

TALLINNA TÄHETORN TALLINN OBSERVATORY

III

Number 1

2004



Tallinna Tähetorn
Tallinn Observatory

**TALLINNA TEHNIKAÜLIKOO
FÜÜSIKAINSTITUUT
TALLINNA TÄHETORN**

**TALLINN TECHNICAL UNIVERSITY
INSTITUTE OF PHYSICS
TALLINN OBSERVATORY**

**TALLINNA TÄHETORN
TALLINN OBSERVATORY**

III

Number 1

TALLINN 2004

Koostanud ja toimetanud
T. Aas, V. Harvig

© Tallinna Tähetorn

ISSN 1406–8559

Contents

| | |
|------------------|---|
| UU Cnc | 9 |
|------------------|---|

Sisukord

| | |
|------------------|---|
| UU Cnc | 9 |
|------------------|---|

Observations of UU Cancri

P. Kalv

Tallinn Technical University, Institute of Physics, Tallinn Observatory Tähetorni 2,
Tallinn, Estonia

T.Oja

Astronomical Observatory, Box 515, SE-751 20 Uppsala, Sweden
tarmo.oja@astro.uu.se

V. Harvig

Tallinn Technical University, Institute of Physics, Tallinn Observatory Tähetorni 2,
Tallinn, Estonia
vharvig@hotmail.com

Introduction

The main problem of UU Cancri was brought forth in the first spectroscopic studies (Popper [(1956), (1977)] and Eggen [(1973)]) : the component whose lines were measured for velocity is eclipsed at phase zero and must be the hotter component, but its hydrogen lines are too strong for a K4 III star. Furthermore, the hydrogen lines strengthen considerably during primary minimum, i.e. the invisible companion star seems to be earlier than K4. Popper also suggests the component stars to be of nearly equal masses and radii. High-dispersion spectra at H_α obtained by [Eaton(1990)] and [Eaton et al.(1991)] as well as IUE spectra only magnified the amount of contradictions: no variations greater than 0^m3 in the ultraviolet continuum; the uv flux is lower than expected from a star as massive as the unseen component; the rotational velocity near conjunction requires the optically undetected companion star to be more massive than the K4 giant. The phase-dependent Balmer absorption seemingly implies a semidetached accreting system, but a strong chromosphere or wind from the secondary of a contact system is possible as well.

Photoelectric V light curves were published by Winiarski and Zola[(1987)], [Lee(1988)], and B, V light curves by [Eaton et al.(1991)]. From these observations three light curve solutions were presented in which the system is a contact binary with both components overfilling their Roche lobes Winiarski and Zola[(1987)], [Barone et al.(1989)], and three semidetached models Winiarski and Zola[(1987)], [Eaton(1990)], [Eaton et al.(1991)]. The most important physical parameters are quite different in these models, e.g. the mass ratio was derived from 0.3 to 1.5. Thereafter [Zola et al.(1994)] rediscussed earlier results and presented an accretion disk model for the system.

Observations

UU Cnc was observed with the Tallinn 50 cm telescope (BV from 1972, $UBVR$ from 1980), the Kvistaberg 40 cm telescope (UBV from 1985), the 60 cm telescope of the Royal Swedish Academy of Sciences at Observatorio Astrofisico del Roque de los Muchachos, La Palma Canary Islands(UBV from 1991) and 2.5 m Nordic Optical Telescope ($UBVRI$ and polarization on seven nights from 1990). Up to 1994 in total 234 observations (one normal point per night, Fig. 1) have been obtained. The brightness of the comparison

Table 1: The comparison and check star for UU Cancri.

| Star | | V | $U-B$ | $B-V$ | $V-R$ | $R-I$ |
|-----------------|-----------|-------------|-------------|-------------|-------------|-------------|
| Comparison star | SAO 97490 | 9.149 | 1.461 | 1.329 | 0.721 | 0.680 |
| | | ± 0.003 | ± 0.004 | ± 0.002 | ± 0.001 | ± 0.006 |
| Check star | SAO 97489 | 9.352 | -0.035 | 0.437 | 0.269 | 0.294 |
| | | ± 0.004 | ± 0.002 | ± 0.002 | ± 0.002 | ± 0.010 |

and the check star (also used as extinction stars) given in Table 1 are from measurements with the Nordic Optical Telescope.

The mean-square-root errors of the normal points, as calculated from the measurements of comparison and the check stars, are less than 0^m01 for V , $B-V$ and $V-R$. In the ultraviolet UU Cnc was too faint for the Tallinn and Kvistaberg telescopes. Often the sky background was bright from full or nearly full Moon and we have tried to observe also at relatively poor atmospheric conditions. Therefore in many nights the error in U may reach up to 0^m04 . On the other hand, some observations made on the same nights at La Palma and Tallinn convince us that it has not happened too often and irregular variations up to 0^m2 in the ultraviolet are real.

The observations are given in Table 4, Table 5a and Table 5b.

Period

The times of minimum were determined with the aid of Pogson's tracing paper method in differential mode [Albo(1964)], computerized by [Kalv(1979)]. We have used all available times of minima beginning from Huth's[(1963)] photographic determinations from the beginning of last century. The results are given in Table 2 and Fig.2. The quadratic term of the light elements derived from the same data is of the same order of magnitude as its error. Therefore we have used linear light elements derived by the least-squares-method:

$$Min = J.D.2425600.6 + 96^d6760 \times E \\ \pm 0.4 \quad \pm 0.0019$$

The determination of the weights of the normal minima given in Table 2 was arbitrary in some respects. The weights corresponding to square-root errors σ of normal minima were calculated according to their dispersion in a preliminary nonweighted solution and were adopted as follows: $\pm 3^d6$ for visual, $\pm 2^d2$ for photographic and $\pm 0^d3$ days for photoelectric times of minima. Striving not to be unjust to modern visual observers, whose observations seem to be as accurate as those of earlier photographic measurements, we adopt $\pm 2^d2$ days for them also. The number of the first photoelectric observations (Eggen [(1973)]) is too small for determining the accurate moment of minimum. Therefore we have merged Eggen's data with the data of our first series (minimum E=166). We also have determined two minima from the measurements by *HIPPARCOS*. The photoelectric minimum E=220, with $|O-C| > 3\sigma$ did not take part in the final levelling off procedure with weights.

