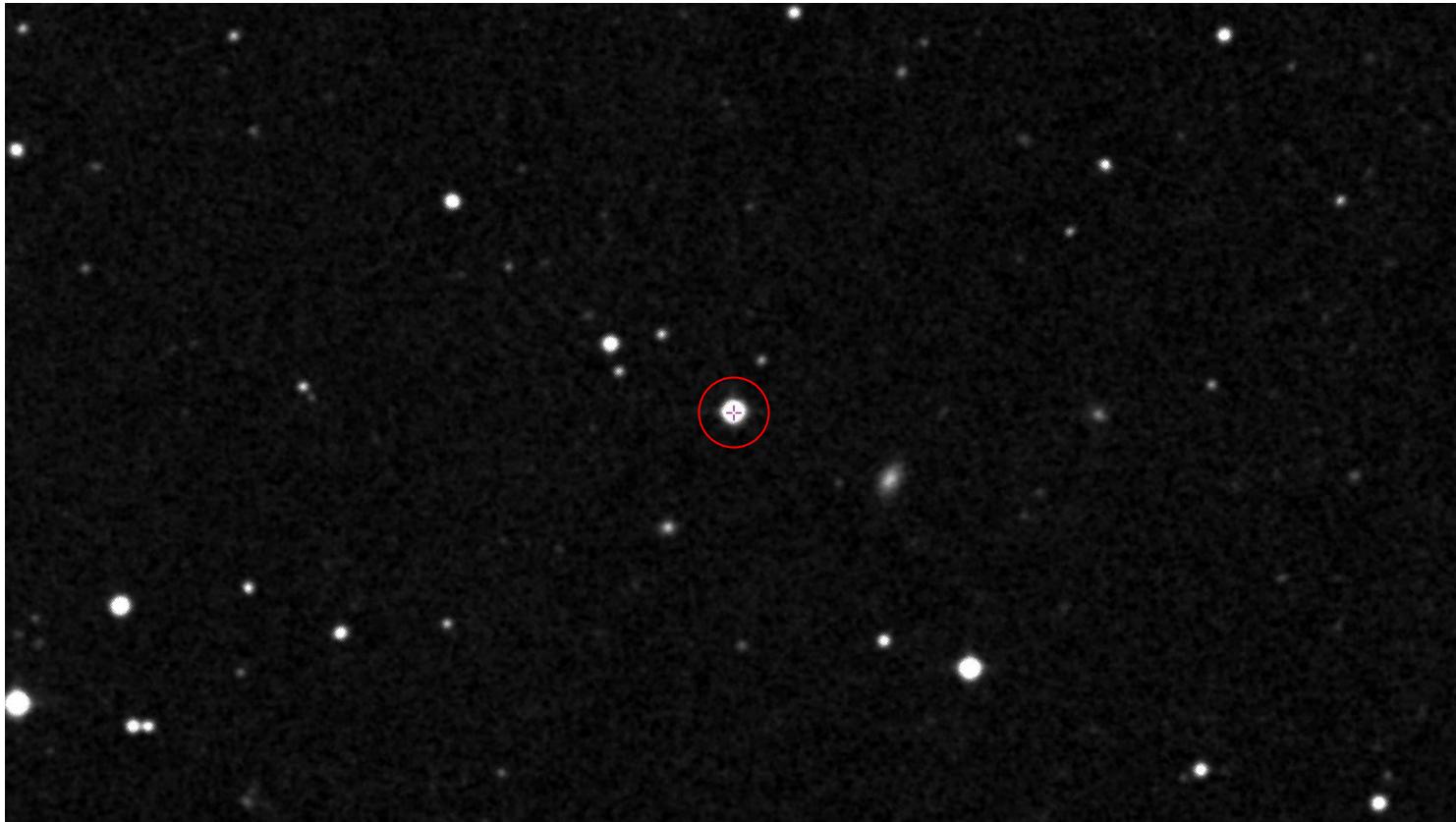


Fig. 1 - SDSS(red) Image (Aladin Lite) (RA: 198.11, Dec: +30.354439)

Why?

