CR-203614

FINAL REPORT FOR CONTRACT NAS5-32081, TASK ASSIGNMENT 4109

Short title: Short Period Type II Cepheids

Terry Teays, Principal Investigator

The purpose of this project was to obtain ultraviolet spectra with the *International Ultraviolet Explorer* of three Type II Cepheid variable stars which exhibit carbon star characteristics. The significance of these objects rests on the fact that it is not clear how to produce stars of such low mass which pulsate, and yet show the effects of the dredge-up of processed nuclear material. The observations discussed here represent the first time that such stars have been observed in the ultraviolet.

All of the observations were obtained with IUE as planned. We decided to concentrate on obtaining complete coverage of the most important target, V553 Centauri, since it is one of the brightest of the seven stars known of this type. We discovered that the twenty year old ephemeris for this object was still viable. Our examination of the ultraviolet spectrum also indicated that there is no evidence for an early-type companion to this star, one of the suggestions for explaining their peculiar nature. For the second star, RT Triangulum Australe, we selected approximately 12 different phases, concentrating on those which we expected to be the most interesting spectroscopically, *viz*. rising light, the "bump", the "hump", and maximum light.

For the faint star GR Normae, we took an exposure to determine its true nature; trying to determine if it really does belong to this class of objects. We have concluded that GR Normae is not a Type II Cepheid, based on the IUE spectrum that we obtained. It appears to be an active binary star instead.

All of the spectra for V553 Cen and RT Tra have been reduced and analyzed. We have binned the data to derive light curves at different ultraviolet wavelengths. For each spectrum we have calculated the heliocentric Julan date, and the pulsation phase of the star. These data have been used to generate ultraviolet light curves. The data for V553 Cen are sufficiently extensive to perform a Fourier decomposition analysis on them, and therefore place them in these diagnostic diagrams *vis-a-vis* the normal (non-pulsating) carbon stars, and other BL Herculis stars. We have also calculated approximate V magnitudes for V553 Cen and used this to estimate the Mg II - V index used by Eaton *et al.*, which places these stars with respect to non-pulsators in terms of chromospheric activity in the Mg II line.

All of the analysis is complete, and a paper is nearing completion describing this work. The final work to complete this paper will be done at no additional cost to NASA. A copy of the current draft is attached. It will be submitted to *Publications of the Astronomical Society of the Pacific*. In addition, a poster paper will be presented on this work at the pulsating star conference in Los Alamos this coming June.

DRAFT

IUE Studies of Short Period Type II Cepheids with Carbon Star Characteristics

Terry J. Teays[1,2] and Charles G. Loomis[2]

Science Programs, Computer Sciences Corporation, 10,000A Aerospace Road, Lanham-Seabrook, MD 20706

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[1]Staff member of the *International Ultraviolet Explorer* Observatory, which is operated by the Laboratory for Astronomy and Solar Physics, NASA/Goddard Space Flight Center

[2]Guest Observer with the *International Ultraviolet Explorer*

1. Introduction

The short period Type II Cepheids (BL Herculis stars) have a period range from one to three days. At their relatively low luminosities, the BL Herculis stars are evolving throught he instability strip directly from the Horizontal Branch, or are on blue loops from the lower asymptotic giant branch (AGB). The BL Herculis stars are believed to be stars of relatively low mass, in the 0.4-0.8 $M_{\odot}$ range.

A few Type II Cepheids also exhibit carbon star characteristics. Carbon stars are believed to be created when carbon is dredged up as a result of the convective envelope in the outer hydrogen shell reaching in to the region between the C-O core and the hydrogen shell, an activity expected to occur during shell flashes on the AGB. The models of Boothroyd and Sackmann (1988) and Lattanzio (1989) can produce carbon stars with as low a mass as 0.8 $M_{\odot}$, but there are no models which produce carbon stars in the BL Herculis mass range, so the BL Herculis carbon stars are still poorly understood. Are these stars which are normal BL Herculis stars from the stellar evolution standpoint, but have some peculiarity that has made them carbon stars, or are they stars which happen to lie in the same part of the HR diagram as the more normal BL Herculis stars, but have a different evolutionary history?

We selected two short period, Type II carbon star Cepheids for in depth study with the *International Ultraviolet Explorer* (*IUE*) satellite, viz., V553 Centauri and RT Triangulum Australe. In addition, two spectra were obtained of the star GR Normae. We obtained excellent phase coverage of V553 Centauri, and a fairly good sampling of the light curve for RT Triangulum Australe. GR Normae's faintness compelled us to use fairly long exposures, which caused significant smearing of the phases, but, as will be discussed below, GR Normae appears to belong in the class of active stars such as FK Comae.

2. Observations

The observations of the three stars were obtained using the Long Wavelength Prime (LWP) camera on IUE to take low resolution spectra in the wavelength range 1910-3300 ÅTable 1 gives the log of observations. In Table 1 the first column indicates which target was being observed, the second column lists the image sequence number, the third column gives the start time of the exposure (in UT), the fourth column lists the exposure time in minutes, the fifth column gives the Heliocentric Julian Date of the time of mid-exposure, the sixth column gives the phase, based on the ephemerides discussed below, and the final column lists the data numbers (DN) on the raw *IUE* image (where C represents the maximum count rate in the continuum, and B is the background count rate. Both of these are in raw DN numbers, which run from 0 to 255.) Two of the spectra were overexposed in the brightest portions of the image, and this is indicated by a rought estimate of the overexposure level (e.g. 2X).