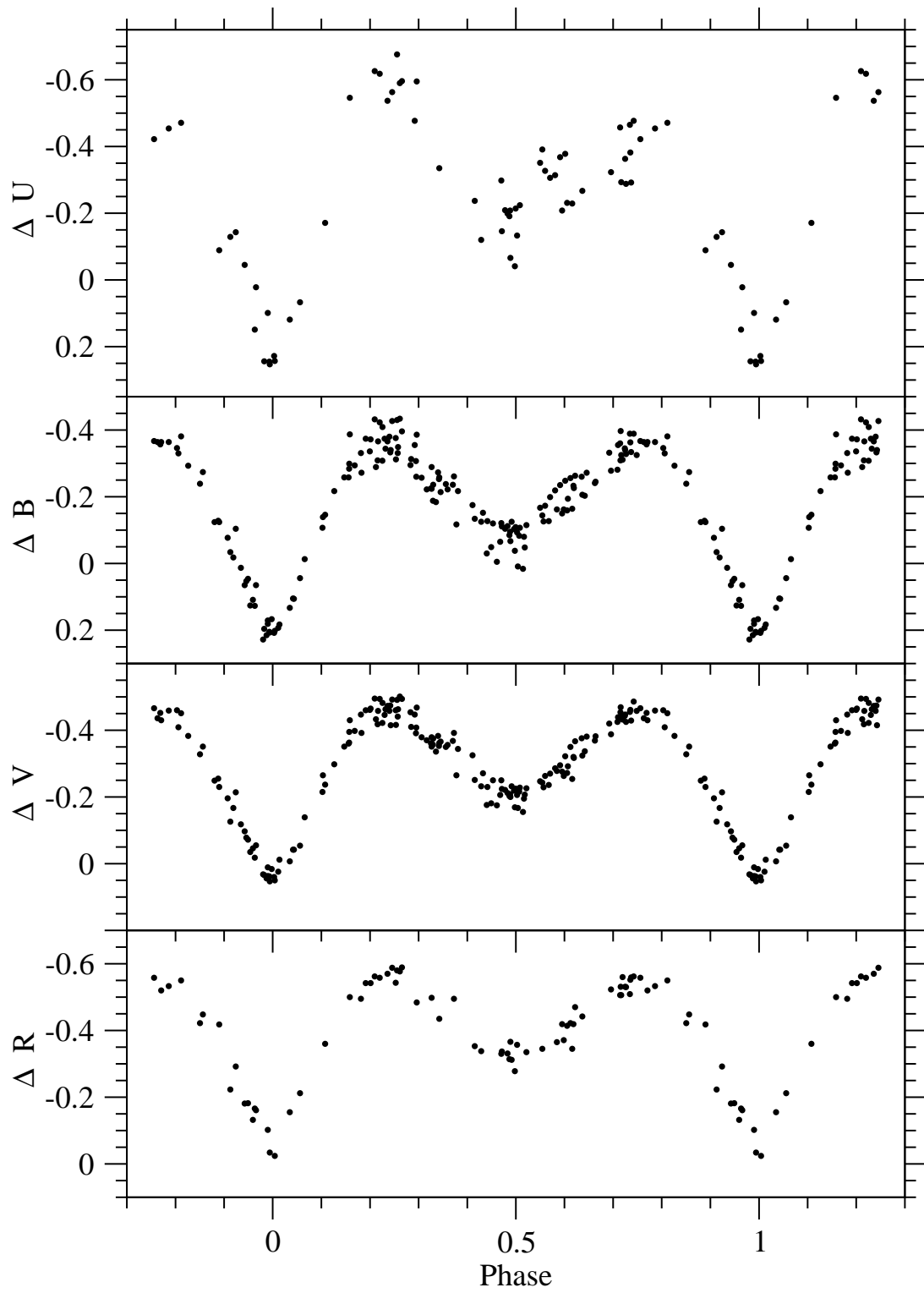


Fig.1 All our observations.

UU Cnc

| JD Hel. 2400000+ | $\pm\sigma$ | E | $O - C$ | Observer |
|------------------|-------------|-----|---------|-------------|
| 25594 | 4.4 | 0 | -6.77 | <i>H</i> |
| 25692 | 4.4 | 1 | -5.45 | <i>H</i> |
| 25986 | 4.4 | 4 | -1.48 | <i>H</i> |
| 26084 | 4.4 | 5 | -0.15 | <i>H</i> |
| 26276 | 4.4 | 7 | -1.50 | <i>H</i> |
| 26374 | 4.4 | 8 | -0.18 | <i>H</i> |
| 26664 | 4.4 | 11 | -0.20 | <i>H</i> |
| 26762 | 4.4 | 12 | 1.12 | <i>H</i> |
| 27052 | 4.4 | 15 | 1.10 | <i>H</i> |
| 27436 | 4.4 | 19 | -1.61 | <i>H</i> |
| 27534 | 4.4 | 20 | -0.28 | <i>H</i> |
| 28500 | 4.4 | 30 | -1.04 | <i>H</i> |
| 28598 | 4.4 | 31 | 0.29 | <i>H</i> |
| 28888 | 4.4 | 34 | 0.26 | <i>L</i> |
| 28985 | 4.4 | 35 | 0.59 | <i>L</i> |
| 29568 | 4.4 | 41 | 3.54 | <i>H</i> |
| 29665 | 4.4 | 42 | 3.86 | <i>H</i> |
| 30337 | 4.4 | 49 | -0.87 | <i>H</i> |
| 30435 | 4.4 | 50 | 0.46 | <i>H</i> |
| 30727 | 4.4 | 53 | 2.43 | <i>H</i> |
| 30825 | 4.4 | 54 | 3.76 | <i>H</i> |
| 31017 | 4.4 | 56 | 2.40 | <i>H</i> |
| 31398 | 4.4 | 60 | -3.30 | <i>H</i> |
| 31496 | 4.4 | 61 | -1.97 | <i>H</i> |
| 32662 | 6.8 | 73 | 4.32 | <i>B</i> |
| 32663 | 4.4 | 73 | 4.92 | <i>H</i> |
| 32853 | 4.4 | 75 | 1.57 | <i>H</i> |
| 32948 | 6.8 | 76 | -0.10 | <i>B</i> |
| 32950 | 4.4 | 76 | 1.90 | <i>H, S</i> |
| 33045 | 6.8 | 77 | 1.02 | <i>B</i> |
| 33047 | 4.4 | 77 | 2.22 | <i>H</i> |
| 33239 | 4.4 | 79 | 0.87 | <i>H, S</i> |
| 33332 | 6.8 | 80 | -2.80 | <i>B</i> |
| 33337 | 4.4 | 80 | 2.20 | <i>H, S</i> |
| 33625 | 4.4 | 83 | 0.17 | <i>H, S</i> |
| 33716 | 6.8 | 84 | -5.51 | <i>B</i> |
| 33915 | 4.4 | 86 | 0.14 | <i>H</i> |
| 34011 | 4.4 | 87 | -0.53 | <i>H</i> |
| 34109 | 4.4 | 88 | 0.79 | <i>H, S</i> |
| 34400 | 4.4 | 91 | 1.77 | <i>H, S</i> |
| 34402.5 | 6.8 | 91 | 4.27 | <i>B</i> |
| 34496 | 4.4 | 92 | 1.09 | <i>S</i> |
| 34688 | 4.4 | 94 | -0.26 | <i>H</i> |
| 34786 | 4.4 | 95 | 1.06 | <i>H</i> |
| 35076 | 4.4 | 98 | 1.04 | <i>H</i> |