Period Verification

Distance Estimation

Data Analysis

img_index	images	date_index	time	phase	Magnitude	Magnitude error
0	0 data/20210319/UZCom-2-RA.wcs.proc.fits	0	2021-03-19 16:19:54.110	0	13.6243282012939	0.425815158625092
1	1 data/20210319/UZcom-3-RA.wcs.proc.fits	0	2021-03-19 16:22:22.110	0.002324423478899	14.0275150512695	0.386135346921137
2	2 data/20210319/UZcom-4-RA.wcs.proc.fits	0	2021-03-19 17:25:11.110	0.061518694370578	13.9107503498077	0.340472028971699
3	3 data/20210319/UZCom-1-RA.wcs.proc.fits	0	2021-03-19 17:27:03.110	0.063277717543799	13.6089950256348	0.447573662143623
4	4 data/20210322/UZCom-5-RA.wcs.proc.fits	1	2021-03-22 16:20:02.120	0.071008002449767	13.708155758667	0.344078051286574
5	5 data/20210322/UZCom-2-RA.wcs.proc.fits	1	2021-03-22 16:21:42.120	0.072578558854428	13.6523469398499	0.359649790458308
6	6 data/20210322/UZCom-7-RA.wcs.proc.fits	1	2021-03-22 17:20:05.120	0.127595149709708	13.7982317672729	0.511622716296279
7	7 data/20210322/UZCom-3-RA.wcs.proc.fits	1	2021-03-22 18:20:04.120	0.184119474713464	14.0013897415161	0.43535956029055
8	8 data/20210322/UZCom-1-RA.wcs.proc.fits	1	2021-03-22 18:21:46.120	0.185721442246218	13.7762242904663	0.398525660142843
9	9 data/20210322/UZCom-11-RA.wcs.proc.fits	1	2021-03-22 19:20:02.120	0.240628094153172	14.3385417449951	0.342669554808984
10	10 data/20210322/UZCom-12-RA.wcs.proc.fits	1	2021-03-22 19:21:42.120	0.242198650557834	13.8244947044373	0.32377796221341
11	11 data/20210322/UZCom-8-RA.wcs.proc.fits	1	2021-03-22 20:20:06.120	0.297230946977161	13.7717978225708	0.449018023795449
12	12 data/20210322/UZCom-9-RA.wcs.proc.fits	1	2021-03-22 20:22:28.120	0.299461137071781	14.02399829216	0.393411618110109
13	13 data/20210322/UZCom-10-RA.wcs.proc.fits	1	2021-03-22 21:22:27.120	0.355985462075536	14.032913451767	0.403869835703101
14	14 data/20210322/UZCom-6-RA.wcs.proc.fits	1	2021-03-22 21:24:07.120	0.357556018480197	13.7042374954224	0.436281015631283
15	15 data/20210326/UZCom-5-RA.wcs.proc.fits	2	2021-03-26 16:30:26.120	0.508651208923856	13.644774936676	0.114875271782094
16	16 data/20210326/UZCom-2-RA.wcs.proc.fits	2	2021-03-26 16:32:05.120	0.510206059764471	13.9751332847595	0.352677313328785
17	17 data/20210326/UZCom-7-RA.wcs.proc.fits	2	2021-03-26 17:30:14.120	0.5650027727231	13.9960346511841	0.521679184242711