2.1. V553 Centauri

V553 Centauri was first recognized as a Cepheid by Hoffmeister (1957). Herbig's (1952) spectra revealed that it was a carbon star, and subsequent spectroscopic studies which detailed its nature as a carbon star were carried out by Evans, Wisse, and Wisse (1972), Wallerstein, Brown, and Bates (1979), and Cottrell (1979). Detailed light curves were produced by Landolt (1975) and Evans, Wisse, and Wisse (1972), and the latter's period (2.061051 days) still seems to work well for phasing our observations taken in 1992.

2.2. RT Triangulum Australe

A detailed light curve of RT Triangulum Australe is shown by Diethelm (1983). The star's period is 1.946 days, but it is not determined with greater precision than this. Though we tried using the periods and epochs of maximum light given by Kwee & Diethelm (1984), Diethelm (1986), and Kholopov (1985), we were unable to make a close match between our observations and the old ground-based photometry. Since we were only able to obtain twelve (**??**) spectra of RT Triangulum Australe, we do not have the detailed phase coverage that we obtained for V553 Cen, but we were able to obtain spectra at key phases, viz., the "hump", maximum light, and during the (more gradual) descending light.

3. Results

One of the first conclusions concerning V553 Centauri is that it does not appear to have an early-type companion, since there is no signature of the continuum from such a hot star in the spectra. This had been one of the speculations concerning the cause of the peculiar nature of the short period Type II Cepheid carbon stars. While we can not rule out a later type companion on the basis of the IUE spectra, the scenario of a more massive companion which was already in the white dwarf phase, for instance, does seem to be ruled out. This has been confirmed by recent radial velocity data by Wallerstein & Gonzalez (1996).

The spectra for V553 Centauri were binned to determine average fluxes in a number of bands. The central wavelengths (with the bandwidths following in parentheses) selected were 2200 (200), 2350 (100), 2500 (150), 2700 (100), 2800, (50), 2900 (100), and 3100 (100) Å. Table 2 lists the results of thes binning operation. In column 1 the heliocentric Julian date is given, while column 2 lists the phase, based on the Evans, Wisse, & Wisse (1972) period. Columns 3 through 10 give the fluxes (in ergs/square cm/sec) in each wavelength interval. The final column gives an approximate V magnitude for the star at this phase.

Since we did not have simultaneous photometry at visual wavelengths, we compared the detailed light curve of Evans, Wisse, & Wisse (1972) to measurements taken with IUE's Fine Error Sensor (FES) between acquiring the spectra. We fit the ground-based light curve with a polynomial and checked it with the FES measurements to verify that it still represented the star's variation faithfully. We then projected this V light curve onto the ultraviolet light curves to estimate the visual flux at the time corresponding to the time of acquisition of the ultraviolet spectrum. It is this reference magnitude which is given in column 11 of Table 2.

4. Discussion

5. Summary and Conclusions

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Table 1. Log of Observations

Star	LWP	Year/Day[a]	hr:mm:ss	Ex. T.[b]	HJD[c]	Phase[c]	C/B[d]
V553 Cen	20848	91/201	11:53:03	20	8458.004	0.179	2X/35
V553 Cen	20849	91/201	12:51:18	10	8458.041	0.197	215/45
V553 Cen	20883	91/206	15:15:05	11	8463.141	0.672	208/52
V553 Cen	20885	91/206	17:39:17	11	8463.241	0.721	217/34
V553 Cen	20886	91/206	18:36:34	12	8463.282	0.741	213/38
V553 Cen	23439	92/187	11:33:02	10	8808.988	0.539	137/33
V553 Cen	23440	92/187	12:34:56	15	8809.032	0.560	165/34
V553 Cen	23441	92/187	13:31:43	15	8809.072	0.579	175/38
V553 Cen	23442	92/187	14:32:17	15	8809.114	0.600	182/48
V553 Cen	23443	92/187	15:27:00	15	8809.152	0.618	199/55
3 V553 Cen	23444	92/187	16:21:57	13	8809.189	0.636	180/41
V553 Cen	23445	92/187	17:14:17	15	8809.245	0.663	204/36
V553 Cen	23446	92/187	18:04:45	12	8809.260	0.671	177/33
V553 Cen	23535	92/202	03:46:26	15	8823.664	0.660	201/34
V553 Cen	23536	92/202	04:47:09	12	8823.706	0.680	180/34
V553 Cen	23537	92/202	05:43:18	12	8823.745	0.699	200/34
V553 Cen	23538	92/202	06:41:10	12	8823.785	0.718	205/34
V553 Cen	23539	92/202	07:38:51	12	8823.825	0.738	210/35
V553 Cen	23540	92/202	08:35:53	11	8823.864	0.757	200/33
V553 Cen	23541	92/202	09:32:14	11	8823.903	0.776	195/33
V553 Cen	23542	92/202	10:28:46	10	8823.942	0.795	201/32
V553 Cen	23543	92/202	11:26:46	10	8823.982	0.814	198/33
V553 Cen	23544	92/202	12:15:15	10	8824.016	0.830	206/35