UU Cnc: continued

| JD Hel. 2400000+ | $\pm\sigma$ | E | $O - C$ | Observer |
|------------------|-------------|-------|---------|---------------|
| 35174 | 4.4 | 99 | 2.36 | <i>H</i> |
| 35175 | 6.8 | 99 | 3.36 | <i>B</i> |
| 35465 | 6.8 | 102 | 3.34 | <i>B</i> |
| 35560.4 | 6.8 | 103 | 2.06 | <i>B</i> |
| 35844 | 4.4 | 106 | -4.36 | <i>H</i> |
| 35942 | 4.4 | 107 | -3.04 | <i>H</i> |
| 36235 | 4.4 | 110 | -0.07 | <i>H</i> |
| 36237 | 6.8 | 110 | 1.93 | <i>B</i> |
| 36332 | 4.4 | 111 | 0.26 | <i>H</i> |
| 36522 | 4.4 | 113 | -3.09 | <i>H</i> |
| 36620 | 4.4 | 114 | -1.77 | <i>H</i> |
| 36621.5 | 6.8 | 114 | -0.27 | <i>B</i> |
| 36910 | 4.4 | 117 | -1.79 | <i>H</i> |
| 37007.5 | 6.8 | 118 | -0.97 | <i>B</i> |
| 37008 | 4.4 | 118 | -0.47 | <i>H</i> |
| 37297 | 4.4 | 121 | -1.50 | <i>H</i> |
| 37390 | 6.8 | 122 | -5.17 | <i>B</i> |
| 37394 | 4.4 | 122 | -1.17 | <i>H</i> |
| 37685 | 4.4 | 125 | -0.20 | <i>H</i> |
| 37690.5 | 6.8 | 125 | 5.30 | <i>B</i> |
| 37782 | 4.4 | 126 | 0.13 | <i>H</i> |
| 37784.8 | 6.8 | 126 | 2.93 | <i>B</i> |
| 37976 | 4.4 | 128 | 0.78 | <i>H</i> |
| 38079 | 6.8 | 129 | 7.10 | <i>B</i> |
| 38172 | 6.8 | 130 | 3.43 | <i>B</i> |
| 38465.5 | 6.8 | 133 | 6.90 | <i>B</i> |
| 41648.6 | 1.0 | 166 | -0.29 | <i>E + KO</i> |
| 43584.4 | 4.4 | 186 | 2.00 | <i>T</i> |
| 44162.1 | 1.0 | 192 | -0.35 | <i>KO</i> |
| 44645.63 | 1.0 | 197 | -0.19 | <i>WZ</i> |
| 45032.0 | 1.0 | 201 | -0.53 | <i>WZ</i> |
| 45033.3 | 4.4 | 201 | 0.77 | <i>T</i> |
| 45034.4 | 4.4 | 201 | 1.87 | <i>Br</i> |
| 45225.5 | 1.0 | 203 | -0.38 | <i>KO</i> |
| 46096.1 | 1.0 | 212 | 0.14 | <i>KO</i> |
| 46093.47 | 4.4 | 212 | -2.49 | <i>I</i> |
| 46482.3 | 1.0 | 216 | -0.36 | <i>KCL</i> |
| 46870.3 | 1.0 | 220 | 0.94 | <i>KCL</i> |
| 47352.7 | 1.0 | 225 | -0.04 | <i>KO</i> |
| 47932.92 | 1.0 | 231 | 0.13 | <i>EHH</i> |
| 48996.4 | 1.0 | 242 | 0.18 | <i>KO</i> |
| 41695.8 | - | 166.5 | -0.92 | <i>E + KO</i> |
| 43630.5 | - | 186.5 | 0.12 | <i>KO</i> |
| 44596.2 | - | 196.5 | -1.01 | <i>KO</i> |
| 46047.9 | - | 211.5 | 0.45 | <i>KO</i> |
| 46821.20 | - | 219.5 | 0.28 | <i>KCL</i> |
| 46918.78 | - | 220.5 | 1.18 | <i>KCL</i> |

| JD Hel. 2400000+ | $\pm\sigma$ | E | $O - C$ | Observer |
|------------------|-------------|-------|---------|-----------|
| 47111.5 | — | 222.5 | 0.53 | <i>KO</i> |
| 48562.1 | — | 237.5 | 0.79 | <i>KO</i> |

Observers:

B - Beyer 1964, Br - Brelstaff 1985, E - Eggen 1973,
 EHH - Eaton, Hall, Honeycutt 1991, H - Huth 1963, I - Isles 1986,
 KCL - Kim, Chun, Lee 1988, KO - this paper, L - Lause 1938,
 S - Schachowskoi 1956, T - Taylor 1984, 1985, WZ - Winiarski, Zola 1987.

Light curves

It is obvious from Fig. 1 that the dispersion around a mean curve is considerably higher than the errors of observation. Fig. 3 shows the residuals as a function of time.

It appears that the orbital light-variations are modulated with a wave lasting at least 8000 days. These intrinsic variations are colour-dependent with an amplitude of about 0^m10 in B and 0^m06 in V . In U the amplitude is probably greater than 0^m11 whereas in R these variations are imperceptible.

Evidently the same variations were mentioned already by Eaton et al (1991) as a difference between Winiarski's and Zola's [(1987)] lightcurve (observed at around the maximum of the 8000 day cycle) and that measured with Vanderbilt-Tennessee State APT near the minimum of the cycle.

The long-period changes were approximated with polynomial (except R) and for further use deviations from the polynomial were taken. We have combined all available observations. Thereafter the observations were joined to normal points and normalized by max II of the orbital light curve.

The normalized light curves are showing contradictory behaviour of depths of minima. From Table 3 it appears that from R to U in every light curve the depth of both minima is increasing.

For this phenomenon the only explanation we could imagine is some kind of third light in the system.

Table 3: Depths of minima from orbital light-curves, corrected for intrinsic variations and normalized by max II.

| Band | Flux | |
|------|--------|--------|
| | min I | min II |
| U | 0.535 | 0.755 |
| B | 0.595 | 0.763 |
| V | 0.636 | 0.791 |
| R | 0.645: | 0.805 |

We hope to publish the results of the investigation in near future.

The autors are grateful to Toomas Aas for his persistent help.