18	18 data/20210326/UZCom-4-RA.wcs.proc.fits	2	2021-03-26 17:31:57.120	0.5666204458199	13.9902555099487	0.422265143499575
19	19 data/20210326/UZCom-3-RA.wcs.proc.fits	2	2021-03-26 18:30:03.120	0.621370042086388	13.6705908340454	0.473057650013889
20	20 data/20210326/UZCom-1-RA.wcs.proc.fits	2	2021-03-26 18:31:45.120	0.622972009619144	13.9436154907227	0.365801431067782
21	21 data/20210326/UZCom-11-RA.wcs.proc.fits	2	2021-03-26 19:30:03.120	0.677910072654191	15.0882386016846	1.95749205823094
22	22 data/20210326/UZCom-12-RA.wcs.proc.fits	2	2021-03-26 20:30:00.120	0.734402986529853	13.6752782409668	0.00291252671741
23	23 data/20210326/UZCom-8-RA.wcs.proc.fits	2	2021-03-26 20:32:17.120	0.736554648804239	13.5524739807129	0.287103629832217
24	24 data/20210326/UZCom-9-RA.wcs.proc.fits	2	2021-03-26 20:34:00.120	0.73817232190104	13.6791312171936	0.337023685749707
25	25 data/20210326/UZCom-10-RA.wcs.proc.fits	2	2021-03-26 22:30:00.120	0.847483047665458	13.5217968688965	0.372841836385334
26	26 data/20210326/UZCom-6-RA.wcs.proc.fits	2	2021-03-26 22:31:42.120	0.849085015198211	13.6505971183777	0.11559562576182
27	27 data/20210410/20210410192948-643-RA.wcs.proc.fits	3	2021-04-10 18:29:47.871	0.975541552349003	14.1626874298096	0.531866654142105
28	28 data/20210410/20210410183126-962-RA.wcs.proc.fits	3	2021-04-10 18:31:26.962	0.977097832395948	14.0268671161652	0.487912955578663
29	29 data/20210410/20210410182947-871-RA.wcs.proc.fits	3	2021-04-10 19:29:48.643	0.032093707612255	14.3011249008179	0.511827996397244
30	30 data/20210410/20210410193127-709-RA.wcs.proc.fits	3	2021-04-10 19:31:27.709	0.033649595020094	14.2376248054504	0.549033363623054
31	31 data/20210411/20210411170514-154-RA.wcs.proc.fits	4	2021-04-11 15:59:33.003	0.190918699230505	14.3444428470612	0.55985799616095
32	32 data/20210411/20210411155933-003-RA.wcs.proc.fits	4	2021-04-11 16:01:12.083	0.192474806516245	14.2259409225464	0.507425272109621
33	33 data/20210411/20210411160112-083-RA.wcs.proc.fits	4	2021-04-11 17:05:14.154	0.252816698678373	14.1672896579742	0.553144756770124
34	34 data/20210411/20210411170653-233-RA.wcs.proc.fits	4	2021-04-11 17:06:53.233	0.254372790258547	14.4128400039673	0.572631715621922

Phase Coverage

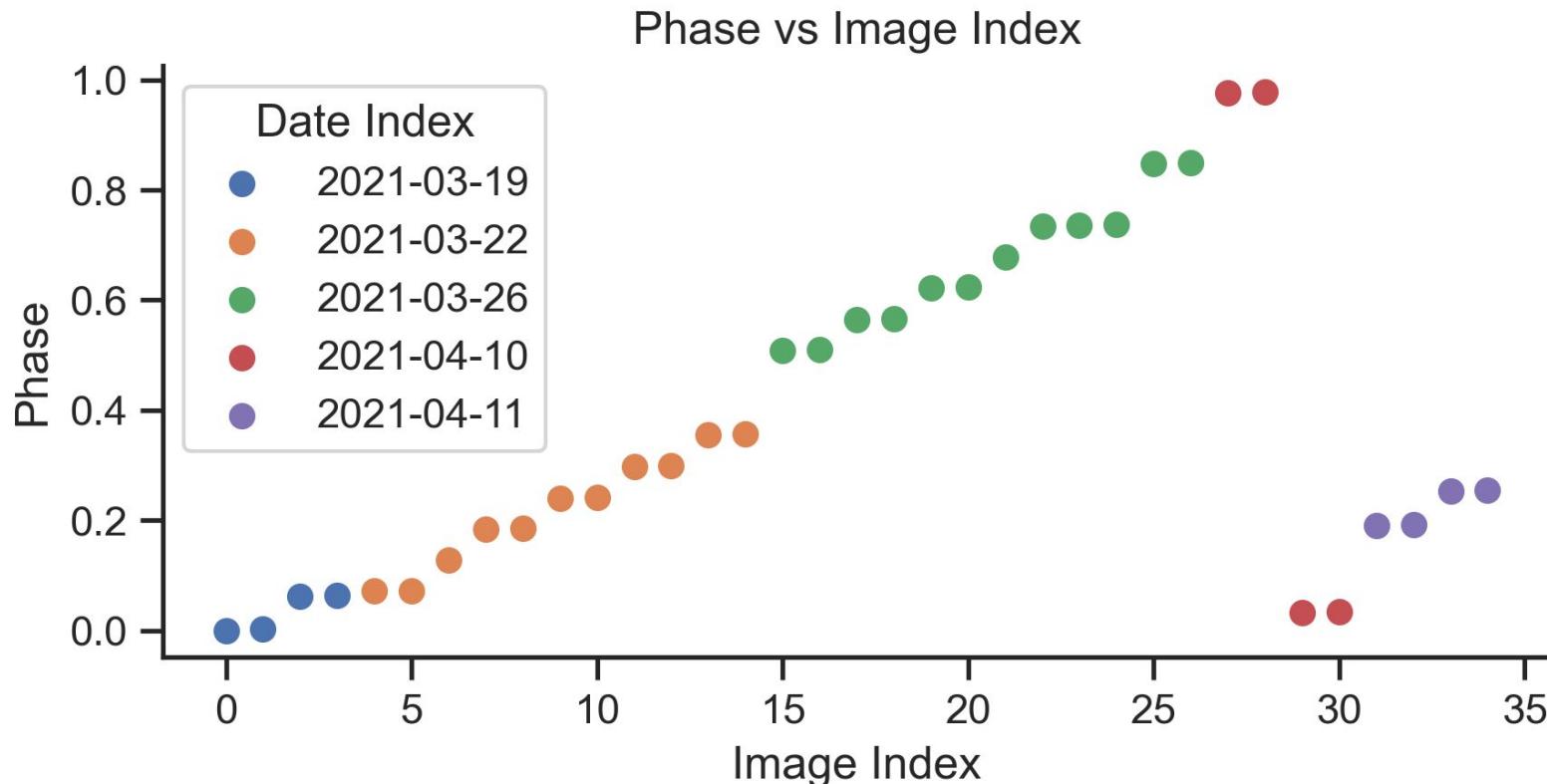
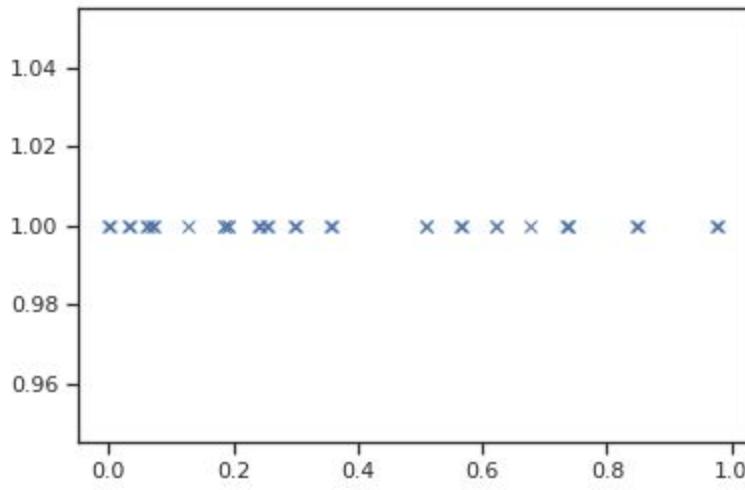