Table 1—Continued

Star	LWP	Year/Day[a]	hr:mm:ss	Ex. T.[b]	HJD[c]	Phase[c]	C/B[d]
V553 Cen	23545	92/202	13:12:16	11	8824.056	0.850	235/41
V553 Cen	23546	92/202	13:56:55	10	8824.087	0.865	239/42
V553 Cen	23547	92/202	14:53:51	9	8824.126	0.884	222/42
V553 Cen	23548	92/202	15:35:36	8	8824.155	0.898	233/37
V553 Cen	23549	92/202	16:18:00	7	8824.184	0.912	209/34
V553 Cen	23550	92/202	16:58:56	7	8824.212	0.925	213/34
V553 Cen	23551	92/202	17:40:18	7	8824.241	0.940	213/34
V553 Cen	23552	92/202	18:24:14	7	8824.271	0.954	224/33
RT TrA	20850	91/201	13:46:59	18	8458.081	0.228	180/115
RT TrA	23990	92/268	00:14:37	30	8890.520	0.433	229/36
RT TrA	23991	92/268	01:19:10	25	8890.563	0.456	203/36
RT TrA	23992	92/268	02:17:41	30	8890.605	0.477	240/38
RT TrA	24013	92/271	09:58:43	25	8893.923	0.182	120/43
V553 Cen	24858	93/037	20:11:15	15	9025.346	0.513	180/35
V553 Cen	24866	93/039	19:44:06	15	9027.321	0.472	150/37
RT TrA	24875	93/040	20:24:15	35	9028.360	0.262	168/39
V553 Cen	24876	93/040	21:48:34	6	9028.411	0.001	212/35
V553 Cen	24877	93/040	22:28:18	6	9028.439	0.014	200/35
V553 Cen	24878	93/040	23:07:27	6	9028.466	0.027	214/48
V553 Cen	24879	93/040	23:45:39	7	9028.492	0.040	244/63
V553 Cen	24880	93/041	00:24:43	5	9028.519	0.053	211/66
V553 Cen	24881	93/041	01:03:55	5	9028.546	0.066	202/57
V553 Cen	24882	93/041	01:40:43	6	9028.572	0.079	202/44

Table 1—Continued

Star	LWP	Year/Day[a]	hr:mm:ss	Ex. T.[b]	HJD[c]	Phase[c]	C/B[d]
V553 Cen	24883	93/041	04:24:31	7	9028.686	0.134	190/32
RT TrA	24944	93/048	14:00:27	40	9036.096	0.237	200/40
RT TrA	24946	93/048	18:07:30	35	9036.267	0.325	150/40
RT TrA	24947	93/048	19:20:53	30	9036.315	0.350	141/38
RT TrA	24948	93/048	??:??:??	35	9036.357	0.0371	143/38
V553 Cen	24983	93/053	03:50:21	10	9040.665	0.213	1.5X/34
V553 Cen	25044	93/061	23:45:37	8	9049.495	0.230	170/37
RT TrA	25045	93/062	00:50:43	30	9049.546	0.148	170/35
V553 Cen	25046	93/062	02:18:07	9	9049.601	0.282	170/39
V553 Cen	25046	93/062	02:38:13	9	9049.616	0.289	180/38
V553 Cen	25233	93/089	00:04:27	11	9076.511	0.338	170/33
V553 Cen	25234	93/089	00:51:32	13	9076.544	0.354	190/34
V553 Cen	25235	93/089	01:39:09	14	9076.578	0.371	195/34
V553 Cen	25236	93/089	02:31:11	16	9076.615	0.389	210/35

[a]Dates and times are in UT.

[b]Length of exposure, in minutes.

[c]For mid-point of exposure.

[d]Maximum continuum level in the spectrum, in data numbers.