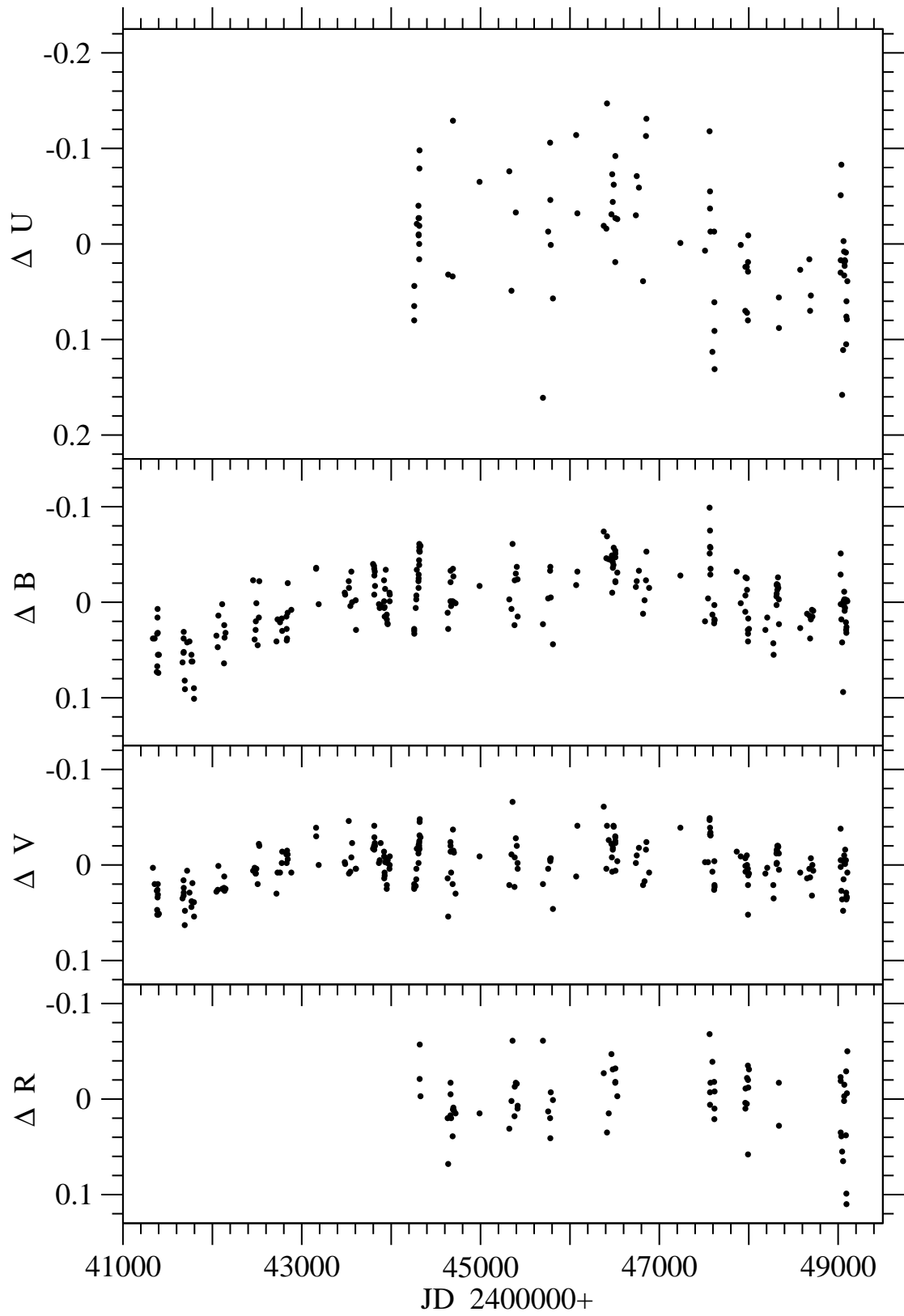


Fig.3 All our residuals.

All our observation data of the UU Cancri

| JD Hel. 2400000+ | ΔU | ΔB | ΔV | ΔR | ΔI |
|------------------|------------|------------|------------|------------|------------|
| 41334.5651 | | -0.325 | -0.458 | | |
| 41354.4074 | | 0.126 | -0.035 | | |
| 41379.4097 | | -0.289 | -0.433 | | |
| 41382.3477 | | -0.340 | -0.415 | | |
| 41383.3788 | | -0.312 | -0.416 | | |
| 41386.4143 | | -0.313 | -0.410 | | |
| 41387.3588 | | -0.307 | -0.391 | | |
| 41390.3436 | | -0.225 | -0.361 | | |
| 41391.3376 | | -0.184 | -0.336 | | |
| 41395.3958 | | -0.117 | -0.265 | | |
| 41402.3123 | | -0.049 | -0.181 | | |
| 41666.5725 | | -0.272 | -0.392 | | |
| 41677.4593 | | -0.260 | -0.408 | | |
| 41678.5132 | | -0.257 | -0.379 | | |
| 41679.5263 | | -0.222 | -0.370 | | |
| 41680.5042 | | -0.224 | -0.351 | | |
| 41691.4696 | | -0.030 | -0.176 | | |
| 41693.4857 | | -0.005 | -0.175 | | |
| 41717.4591 | | -0.281 | -0.425 | | |
| 41744.3761 | | 0.215 | 0.044 | | |
| 41766.4400 | | -0.309 | -0.418 | | |
| 41767.3799 | | -0.308 | -0.422 | | |
| 41777.4354 | | -0.188 | -0.357 | | |
| 41794.3283 | | 0.009 | -0.167 | | |
| 41795.3501 | | 0.016 | -0.155 | | |
| 42045.4984 | | -0.107 | -0.215 | | |
| 42060.4635 | | -0.331 | -0.441 | | |
| 42067.5097 | | -0.236 | -0.375 | | |
| 42109.3846 | | -0.364 | -0.436 | | |
| 42130.3915 | | 0.228 | 0.032 | | |
| 42133.3865 | | 0.193 | 0.024 | | |
| 42136.3350 | | 0.105 | -0.042 | | |
| 42147.3618 | | -0.258 | -0.360 | | |
| 42455.3727 | | -0.253 | -0.353 | | |
| 42472.4311 | | -0.048 | -0.207 | | |
| 42484.3467 | | -0.203 | -0.337 | | |
| 42486.3650 | | -0.241 | -0.369 | | |
| 42492.3049 | | -0.345 | -0.443 | | |
| 42507.4271 | | -0.124 | -0.249 | | |
| 42520.3300 | | 0.183 | -0.012 | | |
| 42525.3523 | | -0.013 | -0.139 | | |
| 42716.5656 | | 0.106 | -0.042 | | |
| 42728.6328 | | -0.294 | -0.398 | | |
| 42757.5588 | | -0.065 | -0.206 | | |
| 42776.5201 | | -0.245 | -0.382 | | |

All our observation data of the UU Cancri: continued

| JD Hel. 2400000+ | ΔU | ΔB | ΔV | ΔR | ΔI |
|------------------|------------|------------|------------|------------|------------|
| 42781.4848 | | -0.309 | -0.454 | | |
| 42828.3305 | | -0.336 | -0.461 | | |
| 42831.4374 | | -0.344 | -0.463 | | |
| 42832.3796 | | -0.333 | -0.474 | | |
| 42836.4072 | | -0.295 | -0.454 | | |
| 42842.3969 | | -0.214 | -0.366 | | |
| 42843.4263 | | -0.238 | -0.350 | | |
| 42883.3484 | | -0.357 | -0.452 | | |
| 43160.4660 | | -0.260 | -0.376 | | |
| 43161.4573 | | -0.272 | -0.381 | | |
| 43189.3957 | | 0.013 | -0.118 | | |
| 43480.4877 | | 0.053 | -0.078 | | |
| 43485.5390 | | 0.167 | 0.016 | | |
| 43525.4622 | | -0.175 | -0.325 | | |
| 43528.4175 | | -0.127 | -0.230 | | |
| 43544.4314 | | -0.194 | -0.292 | | |
| 43554.4010 | | -0.355 | -0.439 | | |
| 43563.3924 | | -0.346 | -0.460 | | |
| 43603.3639 | | -0.366 | -0.458 | | |
| 43607.3473 | | -0.349 | -0.463 | | |
| 43797.5948 | | -0.409 | -0.482 | | |
| 43808.6360 | | -0.273 | -0.383 | | |
| 43810.5360 | | -0.222 | -0.356 | | |
| 43811.5804 | | -0.236 | -0.368 | | |
| 43812.6085 | | -0.217 | -0.344 | | |
| 43817.5637 | | -0.152 | -0.271 | | |
| 43819.5593 | | -0.120 | -0.250 | | |
| 43863.4783 | | -0.077 | -0.196 | | |
| 43871.4632 | | 0.181 | 0.011 | | |
| 43882.4382 | | -0.139 | -0.265 | | |
| 43920.4189 | | -0.103 | -0.219 | | |
| 43921.4546 | | -0.083 | -0.216 | | |
| 43922.3990 | | -0.080 | -0.195 | | |
| 43926.2980 | | -0.126 | -0.229 | | |
| 43927.3224 | | -0.127 | -0.236 | | |
| 43932.3148 | | -0.226 | -0.317 | | |
| 43939.3377 | | -0.332 | -0.420 | | |
| 43950.3709 | | -0.330 | -0.409 | | |
| 43952.3175 | | -0.293 | -0.383 | | |
| 43958.2798 | | -0.128 | -0.255 | | |
| 43961.2915 | | -0.018 | -0.167 | | |
| 43981.3691 | | -0.217 | -0.298 | | |
| 43983.3371 | | -0.258 | -0.351 | | |
| 43984.3407 | | -0.299 | -0.395 | | |
| 44257.4718 | 0.244 | 0.196 | 0.034 | | |
| 44258.4780 | 0.245 | 0.205 | 0.038 | | |
| 44259.4275 | 0.228 | 0.208 | 0.040 | | |