Fig. 2 - Phase Coverage - Phase v/s Image Index

Phase Coverage Contd.



Manual Approach

Target and Reference Stars

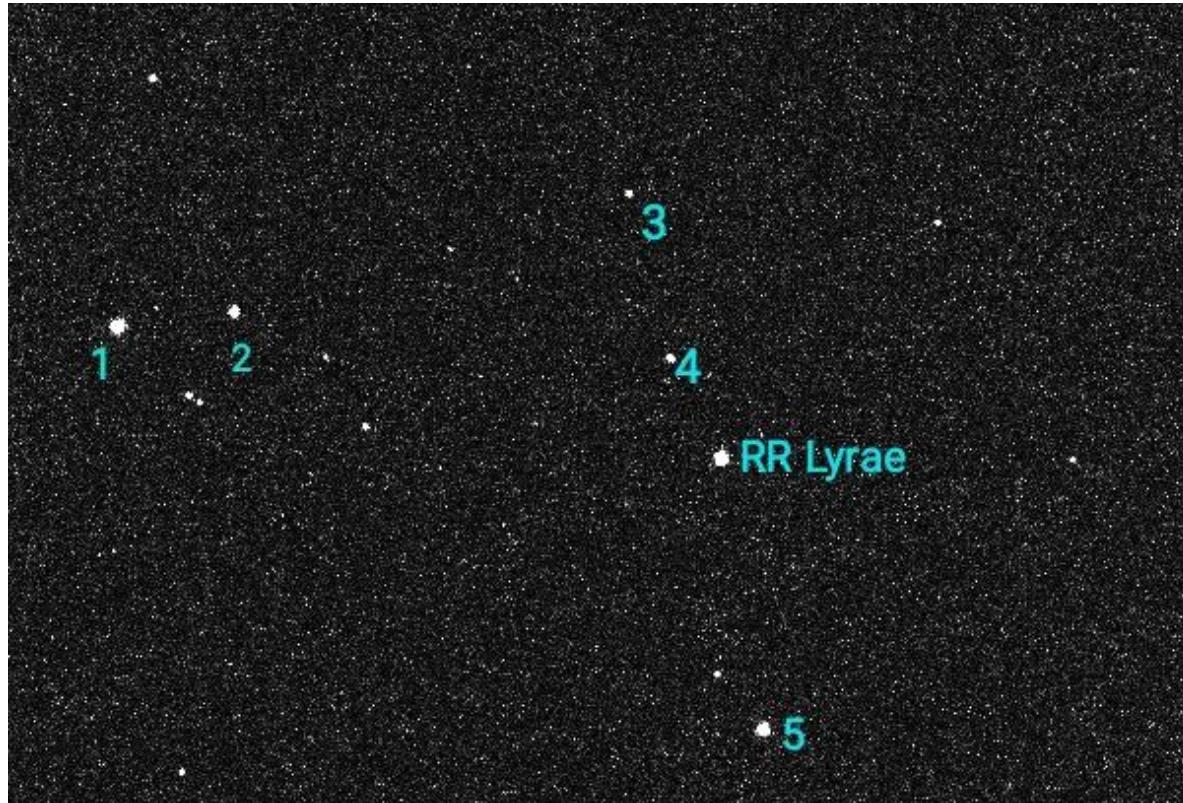


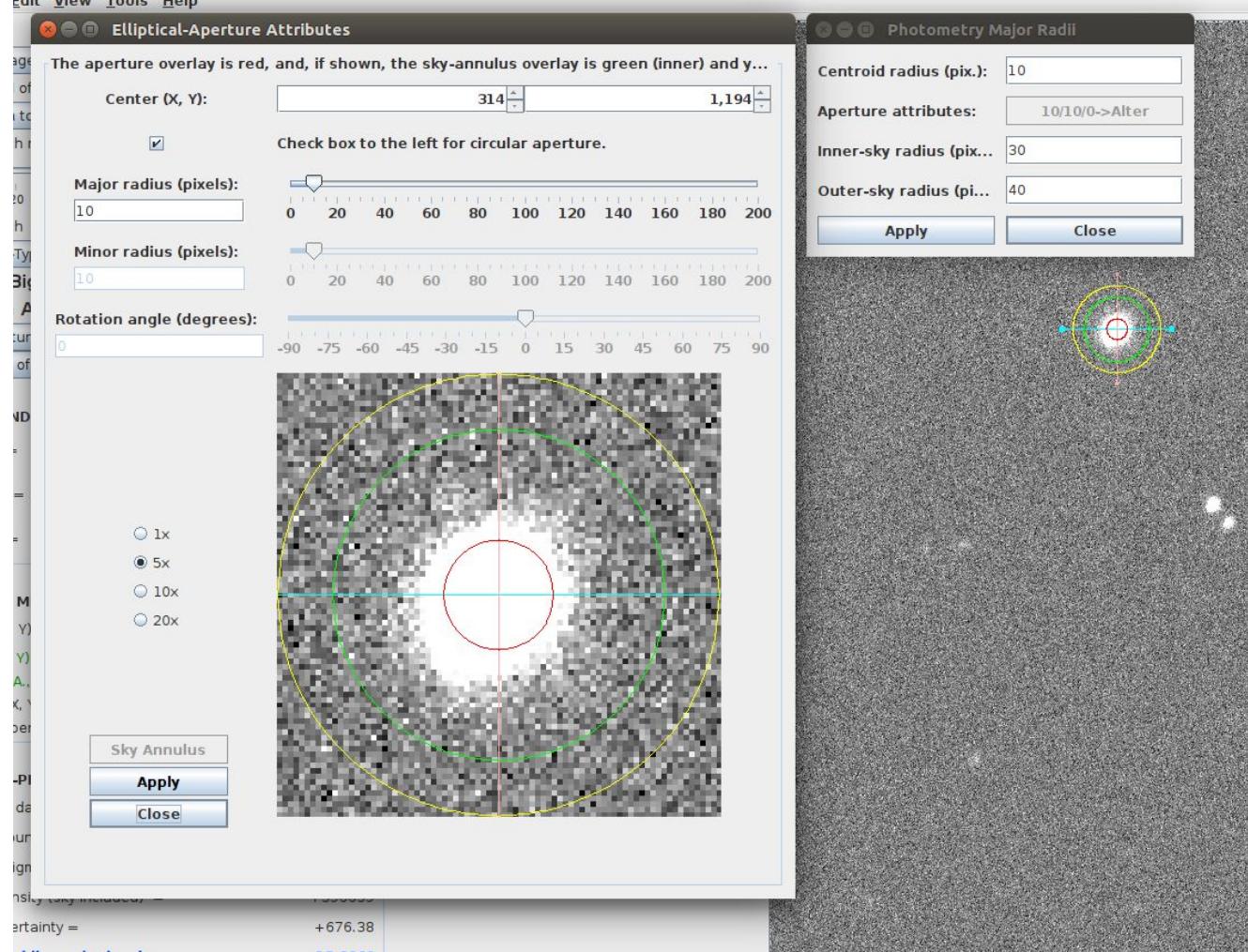
Fig. 3 - Image #1, Target and Reference Stars

Table of Manual Calculations

Aperture used - 10/30/40

Date	Image Number	Star ID	Object ID	RA (icrs)	Dec (icrs)	Img_Mag (APT)	e_Img_Mag (APT)	Real Magnitude (From Catalogue)	Zero Point	median_ZP	e_ZP	median_error	Mag of RR Lyre
19/03/2021	1	0	1444219811146	13:12:26.779	+30:21:15.42	-14.276	0.0019	-	-	-	-	-	13.1559
	1	1	1443819821387	13:12:51.314	+30:19:06.64	-14.4156	0.0017	13.0371	27.4527	-	-	-	-
	1	2	1443919819870	13:12:47.572	+30:19:50.48	-12.9096	0.004	14.5027	27.4123	-	-	-	-
	1	3	1444519815161	13:12:36.409	+30:22:48.64	-11.2459	0.0132	16.2778	27.5237	-	-	-	-
	1	4	1444319812898	13:12:30.983	+30:21:45.62	-11.696	0.0091	15.7268	27.4228	-	-	-	-
	1	5	1443819807790	13:12:18.758	+30:19:23.18	-13.9164	0.0023	13.5155	27.4319	27.4319	0.04318992938	0.04508992938	-
	2	0	1444219811146	13:12:26.779	+30:21:15.42	-14.2990	0.0018	-	-	-	-	-	13.1519
	2	1	1443819821387	13:12:51.314	+30:19:06.64	-14.4359	0.0039	13.0371	27.473	-	-	-	-
	2	2	1443919819870	13:12:47.572	+30:19:50.48	-12.9282	0.004	14.5027	27.4309	-	-	-	-
	2	3	1444519815161	13:12:36.409	+30:22:48.64	-11.269	0.0121	16.2778	27.5468	-	-	-	-
	2	4	1444319812898	13:12:30.983	+30:21:45.62	-11.7003	0.0091	15.7268	27.4271	-	-	-	-
	2	5	1443819807790	13:12:18.758	+30:19:23.18	-13.9354	0.0022	13.5155	27.4509	27.4509	0.04615551971	0.04795551971	-
	3	0	1444219811146	13:12:26.779	+30:21:15.42	-14.3568	0.0017	-	-	-	-	-	13.1692
	3	1	1443819821387	13:12:51.314	+30:19:06.64	-14.5194	0.0016	13.0371	27.5565	-	-	-	-
	3	2	1443919819870	13:12:47.572	+30:19:50.48	-13.0233	0.0036	14.5027	27.526	-	-	-	-
	3	3	1444519815161	13:12:36.409	+30:22:48.64	-11.3703	0.0118	16.2778	27.6481	-	-	-	-
	3	4	1444319812898	13:12:30.983	+30:21:45.62	-11.7951	0.0084	15.7268	27.5219	-	-	-	-
	3	5	1443819807790	13:12:18.758	+30:19:23.18	-14.0036	0.0021	13.5155	27.5191	27.526	0.05639695027	0.05809695027	-
	4	0	1444219811146	13:12:26.779	+30:21:15.42	-14.3624	0.0017	-	-	-	-	-	13.1696
	4	1	1443819821387	13:12:51.314	+30:19:06.64	-14.5281	0.0015	13.0371	27.5652	-	-	-	-
	4	2	1443919819870	13:12:47.572	+30:19:50.48	-12.9311	0.0033	14.5027	27.4338	-	-	-	-
	4	3	1444519815161	13:12:36.409	+30:22:48.64	-11.3649	0.0099	16.2778	27.6427	-	-	-	-
	4	4	1444319812898	13:12:30.983	+30:21:45.62	-11.7117	0.0065	15.7268	27.4385	-	-	-	-
	4	5	1443819807790	13:12:18.758	+30:19:23.18	-14.0165	0.002	13.5155	27.532	27.532	0.07967712344	0.08137712344	-