IUE [Loomis . Carbon_Stars] Mg2.30A bin

RESULTS OF BINNED FLUX FOR V553 CEN

HJD +2440000	phase	2200 (200)	2350 (100)	2500 (150)	2700 (100)	2800 (50)	2900 (100)	3100 (100)	2806 (30)	V
8458.041	0.197	3.3806e-14	3.2158e-14	4.6030e-14	1.3212e-13	8.7434e-14	2.5015e-13	3.8976e-13	5.9878e-14	8.390
8463.141	0.672	1.8617e-14	1.9578e-14	4.1990e-14	9.6401e-14	7.5901e-14	1.7374e-13	2.9078e-13	6.0091e-14	8.629
8463.241	0.721	2.5427e-14	2.2690e-14	4.4652e-14	1.0577e-13	8.9897e-14	1.9544e-13	3.0143e-13	7.2952e-14	8.595
8463.282	0.741	2.3936e-14	2.3214e-14	4.0055e-14	1.0731e-13	8.7984e-14	1.9263e-13	2.9956e-13	7.3195e-14	8.581
8808.988	0.539	6.0714e-15	2.1451e-15	1.7449e-14	5.7839e-14	3.2159e-14	1.2434e-13	2.0889e-13	2.1544e-14	8.746
8809.032	0.560	1.1750e-14	6.6408e-15	1.7262e-14	6.2463e-14	4.0375e-14	1.3075e-13	2.0968e-13	2.7241e-14	8.731
8809.072	0.579	4.8053e-15	6.7320e-15	2.1486e-14	6.0737e-14	4.1372e-14	1.3544e-13	2.1151e-13	2.6958e-14	8.714
8809.114	0.600	1.8190e-15	1.8117e-14	2.0796e-14	6.3645e-14	4.1615e-14	1.3138e-13	2.0934e-13	2.6608e-14	8.693
8809.152	0.618	8.1201e-15	1.4261e-14	1.8446e-14	6.7922e-14	5.1240e-14	1.4532e-13	2.3226e-13	3.6070e-14	8.676
8809.189	0.636	8.7224e-15	1.5683e-14	2.7649e-14	7.2498e-14	5.6214e-14	1.4536e-13	2.3328e-13	4.0049e-14	8.659
8809.245	0.663	1.1232e-14	1.8943e-14	3.0876e-14	8.1588e-14	6.2516e-14	1.5792e-13	2.5099e-13	4.4024e-14	8.636
8809.260	0.671	1.1296e-14	1.9523e-14	3.2827e-14	8.9444e-14	6.7957e-14	1.6751e-13	2.7019e-13	5.0967e-14	8.630
8823.664	0.660	1.9431e-14	1.6902e-14	3.0746e-14	8.2828e-14	6.4163e-14	1.6236e-13	2.6158e-13	4.7510e-14	8.638
8823.706	0.680	2.1234e-14	2.1766e-14	3.5911e-14	9.1009e-14	7.1332e-14	1.7247e-13	2.7489e-13	5.4462e-14	8.623
8823.745	0.699	2.5244e-14	2.6524e-14	3.6577e-14	9.8426e-14	7.8547e-14	1.8266e-13	2.8424e-13	6.1921e-14	8.610
8823.785	0.718	3.2921e-14	2.1544e-14	4.1460e-14	1.0231e-13	8.6715e-14	1.8744e-13	2.9398e-13	7.0226e-14	8.597
8823.825	0.738	2.8047e-14	2.6902e-14	4.1485e-14	1.0833e-13	9.0115e-14	1.9502e-13	2.9864e-13	7.4450e-14	8.583
8823.864	0.757	2.7361e-14	3.2230e-14	4.3282e-14	1.0510e-13	9.1159e-14	1.9818e-13	2.9794e-13	7.7863e-14	8.568
8823.903	0.776	2.4284e-14	2.4161e-14	4.2915e-14	1.0648e-13	8.9900e-14	2.0128e-13	3.0152e-13	7.3520e-14	8.549
8823.942	0.795	2.5155e-14	2.6649e-14	4.2253e-14	1.0903e-13	9.3910e-14	2.0295e-13	3.1475e-13	7.6268e-14	8.526
8823.982	0.814	2.3621e-14	2.7661e-14	4.5322e-14	1.1761e-13	9.1373e-14	2.0983e-13	3.3360e-13	7.6268e-14	8.496
8824.016	0.830	2.6191e-14	3.8994e-14	4.8363e-14	1.2090e-13	9.7274e-14	2.1974e-13	3.4433e-13	7.1972e-14	8.467
8824.056	0.850	4.2659e-14	3.3389e-14	5.3327e-14	1.2941e-13	1.0757e-13	2.2905e-13	3.5947e-13	8.5937e-14	8.424
8824.087	0.865	4.2645e-14	3.6298e-14	5.3380e-14	1.4287e-13	1.0448e-13	2.4154e-13	3.7574e-13	7.9198e-14	8.388
8824.126	0.884	5.9951e-14	4.6431e-14	6.3373e-14	1.5482e-13	1.1680e-13	2.6500e-13	4.1154e-13	8.5746e-14	8.340
8824.155	0.898	6.0773e-14	3.4945e-14	6.9266e-14	1.6184e-13	1.1734e-13	2.7491e-13	4.2651e-13	8.0899e-14	8.305
8824.184	0.912	6.1531e-14	4.5300e-14	7.4311e-14	1.7672e-13	1.2658e-13	2.9614e-13	4.4925e-13	9.0175e-14	8.272
8824.212	0.925	6.1255e-14	4.1117e-14	7.6008e-14	1.8549e-13	1.3554e-13	3.0029e-13	4.6358e-13	9.6427e-14	8.247
8824.241	0.940	6.8072e-14	5.7972e-14	8.3636e-14	1.8970e-13	1.3429e-13	3.0763e-13	4.5876e-13	9.9939e-14	8.227
8824.271	0.954	6.7609e-14	4.7711e-14	8.2499e-14	1.9346e-13	1.3872e-13	3.2182e-13	4.6090e-13	1.0011e-13	8.222
9025.346	0.513	7.9357e-15	6.1326e-15	1.7521e-14	6.0179e-14	3.8618e-14	1.3280e-13	2.1571e-13	2.5680e-14	8.756
9027.321	0.472	1.1641e-14	5.4099e-15	1.7743e-14	6.3318e-14	3.9420e-14	1.3671e-13	2.2159e-13	2.6464e-14	8.742
9028.411	0.001	6.2237e-14	4.4014e-14	8.5847e-14	1.8647e-13	1.4662e-13	3.3269e-13	4.7752e-13	1.0924e-13	8.243
9028.439	0.014	6.2029e-14	5.1462e-14	8.5851e-14	1.9316e-13	1.4839e-13	3.3519e-13	4.8440e-13	1.0879e-13	8.252
9028.466	0.027	6.8572e-14	5.7808e-14	8.6054e-14	1.7891e-13	1.3683e-13	3.2692e-13	4.8362e-13	1.0054e-13	8.261
9028.492	0.040	5.2876e-14	6.7262e-14	8.4590e-14	1.8202e-13	1.3358e-13	3.2758e-13	4.9623e-13	8.7401e-14	8.270