All our observation data of the UU Cancri: continued

| JD Hel. 2400000+ | ΔU | ΔB | ΔV | ΔR | ΔI |
|------------------|------------|------------|------------|------------|------------|
| 44274.3512 | | -0.284 | -0.363 | | |
| 44281.4006 | | -0.374 | -0.446 | | |
| 44282.3557 | | -0.380 | -0.458 | | |
| 44287.3871 | -0.477 | -0.355 | -0.447 | | |
| 44305.3485 | -0.209 | -0.104 | -0.221 | | |
| 44306.3467 | -0.208 | -0.095 | -0.208 | | |
| 44307.4391 | -0.214 | -0.109 | -0.225 | | |
| 44308.2945 | -0.224 | -0.107 | -0.228 | | |
| 44312.3188 | -0.351 | -0.167 | -0.247 | | |
| 44313.2991 | -0.327 | -0.173 | -0.263 | | |
| 44314.2892 | -0.306 | -0.199 | -0.270 | | |
| 44315.2938 | -0.314 | -0.219 | -0.286 | | |
| 44316.2885 | -0.368 | -0.235 | -0.295 | | |
| 44317.3102 | -0.378 | -0.248 | -0.322 | | |
| 44318.3385 | | -0.256 | -0.350 | -0.422 | |
| 44319.2669 | | -0.263 | -0.367 | -0.470 | |
| 44328.3346 | | -0.397 | -0.469 | -0.531 | |
| 44631.4050 | | -0.239 | -0.328 | -0.422 | |
| 44637.4302 | -0.129 | -0.034 | -0.126 | -0.223 | |
| 44663.3913 | | -0.331 | -0.447 | -0.495 | |
| 44664.3461 | | -0.374 | -0.460 | -0.542 | |
| 44665.3076 | | -0.372 | -0.465 | -0.542 | |
| 44670.3090 | | -0.376 | -0.460 | -0.543 | |
| 44687.2977 | -0.120 | -0.125 | -0.232 | -0.338 | |
| 44691.2868 | -0.298 | -0.121 | -0.250 | -0.330 | |
| 44696.2987 | | -0.115 | -0.226 | -0.335 | |
| 44702.3489 | | -0.162 | -0.278 | -0.365 | |
| 44720.3588 | | -0.364 | -0.430 | -0.520 | |
| 44989.4832 | -0.391 | -0.144 | -0.243 | -0.345 | |
| 45321.6002 | 0.099 | 0.171 | 0.037 | -0.102 | |
| 45345.3943 | -0.537 | -0.366 | -0.473 | -0.570 | |
| 45358.6004 | | -0.261 | -0.392 | -0.495 | |
| 45380.4417 | | -0.162 | -0.263 | -0.371 | |
| 45382.3569 | | -0.233 | -0.320 | -0.419 | |
| 45394.3304 | -0.477 | -0.389 | -0.486 | -0.562 | |
| 45405.3631 | | -0.274 | -0.351 | -0.448 | |
| 45414.3429 | | 0.046 | -0.072 | -0.182 | |
| 45415.3119 | | 0.109 | -0.046 | -0.132 | |
| 45698.6506 | -0.089 | -0.124 | -0.230 | -0.418 | |
| 45756.3360 | -0.191 | -0.085 | -0.203 | -0.314 | |
| 45778.3369 | -0.457 | -0.360 | -0.440 | -0.506 | |
| 45780.2894 | -0.465 | -0.389 | -0.455 | -0.509 | |
| 45785.2853 | -0.454 | -0.364 | -0.459 | -0.533 | |
| 45809.3408 | 0.119 | 0.133 | -0.007 | -0.155 | |
| 46069.4950 | -0.494 | -0.364 | -0.434 | | |
| 46082.4320 | -0.382 | -0.262 | -0.365 | | |
| 46378.6706 | -0.143 | -0.104 | -0.214 | -0.292 | |

All our observation data of the UU Cancri: continued

| JD Hel. 2400000+ | ΔU | ΔB | ΔV | ΔR | ΔI |
|------------------|------------|------------|------------|------------|------------|
| 46407.5760 | -0.599 | -0.413 | -0.460 | | |
| 46414.6264 | -0.595 | -0.386 | -0.468 | -0.484 | |
| 46433.5142 | | -0.125 | -0.232 | -0.312 | |
| 46464.4655 | -0.471 | -0.381 | -0.451 | -0.550 | |
| 46469.5030 | | -0.270 | -0.324 | | |
| 46472.4460 | -0.311 | -0.135 | -0.227 | | |
| 46479.3742 | 0.022 | 0.065 | -0.055 | -0.161 | |
| 46480.3460 | | 0.091 | -0.041 | | |
| 46487.2730 | | 0.023 | -0.116 | | |
| 46489.3530 | -0.131 | -0.050 | -0.160 | | |
| 46506.4257 | -0.563 | -0.427 | -0.492 | -0.588 | |
| 46507.3972 | -0.676 | -0.430 | -0.491 | -0.580 | |
| 46508.3234 | | -0.421 | -0.490 | | |
| 46508.3750 | -0.596 | -0.396 | -0.494 | -0.589 | |
| 46509.4079 | | -0.384 | -0.452 | | |
| 46529.3641 | -0.199 | -0.112 | -0.212 | -0.331 | |
| 46737.6609 | -0.289 | -0.241 | -0.339 | | |
| 46747.6304 | -0.508 | -0.378 | -0.464 | | |
| 46771.6326 | 0.114 | 0.139 | -0.004 | | |
| 46817.4601 | -0.132 | -0.085 | -0.203 | | |
| 46834.4787 | | -0.228 | -0.322 | | |
| 46850.3740 | -0.563 | -0.371 | -0.455 | | |
| 46855.3339 | -0.495 | -0.297 | -0.360 | | |
| 46885.3244 | | -0.316 | -0.388 | | |
| 47235.2979 | -0.456 | -0.389 | -0.493 | | |
| 47510.5625 | -0.249 | -0.198 | -0.332 | | |
| 47544.4954 | | 0.159 | 0.004 | | |
| 47561.4334 | -0.546 | -0.387 | -0.430 | -0.500 | |
| 47563.3963 | | -0.375 | -0.466 | | |
| 47566.3884 | -0.626 | -0.432 | -0.495 | -0.562 | |
| 47567.3798 | -0.618 | -0.423 | -0.494 | -0.558 | |
| 47570.4281 | | -0.402 | -0.493 | | |
| 47571.3915 | -0.590 | -0.434 | -0.501 | -0.577 | |
| 47573.3603 | | -0.391 | -0.484 | | |
| 47593.3736 | -0.066 | -0.067 | -0.200 | -0.366 | |
| 47613.3628 | -0.323 | -0.278 | -0.388 | -0.523 | |
| 47615.3894 | -0.293 | -0.325 | -0.439 | -0.506 | |
| 47616.3486 | -0.288 | -0.328 | -0.425 | -0.530 | |
| 47617.3609 | -0.292 | -0.334 | -0.429 | -0.559 | |
| 47865.5009 | | -0.338 | -0.433 | | |
| 47910.4469 | -0.448 | -0.365 | -0.470 | | |
| 47961.3718 | -0.383 | -0.309 | -0.436 | -0.517 | -0.433 |
| 47962.3965 | -0.397 | -0.309 | -0.416 | -0.500 | -0.507 |
| 47964.4049 | | -0.289 | -0.379 | -0.498 | |
| 47978.3664 | -0.146 | -0.111 | -0.224 | -0.337 | |
| 47981.4091 | -0.133 | -0.093 | -0.206 | -0.357 | |
| 47990.3451 | -0.208 | -0.150 | -0.276 | -0.419 | |