Tab. 1 - Manual Calculations



Automated Approach

Example Image - 1

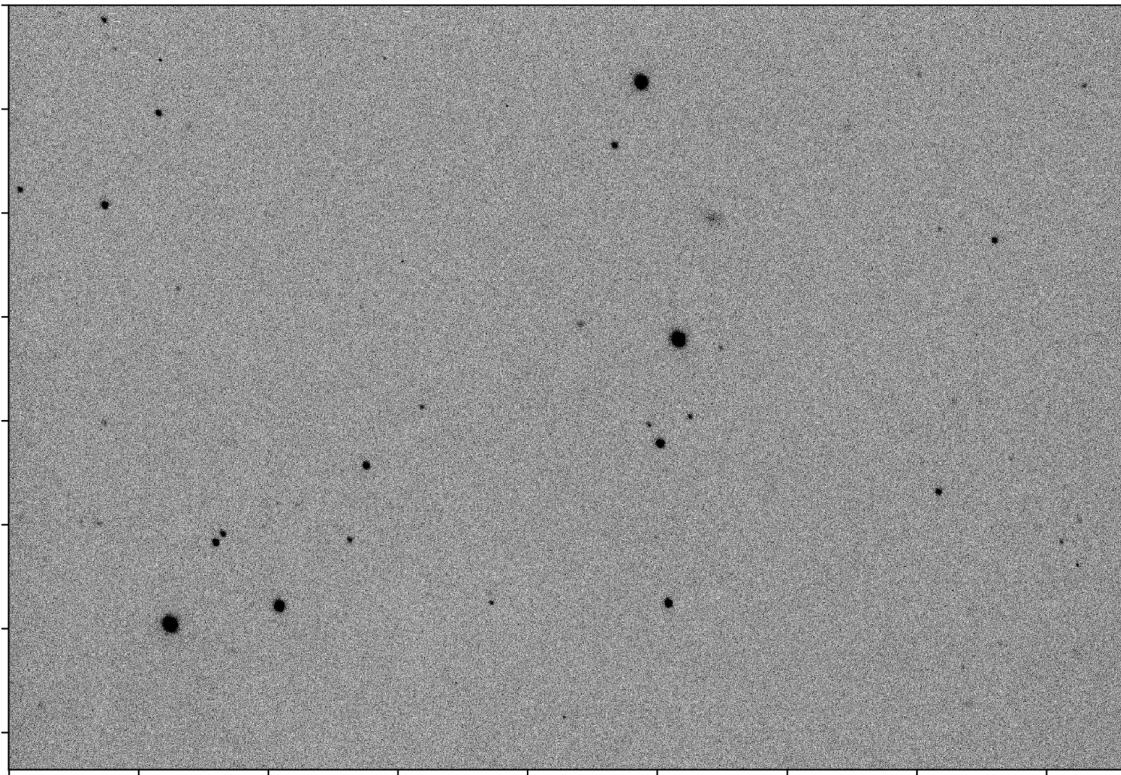


Fig. 4 - Image #1, Pre-analysis

Example Image - 2

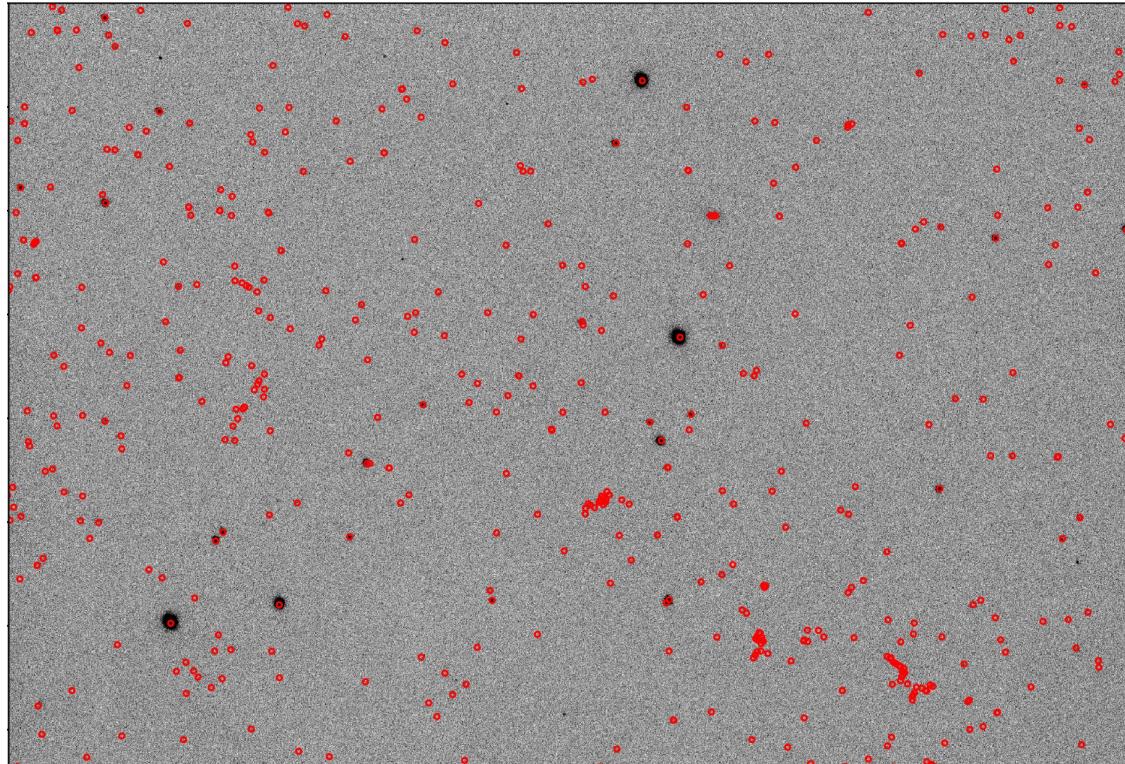


Fig. 5 - Image #1, Post-analysis

Aperture Photometry

Using `photutils` library

- Aperture (5 pixels)
- Annulus around the aperture (15 pixels - 20 pixels)
- Zero Point Bias -
 - 'zp_mean': 27.67369,
 - 'zp_median': 27.46269,
 - 'zp_std': 0.44553
- Magnitude estimate for 1st image - 13.666