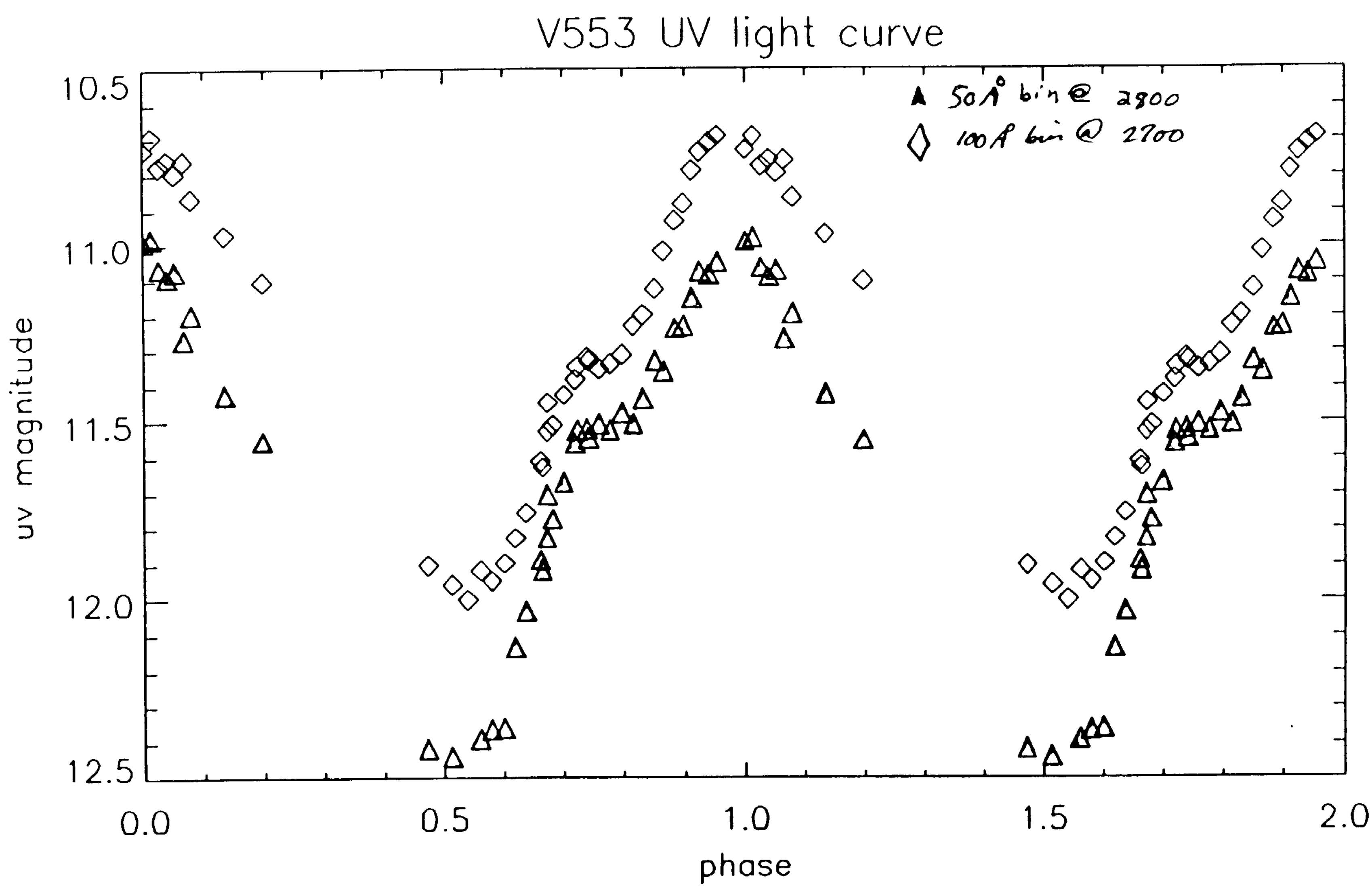
RESULTS OF BINNED FLUX FOR V553 CEN

HJD +2440000	phase	2200 (200)	2350 (100)	2500 (150)	2700 (100)	2800 (50)	2900 (100)	3100 (100)	2800 (30)	V
9028.519	0.053	4.6844e-16	5.2059e-14	8.1473e-14	1.7560e-13	1.3618e-13	3.1877e-13	4.7865e-13	9.1973e-14	8.279
9028.546	0.066	3.5463e-15	5.1983e-14	5.8210e-14	1.8147e-13	1.1359e-13	3.0861e-13	4.6056e-13	7.9070e-14	8.288
9028.572	0.079	5.6814e-14	5.2344e-14	7.5917e-14	1.6457e-13	1.2151e-13	3.0303e-13	4.7241e-13	8.3706e-14	8.297
9028.686	0.134	3.0999e-14	2.4584e-14	5.8331e-14	1.4953e-13	9.8629e-14	2.7378e-13	4.3302e-13	6.9158e-14	8.288
9040.665	0.946	7.0990e-14	5.4050e-14	8.5520e-14	1.9380e-13	1.4891e-13	3.1680e-13	4.9900e-13	1.0800e-13	8.227
9049.495	0.230	2.4540e-14	2.2860e-14	3.7580e-14	1.0940e-13	7.1840e-14	2.1490e-13	3.6280e-13	4.9443e-14	8.422
9049.601	0.282	1.9230e-14	1.6040e-14	3.1620e-14	9.0590e-14	5.5280e-14	1.8020e-13	2.9830e-13	3.6236e-14	8.480
9049.616	0.289	1.5680e-14	1.6660e-14	3.0670e-14	8.3380e-14	5.4040e-14	1.8090e-13	2.8540e-13	3.6323e-14	8.488
9076.511	0.338	9.9534e-15	1.1614e-14	2.1817e-14	7.6424e-14	4.1543e-14	1.5926e-13	2.5800e-13	2.7250e-14	8.551
9076.544	0.354	1.2379e-14	1.0835e-14	2.6144e-14	7.8422e-14	4.3381e-14	1.6280e-13	2.6173e-13	2.7951e-14	8.572
9076.578	0.371	1.1592e-14	1.1778e-14	2.3706e-14	7.5872e-14	4.4166e-14	1.6236e-13	2.5262e-13	2.9317e-14	8.596
9076.615	0.389	8.6761e-15	8.1256e-15	2.1158e-14	6.8534e-14	4.4315e-14	1.5723e-13	2.4195e-13	2.8609e-14	8.621

UV_MAG.V553 [loomis. Carbon_Stars]

$$\text{UV Mags} = 2.5 \log_{10}\left(\frac{3.65 \times 10^{-7}}{f_{bin}}\right)$$

HJD + 2440000	phase	2200	2350	2500	2700	2800	2900	3100
8458.04	0.197	12.5832	12.6375	12.2481	11.1033	11.5515	10.4102	9.92874
8463.14	0.672	13.2310	13.1763	12.3479	11.4455	11.7051	10.8060	10.2468
8463.24	0.721	12.8925	13.0161	12.2811	11.3448	11.5214	10.6782	10.2078
8463.28	0.741	12.9581	12.9914	12.3991	11.3291	11.5447	10.6939	10.2145
8808.99	0.539	14.4475	15.5771	13.3013	12.0002	12.6375	11.1692	10.6059
8809.03	0.560	13.7306	14.3502	13.3130	11.9167	12.3905	11.1146	10.6018
8809.07	0.579	14.7014	14.3354	13.0753	11.9471	12.3640	11.0764	10.5924
8809.11	0.600	15.7562	13.2605	13.1108	11.8963	12.3576	11.1094	10.6036
8809.15	0.618	14.1318	13.5204	13.2410	11.8257	12.1317	10.9999	10.4908
8809.19	0.636	14.0541	13.4172	12.8015	11.7549	12.0311	10.9996	10.4860
8809.25	0.663	13.7796	13.2121	12.6817	11.6267	11.9158	10.9096	10.4066
8809.26	0.671	13.7734	13.1794	12.6152	11.5269	11.8251	10.8456	10.3266