All our observation data of the UU Cancri: continued

| JD Hel. 2400000+ | ΔU | ΔB | ΔV | ΔR | ΔI |
|------------------|------------|------------|------------|------------|------------|
| 47991.3477 | -0.231 | -0.159 | -0.272 | -0.414 | |
| 47992.3710 | -0.229 | -0.164 | -0.254 | -0.345 | |
| 47994.3600 | -0.267 | -0.206 | -0.324 | -0.442 | |
| 48002.3618 | | -0.311 | -0.432 | -0.560 | |
| 48186.6230 | | -0.182 | -0.311 | | |
| 48206.5960 | | -0.289 | -0.396 | | |
| 48274.4233 | | -0.052 | -0.194 | | |
| 48278.4003 | | -0.092 | -0.216 | | |
| 48310.4368 | | -0.098 | -0.217 | | |
| 48311.4444 | | -0.056 | -0.178 | | |
| 48312.4395 | | -0.035 | -0.151 | | |
| 48313.4500 | | -0.009 | -0.136 | | |
| 48314.4784 | | 0.042 | -0.093 | | |
| 48315.4615 | | 0.069 | -0.058 | | |
| 48319.4407 | | 0.162 | -0.003 | | |
| 48324.4163 | | 0.039 | -0.092 | | |
| 48326.4477 | | -0.023 | -0.144 | | |
| 48330.4335 | | -0.176 | -0.279 | | |
| 48336.3714 | -0.414 | -0.319 | -0.421 | -0.489 | -0.512 |
| 48337.3864 | -0.408 | -0.309 | -0.419 | -0.485 | -0.489 |
| 48575.7032 | -0.241 | -0.210 | -0.344 | | |
| 48652.4805 | | -0.100 | -0.226 | | |
| 48678.4519 | -0.327 | -0.308 | -0.427 | | |
| 48686.4562 | -0.387 | -0.319 | -0.435 | | |
| 48694.3635 | -0.246 | -0.171 | -0.294 | | |
| 48707.3283 | | 0.181 | 0.047 | | |
| 48712.3554 | | 0.041 | -0.105 | | |
| 48721.3457 | | -0.273 | -0.372 | | |
| 49027.4945 | -0.345 | -0.300 | -0.430 | -0.515 | -0.539 |
| 49029.3576 | -0.335 | -0.258 | -0.362 | -0.435 | -0.512 |
| 49029.4322 | -0.264 | -0.233 | -0.368 | -0.488 | |
| 49036.4011 | -0.237 | -0.134 | -0.251 | -0.353 | |
| 49044.3830 | -0.041 | -0.038 | -0.169 | -0.278 | |
| 49055.4450 | -0.141 | -0.106 | -0.253 | -0.334 | -0.519 |
| 49060.5554 | -0.284 | -0.260 | -0.361 | | |
| 49066.3200 | -0.363 | -0.340 | -0.447 | -0.531 | |
| 49067.3498 | -0.382 | -0.363 | -0.461 | -0.552 | |
| 49069.3373 | -0.422 | -0.367 | -0.466 | -0.558 | |
| 49072.3999 | -0.432 | -0.351 | -0.456 | | |
| 49073.4025 | -0.439 | -0.355 | -0.451 | | |
| 49077.4265 | -0.380 | -0.285 | -0.386 | | |
| 49078.5005 | | -0.259 | -0.364 | | |
| 49087.3484 | -0.045 | 0.065 | -0.097 | -0.181 | |
| 49089.3521 | 0.149 | 0.127 | -0.018 | -0.166 | |
| 49092.3277 | 0.253 | 0.207 | 0.053 | -0.034 | |
| 49093.3388 | 0.243 | 0.202 | 0.050 | -0.024 | |
| 49098.3342 | 0.067 | 0.044 | -0.054 | -0.212 | |

All our observation data of the UU Cancri: continued

| JD Hel. 2400000+ | ΔU | ΔB | ΔV | ΔR | ΔI |
|------------------|------------|------------|------------|------------|------------|
| 49103.3377 | -0.171 | -0.146 | -0.237 | -0.360 | |

Instrumental polarization at NOT (March 1990)

| fil | PX | EPX | PY | EPY | POL | EPOL | NOBS |
|-----|--------|-------|--------|-------|-------|-------|------|
| 1 | 0.018 | 0.009 | -0.034 | 0.010 | 0.039 | 0.010 | 344 |
| 2 | 0.009 | 0.008 | -0.005 | 0.008 | 0.010 | 0.008 | 344 |
| 3 | -0.008 | 0.008 | -0.007 | 0.008 | 0.011 | 0.008 | 344 |
| 4 | 0.009 | 0.011 | 0.006 | 0.011 | 0.011 | 0.011 | 141 |
| 5 | -0.044 | 0.018 | 0.009 | 0.021 | 0.044 | 0.018 | 141 |

Polarization data of UU Cancri at NOT

| Star | f | d | JD2440000+ | Pq | Pu | Err1 | Err2 | mag | smag | emag | |
|--------|--------|---|------------|-----------|--------|--------|-------|--------|--------|-------|-------|
| 151733 | 1 | 1 | 7961.3643 | -0.444 | -0.096 | 0.412 | 0.385 | 11.301 | 0.011 | 0.004 | |
| | 2 | | | -0.053 | -0.182 | 0.170 | 0.204 | 9.656 | 0.004 | 0.002 | |
| | 3 | | | 0.104 | -0.023 | 0.131 | 0.159 | 9.147 | 0.004 | 0.001 | |
| | 4 | | | 0.053 | -0.104 | 0.063 | 0.115 | 7.579 | 0.003 | 0.001 | |
| | 5 | | | -0.082 | -0.425 | 0.120 | 0.092 | 8.984 | 0.012 | 0.004 | |
| | 1 | | .3667 | -0.085 | -0.111 | 0.417 | 0.289 | 11.320 | 0.013 | 0.005 | |
| | 2 | | | 0.010 | -0.122 | 0.171 | 0.099 | 9.666 | 0.002 | 0.001 | |
| | 3 | | | -0.068 | -0.075 | 0.131 | 0.099 | 9.153 | 0.006 | 0.002 | |
| | 4 | | | -0.207 | -0.277 | 0.063 | 0.120 | 7.575 | 0.005 | 0.002 | |
| | 5 | | | -0.419 | -0.121 | 0.120 | 0.233 | 8.980 | 0.014 | 0.005 | |
| | 1 | | .3691 | -0.793 | 0.503 | 0.411 | 0.145 | 11.295 | 0.007 | 0.003 | |
| | 2 | | | 0.135 | 0.142 | 0.171 | 0.203 | 9.658 | 0.004 | 0.001 | |
| | 3 | | | 0.605 | 0.158 | 0.131 | 0.096 | 9.150 | 0.003 | 0.001 | |
| | 4 | | | 1.158 | 0.186 | 0.063 | 0.240 | 7.569 | 0.002 | 0.001 | |
| | 5 | | | 0.846 | -0.093 | 0.119 | 0.272 | 8.951 | 0.003 | 0.001 | |
| | 1 | | .3711 | -0.208 | 1.248 | 0.412 | 0.443 | 11.298 | 0.006 | 0.002 | |
| | 2 | | | -0.032 | -0.393 | 0.171 | 0.326 | 9.664 | 0.007 | 0.002 | |
| | 3 | | | -0.056 | -0.657 | 0.131 | 0.213 | 9.157 | 0.004 | 0.001 | |
| | 4 | | | -0.286 | 0.234 | 0.063 | 0.281 | 7.569 | 0.003 | 0.001 | |
| | 5 | | | -0.580 | 0.551 | 0.118 | 0.459 | 8.943 | 0.006 | 0.002 | |
| | 151733 | 1 | 1 | 7962.3892 | 0.162 | 0.260 | 0.391 | 0.350 | 11.287 | 0.008 | 0.003 |
| | | 2 | | | -0.141 | -0.189 | 0.168 | 0.104 | 9.653 | 0.003 | 0.001 |
| | | 3 | | | 0.046 | -0.054 | 0.129 | 0.126 | 9.133 | 0.004 | 0.001 |
| | | 4 | | | -0.109 | -0.076 | 0.063 | 0.066 | 7.563 | 0.004 | 0.001 |
| | | 5 | | | -0.060 | -0.083 | 0.108 | 0.131 | 8.743 | 0.004 | 0.002 |
| 1 | | | .3911 | 0.557 | -0.305 | 0.390 | 0.350 | 11.280 | 0.006 | 0.002 | |
| 2 | | | | 0.110 | 0.218 | 0.168 | 0.104 | 9.657 | 0.002 | 0.001 | |