Analysis Table

	img_index	images	date_index	time	phase	Magnitude	Magnitude	error
0	0	data/20210319/UZCom-2-RA.wcs.proc.fits	0	2021-03-19	16:19:54.110	0	13.6243282012939	0.425815158625092
1	1	data/20210319/UZcom-3-RA.wcs.proc.fits	0	2021-03-19	16:22:22.110	0.002324423478899	14.0275150512695	0.386135346921137
2	2	data/20210319/UZcom-4-RA.wcs.proc.fits	0	2021-03-19	17:25:11.110	0.061518694370578	13.9107503498077	0.340472028971699
3	3	data/20210319/UZCom-1-RA.wcs.proc.fits	0	2021-03-19	17:27:03.110	0.063277717543799	13.6089950256348	0.447573662143623
4	4	data/20210322/UZCom-5-RA.wcs.proc.fits	1	2021-03-22	16:20:02.120	0.071008002449767	13.708155758667	0.344078051286574

Tab. 2 - Analysis Table

Magnitude vs Time

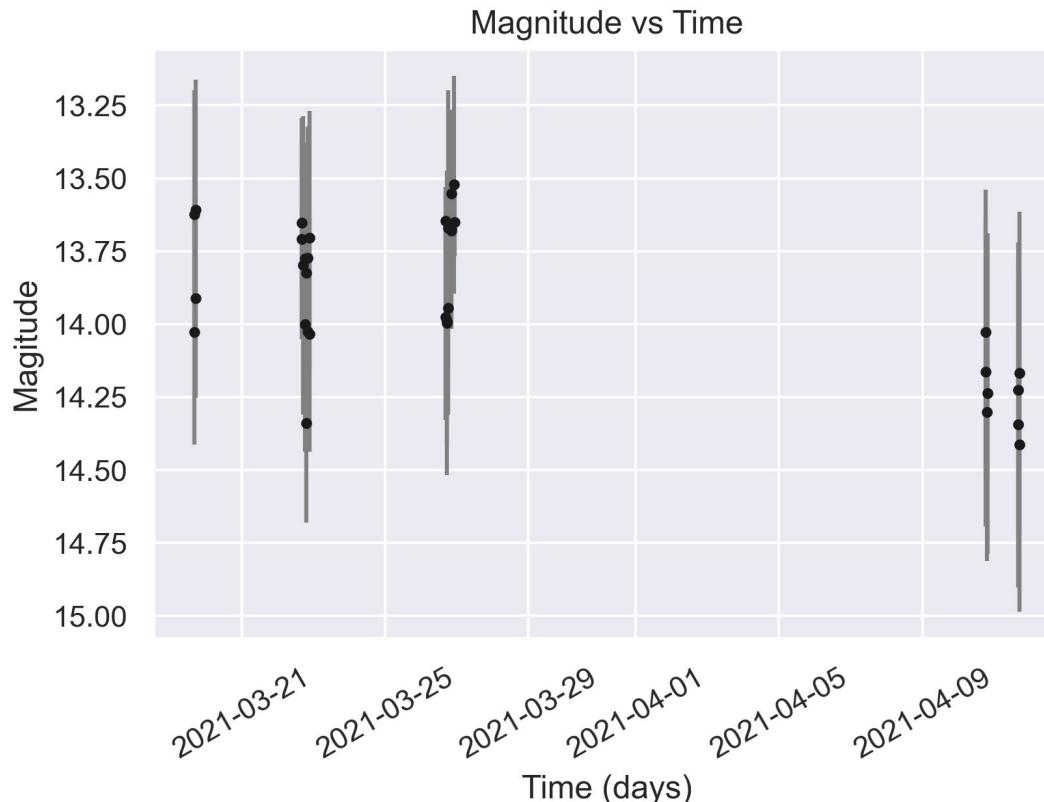


Fig. 6 - Magnitude vs Time

Lomb-Scargle - Periodogram

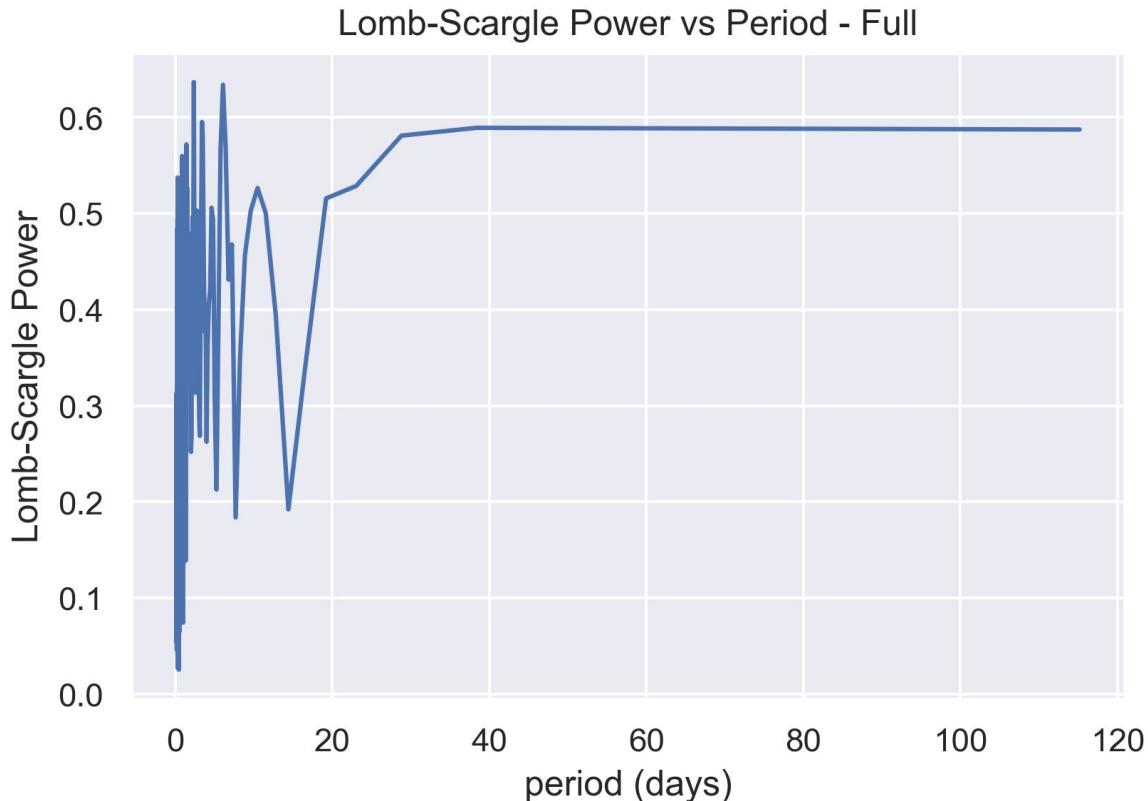


Fig. 7 - Lomb-Scargle Periodogram 1

Lomb-Scargle - Periodogram

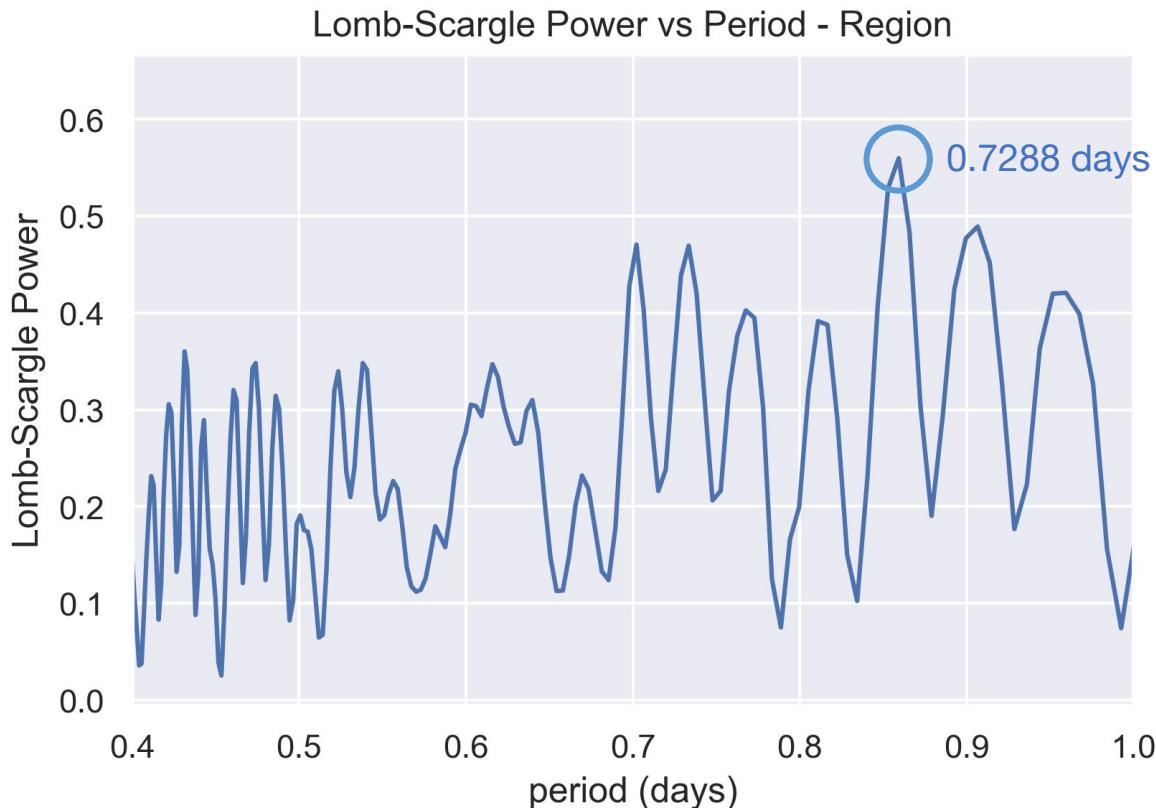


Fig. 8 - Lomb-Scargle Periodogram 2

Lomb-Scargle - Periodogram

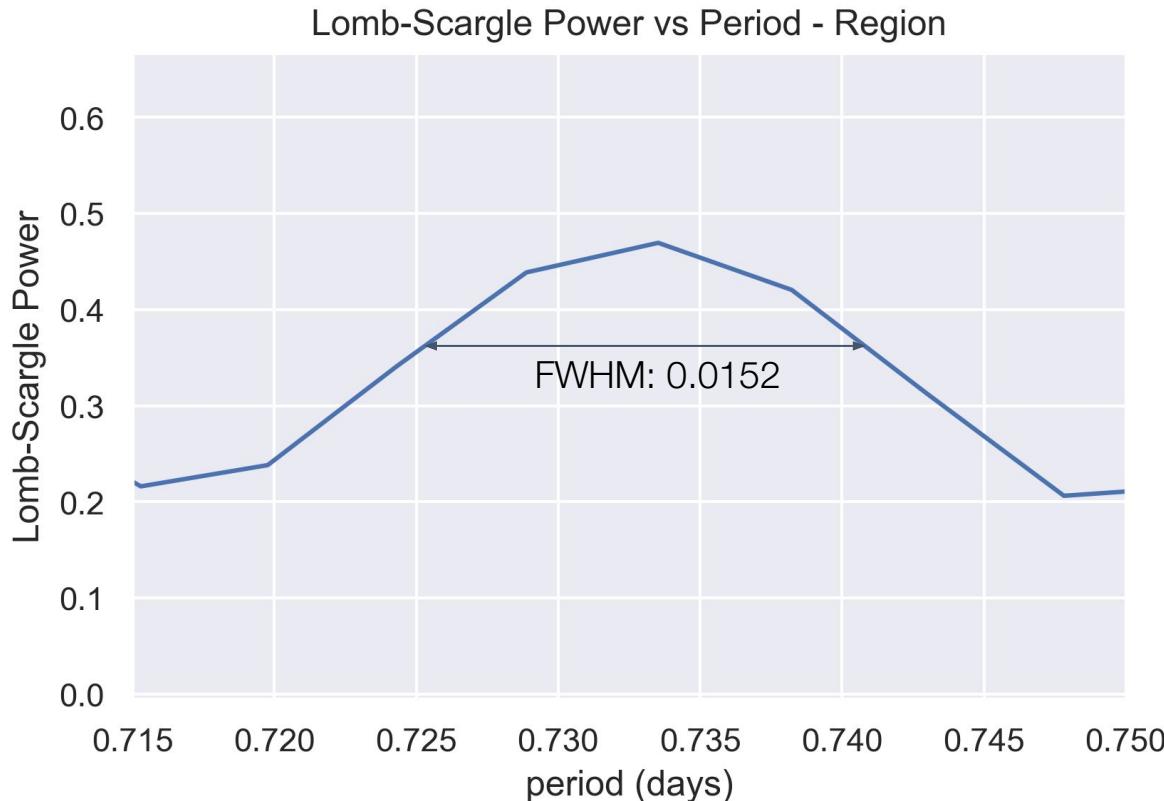