8823.66	0.660	13.1845	13.3359	12.6863	11.6103	11.8875	10.8795	10.3617
8823.71	0.680	13.0882	13.0613	12.5177	11.5080	11.7725	10.8139	10.3078
8823.75	0.699	12.9003	12.8466	12.4977	11.4230	11.6679	10.7516	10.2715
8823.79	0.718	12.6121	13.0724	12.3617	11.3809	11.5605	10.7236	10.2349
8823.83	0.738	12.7860	12.8313	12.3610	11.3189	11.5187	10.6805	10.2179
8823.86	0.757	12.8129	12.6351	12.3150	11.3517	11.5062	10.6631	10.2204
8823.90	0.776	12.9424	12.9479	12.3242	11.3376	11.5213	10.6462	10.2074
8823.94	0.795	12.9042	12.8415	12.3411	11.3119	11.4740	10.6373	10.1608
8823.98	0.814	12.9725	12.8011	12.2650	11.2296	11.5037	10.6011	10.0977
8824.02	0.830	12.8604	12.4282	12.1944	11.1997	11.4357	10.5510	10.0633
8824.06	0.850	12.3307	12.5967	12.0884	11.1258	11.3265	10.5059	10.0166
8824.09	0.865	12.3311	12.5060	12.0873	11.0184	11.3581	10.4483	9.96851
8824.13	0.884	11.9612	12.2387	11.9010	10.9312	11.2371	10.3476	9.86970
8824.16	0.898	11.9465	12.5473	11.8044	10.8830	11.2321	10.3078	9.83091
8824.18	0.912	11.9330	12.2655	11.7281	10.7875	11.1498	10.2270	9.77451
8824.21	0.925	11.9379	12.3707	11.7036	10.7349	11.0756	10.2119	9.74042
8824.24	0.940	11.8233	11.9977	11.5997	10.7106	11.0856	10.1857	9.75177
8824.27	0.954	11.8307	12.2092	11.6146	10.6893	11.0504	10.1367	9.74672
9025.35	0.513	14.1568	14.4366	13.2968	11.9571	12.4388	11.0977	10.5711
9027.32	0.472	13.7408	14.5728	13.2832	11.9019	12.4164	11.0662	10.5419
9028.41	0.001	11.9206	12.2968	11.5714	10.7292	10.9902	10.1006	9.70825
9028.44	0.014	11.9242	12.1270	11.5714	10.6909	10.9772	10.0925	9.69272
9028.47	0.027	11.8154	12.0008	11.5688	10.7741	11.0653	10.1196	9.69447
9028.49	0.040	12.0976	11.8363	11.5874	10.7554	11.0914	10.1174	9.66652
9028.52	0.053	17.2291	12.1145	11.6282	10.7944	11.0704	10.1470	9.70569
9028.55	0.066	15.0313	12.1161	11.9932	10.7587	11.2674	10.1822	9.74752
9028.57	0.079	12.0196	12.1086	11.7049	10.8649	11.1942	10.2020	9.71993
9028.69	0.134	12.6774	12.9291	11.9910	10.9689	11.4207	10.3122	9.81446
9040.67	0.946	11.7777	12.0737	11.5756	10.6873	10.9734	10.1538	9.66048
9049.50	0.230	12.9310	13.0080	12.4683	11.3082	11.7648	10.5751	10.0066
9049.60	0.282	13.1958	13.3927	12.6558	11.5130	12.0493	10.7663	10.2191
9049.62	0.289	13.4174	13.3515	12.6889	11.6031	12.0739	10.7621	10.2671
9076.51	0.338	13.9108	13.7433	13.0587	11.6977	12.3595	10.9005	10.3767
9076.54	0.354	13.6740	13.8187	12.8623	11.6696	12.3125	10.8766	10.3611
9076.58	0.371	13.7453	13.7281	12.9686	11.7055	12.2930	10.8795	10.3996
9076.62	0.389	14.0599	14.1311	13.0920	11.8160	12.2894	10.9144	10.4464