Polarization data of UU Cancri at NOT: continued

| Star | f | d | JD2440000+ | Pq | Pu | Err1 | Err2 | mag | smag | emag |
|--------|---|---|------------|--------|--------|-------|-------|--------|-------|-------|
| | 3 | | | -0.068 | -0.121 | 0.129 | 0.098 | 9.133 | 0.003 | 0.001 |
| | 4 | | | -0.112 | -0.055 | 0.063 | 0.067 | 7.559 | 0.004 | 0.001 |
| | 5 | | | -0.245 | -0.168 | 0.108 | 0.106 | 8.745 | 0.005 | 0.002 |
| | 1 | | .3936 | -0.840 | -1.516 | 0.389 | 0.152 | 11.278 | 0.008 | 0.003 |
| | 2 | | | 0.192 | -0.159 | 0.168 | 0.106 | 9.657 | 0.003 | 0.001 |
| | 3 | | | 0.065 | -0.038 | 0.129 | 0.169 | 9.132 | 0.004 | 0.001 |
| | 4 | | | -0.001 | 0.023 | 0.063 | 0.086 | 7.559 | 0.002 | 0.001 |
| | 5 | | | 0.047 | -0.217 | 0.107 | 0.109 | 8.736 | 0.003 | 0.001 |
| | 1 | | .3960 | 0.823 | 0.446 | 0.389 | 0.367 | 11.277 | 0.014 | 0.005 |
| | 2 | | | -0.458 | 0.186 | 0.168 | 0.179 | 9.658 | 0.003 | 0.001 |
| | 3 | | | -0.137 | -0.195 | 0.129 | 0.110 | 9.134 | 0.003 | 0.001 |
| | 4 | | | -0.111 | -0.071 | 0.063 | 0.088 | 7.559 | 0.002 | 0.001 |
| | 5 | | | -0.212 | -0.127 | 0.108 | 0.167 | 8.739 | 0.004 | 0.001 |
| 151731 | 1 | 1 | 7961.3799 | 0.197 | 0.391 | 0.159 | 0.139 | 9.506 | 0.007 | 0.003 |
| | 2 | | | -0.355 | 0.187 | 0.142 | 0.202 | 9.296 | 0.002 | 0.001 |
| | 3 | | | -0.304 | 0.133 | 0.162 | 0.134 | 9.606 | 0.004 | 0.001 |
| | 4 | | | -0.673 | -0.058 | 0.113 | 0.133 | 8.826 | 0.002 | 0.001 |
| | 5 | | | -1.123 | -0.118 | 0.246 | 0.251 | 10.536 | 0.005 | 0.002 |
| | 1 | | .3823 | -0.004 | -0.168 | 0.159 | 0.290 | 9.510 | 0.005 | 0.002 |
| | 2 | | | -0.282 | 0.208 | 0.142 | 0.160 | 9.297 | 0.006 | 0.002 |
| | 3 | | | -0.453 | -0.033 | 0.162 | 0.099 | 9.611 | 0.007 | 0.002 |
| | 4 | | | -0.308 | 0.027 | 0.113 | 0.129 | 8.824 | 0.004 | 0.001 |
| | 5 | | | -0.429 | -0.048 | 0.246 | 0.391 | 10.532 | 0.009 | 0.003 |
| | 1 | | .3843 | -0.210 | 0.381 | 0.159 | 0.097 | 9.505 | 0.004 | 0.001 |
| | 2 | | | -0.341 | 0.198 | 0.142 | 0.122 | 9.296 | 0.004 | 0.002 |
| | 3 | | | -0.284 | 0.535 | 0.162 | 0.133 | 9.608 | 0.005 | 0.002 |
| | 4 | | | -0.488 | 0.240 | 0.113 | 0.161 | 8.826 | 0.003 | 0.001 |
| | 5 | | | -0.651 | 0.429 | 0.245 | 0.343 | 10.525 | 0.007 | 0.002 |
| | 1 | | .3867 | 0.189 | 0.028 | 0.159 | 0.097 | 9.510 | 0.007 | 0.003 |
| | 2 | | | 0.161 | 0.473 | 0.142 | 0.159 | 9.297 | 0.005 | 0.002 |
| | 3 | | | -0.014 | 0.174 | 0.162 | 0.087 | 9.610 | 0.007 | 0.002 |
| | 4 | | | 0.052 | 0.295 | 0.113 | 0.194 | 8.827 | 0.003 | 0.001 |
| | 5 | | | -0.123 | 0.517 | 0.245 | 0.245 | 10.521 | 0.008 | 0.003 |
| 151731 | 1 | 1 | 7962.3823 | 0.127 | 0.029 | 0.156 | 0.199 | 9.491 | 0.002 | 0.001 |
| | 2 | | | -0.123 | 0.052 | 0.141 | 0.140 | 9.290 | 0.002 | 0.001 |
| | 3 | | | 0.010 | 0.112 | 0.158 | 0.162 | 9.572 | 0.004 | 0.001 |
| | 4 | | | -0.197 | 0.135 | 0.111 | 0.051 | 8.798 | 0.005 | 0.002 |
| | 5 | | | -0.150 | -0.091 | 0.226 | 0.326 | 10.351 | 0.008 | 0.003 |
| | 1 | | .3848 | -0.148 | 0.275 | 0.156 | 0.164 | 9.488 | 0.002 | 0.001 |
| | 2 | | | 0.074 | -0.005 | 0.141 | 0.142 | 9.288 | 0.004 | 0.001 |
| | 3 | | | 0.083 | 0.156 | 0.158 | 0.184 | 9.574 | 0.002 | 0.001 |
| | 4 | | | 0.032 | -0.059 | 0.111 | 0.094 | 8.799 | 0.005 | 0.002 |
| | 5 | | | -0.471 | 0.511 | 0.228 | 0.226 | 10.365 | 0.007 | 0.003 |
| 161614 | 1 | 1 | 7961.3965 | -0.828 | 0.326 | 0.530 | 0.341 | 11.708 | 0.009 | 0.003 |