Fig. 9 - Lomb-Scargle Periodogram 1

Period - 0.7288 ± 0.0076 days

Light Curve

Light Curve for UZ Com

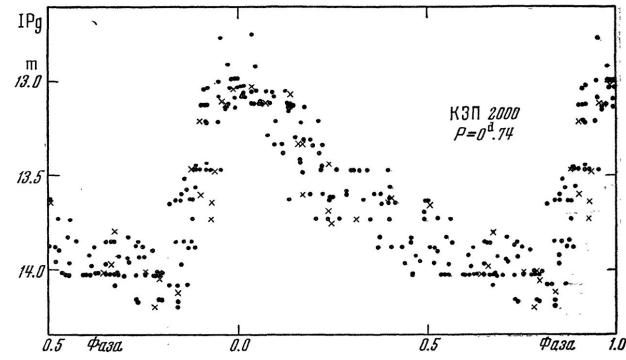
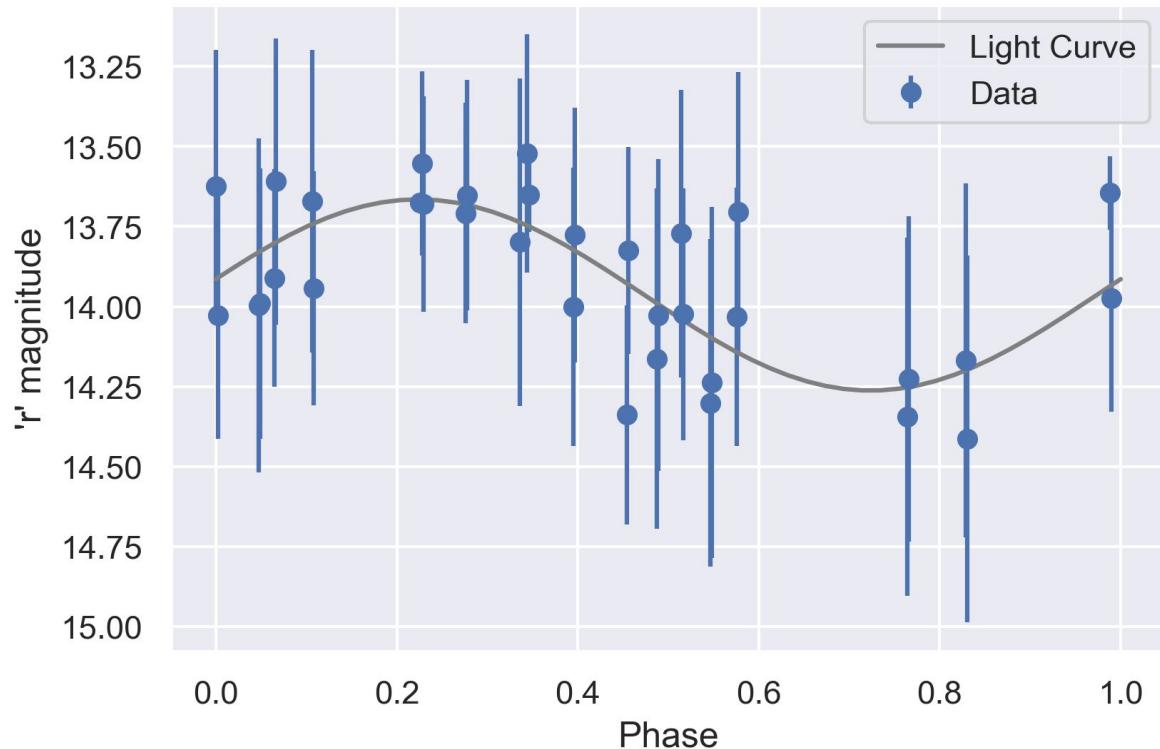


Fig. 10 - Light Curve

Period - Literature

Paper Title	Year	Period (days)	Per Uncertainty (Days)
On Five Variable Stars near SA 57 [5]	1957	0.7369265	-
Metal abundances of RR Lyrae variables in selected galactic star fields [4]	1979	0.736941	0.000002
A List of Minima and Maxima Timings [6]	2012	0.736971	-
From our observations	2021	0.7288	0.0076

Distance Estimation

$$[M/H] = [Fe/H] + \log (0.638 f + 0.362)$$

where $f = 10^{[\infty/Fe]} \sim 1.99526$ (Carney, 1996)

$$[Fe/H] = -1.44 \text{ [4]}$$

Thus, $[M/H] = -0.94837$

$$M_v = 1.067 + 0.502 [M/H] + 0.108[M/H]^2$$

$$\Rightarrow M_v = 0.68805$$

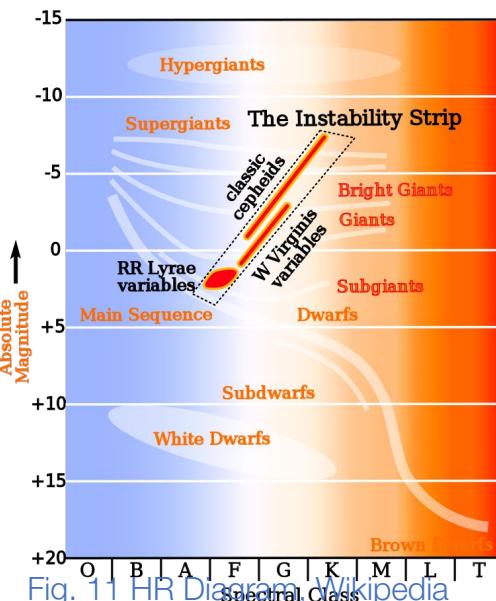


Fig. 11 HR Diagram. Wikipedia

$$M_v = 0.68805$$

Thus,

$$m-M = 5 \times \log_{10}(d/10\text{pc})$$

$$\Rightarrow d = 3939.0364 \text{ pc}$$

Results

Star Name	Time period Obtained	Period in literature	Error in results
UZ Comae Berenices	0.7288 ± 0.076 days	0.736941 ± 0.000002 days	1.104%

Star Name	Star Distance Obtained	Star Distance from literature	Error in results	Open Custer Distance in literature
UZ Comae Berenices	3939 pc	3370 pc	16.88%	128 pc (Latham 1)

Possible Reasons for error

- Very limited number of observational data points
- Usage of V Band instead of R band
- A couple of images were taken on cloudy nights

Conclusions

Conclusions

- Achieved the set goals with reasonable accuracy.
- UZ Com star does not lie in the open cluster Latham 1 as we first hypothesized.

Acknowledgements

- Varun Bhalerao
- GIT
- Vedant Shenoy
- Gaurav Waratkar
- Harsh Kumar

References

- [1] [Svetlov, Dmitry, “On the Periodicity of UZ Comae Berenices” \(1985\)](#)
- [2] [RR Lyrae stars, OGLE Atlas of Variable Star Light Curves](#)
- [3] [GCVS Variability Types, GCVS, CDS](#)
- [4] [Metal abundances of RR-lyrae variables in selected Galactic star fields](#)
- [5] [On Five Variable Stars near SA 57](#)
- [6] [A List of Minima and Maxima Timings](#)

Thank You