V553 UV light curve
50Å bin @ 2800
100Å bin @ 2700
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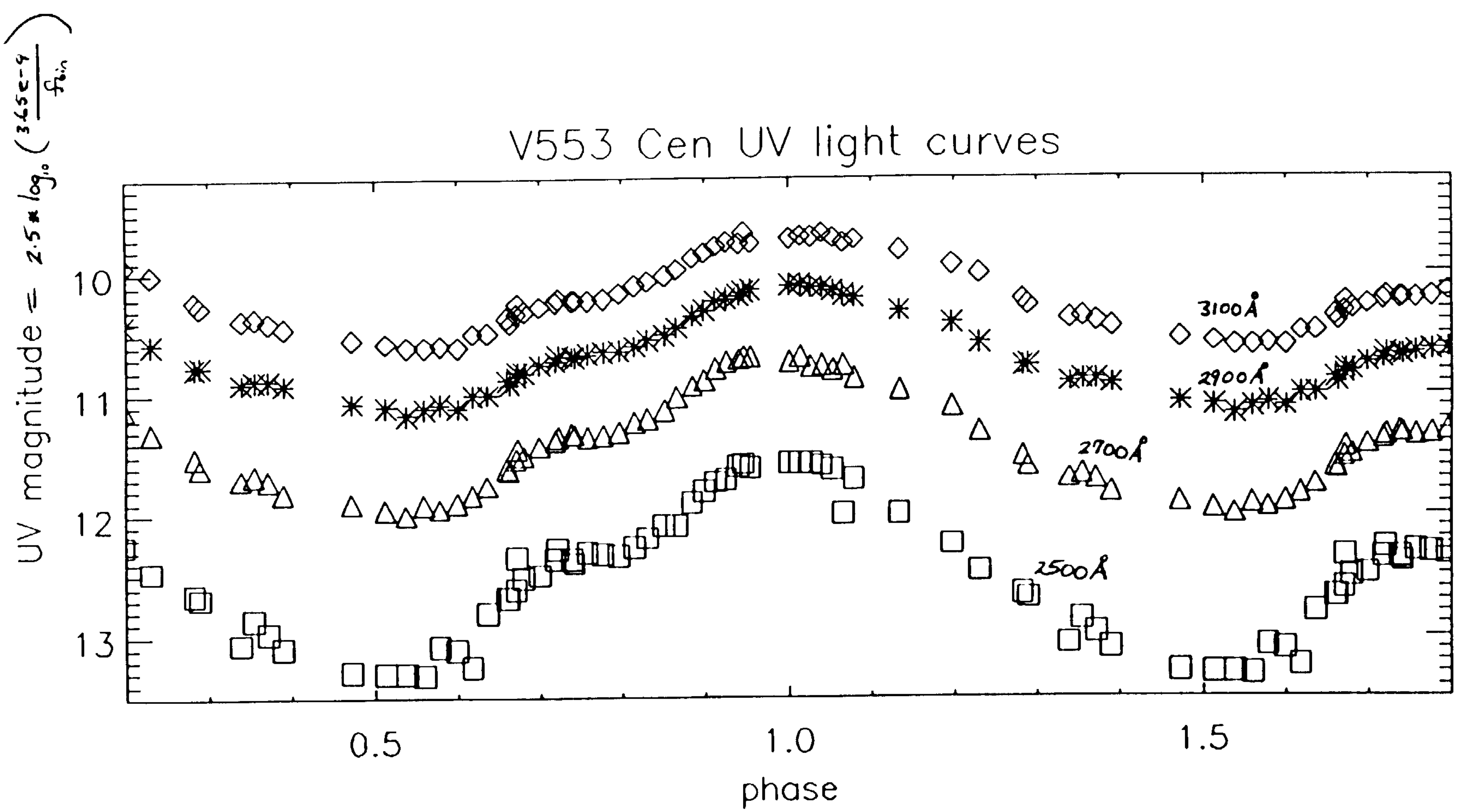
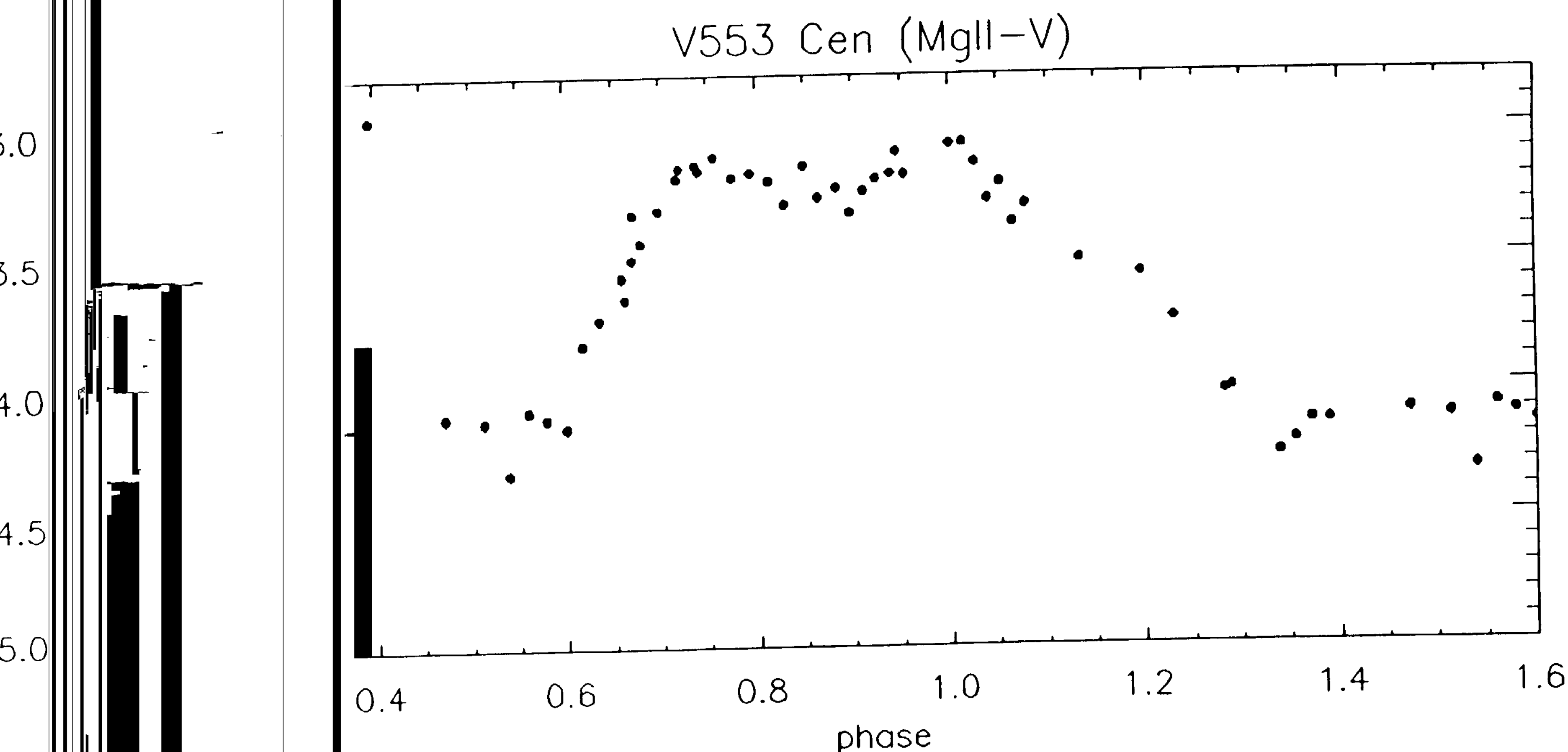
11.0
11.5
12.0
12.5
0.0
0.5
1.0
1.5
2.0
phase


V553 Cen UV light curves
UV magnitude = 2.5 * log₁₀ (3.65e-9 / f_λin)
10
11
12
13
0.5
1.0
1.5
phase
3100Å
2900Å
2700Å
2500Å


V553 Cen (MgII−V)
3.0
3.5
4.0
4.5
5.0
0.4
0.6
0.8
1.0
1.2
1.4
1.6
phase

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13. ABSTRACT *(Maximum 200 words)*

The purpose of this project was to obtain ultraviolet spectra with the *International Ultraviolet Explorer* (IUE) of three Type II Cepheid variable stars which exhibit carbon star characteristics. The significance of these objects rests on the fact that it is not clear how to produce stars of such low mass which pulsate, and yet show the effects of the dredge-up of processed nuclear material. The observations discussed here represent the first time that such stars have been observed in the ultraviolet.

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