Polarization data of UU Cancri at NOT: continued

| Star | f | d | JD2440000+ | Pq | Pu | Err1 | Err2 | mag | smag | emag |
|--------|---|---|------------|--------|--------|-------|-------|--------|-------|-------|
| | 2 | | | -0.119 | 0.058 | 0.199 | 0.245 | 9.979 | 0.004 | 0.001 |
| | 3 | | | -0.204 | 0.311 | 0.159 | 0.172 | 9.570 | 0.002 | 0.001 |
| | 4 | | | -0.224 | 0.100 | 0.081 | 0.111 | 8.109 | 0.004 | 0.001 |
| | 5 | | | -0.277 | 0.019 | 0.148 | 0.268 | 9.428 | 0.006 | 0.002 |
| | 1 | | .3989 | 0.395 | 0.999 | 0.524 | 0.682 | 11.690 | 0.007 | 0.002 |
| | 2 | | | 0.193 | -0.523 | 0.198 | 0.181 | 9.970 | 0.013 | 0.005 |
| | 3 | | | 0.144 | -0.119 | 0.159 | 0.316 | 9.567 | 0.003 | 0.001 |
| | 4 | | | 0.359 | -0.073 | 0.081 | 0.334 | 8.109 | 0.002 | 0.001 |
| | 5 | | | 0.599 | -0.102 | 0.146 | 0.441 | 9.403 | 0.004 | 0.001 |
| | 1 | | .4014 | -0.293 | -0.260 | 0.521 | 0.516 | 11.680 | 0.010 | 0.003 |
| | 2 | | | -0.338 | -0.385 | 0.199 | 0.253 | 9.976 | 0.005 | 0.002 |
| | 3 | | | 0.172 | -0.458 | 0.159 | 0.431 | 9.566 | 0.005 | 0.002 |
| | 4 | | | -0.326 | -1.224 | 0.081 | 0.734 | 8.106 | 0.005 | 0.002 |
| | 5 | | | -1.670 | -0.313 | 0.146 | 1.024 | 9.402 | 0.007 | 0.002 |
| | 1 | | .4033 | 0.590 | -0.700 | 0.525 | 0.602 | 11.692 | 0.011 | 0.004 |
| | 2 | | | -0.181 | -0.250 | 0.198 | 0.185 | 9.973 | 0.010 | 0.003 |
| | 3 | | | -0.202 | -0.230 | 0.159 | 0.141 | 9.566 | 0.003 | 0.001 |
| | 4 | | | 0.165 | -0.118 | 0.081 | 0.145 | 8.107 | 0.004 | 0.002 |
| | 5 | | | -0.327 | 0.162 | 0.146 | 0.275 | 9.400 | 0.004 | 0.001 |
| 161614 | 1 | 1 | 7962.4023 | -0.617 | -0.286 | 0.494 | 0.310 | 11.686 | 0.013 | 0.005 |
| | 2 | | | 0.283 | -0.372 | 0.197 | 0.150 | 9.981 | 0.004 | 0.001 |
| | 3 | | | -0.053 | 0.058 | 0.156 | 0.136 | 9.541 | 0.003 | 0.001 |
| | 4 | | | -0.046 | -0.040 | 0.080 | 0.193 | 8.092 | 0.004 | 0.001 |
| | 5 | | | -0.072 | -0.683 | 0.139 | 0.233 | 9.289 | 0.006 | 0.002 |
| | 1 | | .4063 | 0.523 | -0.080 | 0.500 | 0.537 | 11.693 | 0.016 | 0.006 |
| | 2 | | | -0.059 | -0.313 | 0.196 | 0.210 | 9.972 | 0.014 | 0.005 |
| | 3 | | | 0.024 | 0.315 | 0.155 | 0.155 | 9.538 | 0.003 | 0.001 |
| | 4 | | | 0.011 | 0.153 | 0.080 | 0.184 | 8.090 | 0.004 | 0.001 |
| | 5 | | | 1.006 | 0.609 | 0.139 | 0.230 | 9.297 | 0.006 | 0.002 |

UU Cancri = BD 15*1733

comparison star = BD 16*1614

check/extinction star = BD 15*1731

UU Cancri vaatlused.

UU Cnc vaadeldi Tallinna 50 cm teleskoobiga alates 1972. aastast, Kvistabergi 40 cm teleskoobiga alates 1985. aastast, Rootsi Kuningliku Teaduste Akadeemia Kanaari saarte 60 cm teleskoobiga alates 1991. aastast ja 2.5 m Põhjamaade Optilise Teleskoobiga (NOT) seitsmel ööl alates 1990. aastast. Kokku vaadeldi 234 ööl.

Reference

- [Albo(1964)] Albo, H., 1964, Tartu Publ., 34, 169
- [Barone et al.(1989)] Barone, F., Milano, L., Russo, G., Sarna, M.J., 1989, Ap&SS, 159, 67
- [Beyer(1964)] Beyer, M., 1964, Mitt. Hamburg. Sternw. Bergedorf, No.122, 87
- [(1993)] Bradstreet, D.H., 1993, Binary Maker 2.0, Contact Software
- [Brelstaff(1985)] Brelstaff, T., 1985, BAAVS Circ., No. 60, 19
- [Eaton(1990)] Eaton, J.A., 1990, MNRAS, 247, 62
- [Eaton et al.(1991)] Eaton, J.A., Hall, D.S., Honeycutt, R.K., 1991, ApJ, 376, 289
- [(1973)] Eggen, O. J. 1973, PASP, 85, 42
- [Hipparcos()] *Hipparcos Catalogue Epoch Photometry Data*, HIP 39341
- [(1963)] Huth, H., 1963, Mitt. Verand. Sterne, No. 744-745
- [Isles(1986)] Isles, J., 1986, BAAVS Circ., No. 63, 19
- [Kalv(1979)] Kalv, P., 1979, Tartu AO Teated, No. 58, 64
- [Kim et al.(1988)] Kim, H.I., Chun, Y.W., Lee, Y.S., 1988, Vistas in Astron., 31, 343
- [Lause(1938)] Lause, F., 1938, Astron. Nachrichten., 266, 237
- [Lee(1988)] Lee, Y-S., 1988, Vistas Astron., 31, 323
- [(1956)] Popper, D. M. 1956, PASP, 68, 131
- [(1977)] Popper, D. M. 1977, PASP, 89, 315
- [Schachowskoi(1956)] Schachowskoi, N.M., 1956, Bull. AO Stalinabad, No.17, 35
- [Taylor(1984)] Taylor, M.D., 1984, BAAVS Circ., No. 58, 11
- [Taylor(1985)] Taylor, M.D., 1985, BAAVS Circ., No. 60, 19
- [(1987)] Winiarski, M., Zola, S., 1987, Acta Astronomica, 37, 375
- [Zola et al.(1994)] Zola, S., Hall, D.S., Henry, G.W., 1994, A&A, 285, 531
- [Zola(1995)] Zola, S., 1995, A&A, 294, 525
- [Zola(1998)] Zola, S., 1998, Acta Astronomica, 48, 373.