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# BV 690, a new Bright Type II Cepheid

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**Abstract.** *B* and *V* observations of the suspected variable BV 690 = NSV 04298 are reported. The star shows light variations with a period of $1^d.2400$ and with amplitudes of $0^m.27$, $0^m.36$ and $0^m.11$ in *V*, *B*, and *B* – *V* respectively. The light curves show steeper rise than decline, and there is evidence for the presence of a bump in the descending branch around the phase of 0.35. From considerations of the period, spectral type, presence of the bump and high tangential velocity we conclude that BV 690 belongs to the BL Herculis class of Type II Cepheids.

*Key words*: light curves—ephemeris—type II—Cepheid variable—individual

The light variability of BV 690 (NSV 04298, HD 76296, BD –22 2440, CD –23 7878, SAO 176679) was reported by Strohmeier, Knigge & Ott (1965) who found the star to show light variations of amplitude $0^m.3$ from photographic observations. As the nature of its light variation was not established, this star was included in our observing programme for occasional observations in between our regular observing programme of eclipsing binary stars. These observations were made on 35 nights from 1974 to 1976 with a photoelectric photometer attached to the 1.2 m reflecting telescope of the Japal-Rangapur Observatory. The photometer used had an unrefrigerated EMI 6256B photomultiplier, whose output was fed to a GR 1230A dc amplifier and recorded on a Honeywell-Brown chart recorder. The comparison and three check stars used with BV 690 are listed in Table 1. Observations of all the stars in *B* and *V* filters were reduced to fluxes outside the atmosphere using nightly extinction coefficients obtained from the observations of the comparison star. The differential magnitudes of the variable and the check stars with respect to the comparison star were then transformed to Johnson's standard *UBV* system using the transformation relations obtained from the observations of a number of *UBV* standards on several nights. The average values of the *V* magnitude and (*B* – *V*) colour of the comparison and check stars in the *UBV* system determined by us are given in Table 1, along with the number of observations on which these determinations are based.

The individual differential magnitudes of the check stars with respect to the comparison star have been published by Sanwal *et al.* (1990). Our observations do not indicate any significant variation in any of these stars. The average values of the magnitude difference between the check and the comparison stars are given in Table 2 along with the number of observations of the check stars. From our observations of the check stars we estimate the standard error of a single $\Delta m$ observation to be less than

**Table 1.** $V$ magnitudes and $(B - V)$ colours of the comparison and the check stars observed with BV 690.

| Star | HD | BD/CD | $V$ | $(B-V)$ | n |
|---|---|---|---|---|---|
| Comparison | 76104 | −22 2431 | 8.07 | 0.04 | 15 |
| Check | 76136 | −22 2434 | 8.48 | 0.21 | 5 |
| Check | 76043 | −21 2623 | 8.09 | 0.44 | 1 |
| Check | 76512 | −23 7902 | 6.44 | 0.16 | 1 |

**Table 2.** Magnitude differences with respect to the comparison star.

| Star | $\Delta V$ | n | $\Delta B$ | n |
|---|---|---|---|---|
| Variable (max) | −0.897 | — | −0.432 | — |
| Variable (min) | −0.626 | — | −0.071 | — |
| HD 76136 | 0.407 | 101 | 0.584 | 95 |
| HD 76043 | 0.050 | 40 | 0.442 | 38 |
| HD 76512 | −1.636 | 12 | 1.521 | 11 |

$0^m.01$ both in $B$ and $V$. Table 2 also gives the values of $\Delta V$ and $\Delta B$ for the variable star at its maximum and minimum brightness.

The magnitude differences $\Delta V$ and $\Delta B$ between BV 690 and the comparison star are listed in Table 3 along with the heliocentric Julian date and the phase of each observation. The observations of individual nights show slow but systematic changes in brightness. Observations of different nights were combined to form normal light curves for a large number of trial periods, and the smoothest normal light curve was obtained with a period of $1^d.2400$. We find that the following light elements represent observations in both the filters satisfactorily:

$$\text{Time of maximum (hel. JD)} = 2442359.490 + 1^d.2400\ E.$$

These light elements have been used to calculate the phases of individual $V$ and $B$ observations listed in Table 3. This table also gives the derived values of $\Delta(B - V)$ and its phase. The light variations of the star in $B$ and $V$ filters as well as in $(B - V)$ colour are shown in Figs 1–3 respectively. The small scatter in the light curves and the absence of any systematic difference between 1974–75 and 1975–76 observations indicate that the star has a stable period. The amplitude of light variations is $0^m.27$ in $V$ and $0^m.36$ in B. The duration of the ascending branch is $0^p.4$ while that of the descending one is $0^p.6$. The light variation is fairly smooth but there is an indication of a small bump in the descending branch of the light curve near the phase 0.35. Presence of a bump is also supported by the nature of $(B - V)$ variations near this phase.

The light maximum in $B$ occurs earlier than the light maximum in $V$ by about $0^p.01$. The epoch of maximum light used by us for the calculation of phases corresponds to an average value of the times of maximum for the two colours.

Using the $V$ and $(B - V)$ values for the comparison star given in Table 1, we find that the $V$ magnitude of BV 690 varies from $7^m.17$ at maximum occurring at phase 0.00 to $7^m.44$ at minimum occurring at phase 0.60. Similarly, the $B$ magnitude varies from

**Table 3.** Magnitude differences (BV 690 –BD –22 2431).

| Hel. JD 2440000+ | Phase | $\Delta V$ | Hel. JD 2440000+ | Phase | $\Delta B$ | Phase | $\Delta(B-V)$ |
|---|---|---|---|---|---|---|---|
| 2359.4500 | 0.9677 | −0.884 | 2359.4495 | 0.9673 | −0.423 | 0.9675 | 0.461 |
| .4665 | .9810 | −.891 | .4652 | .9800 | −.431 | .9805 | .460 |
| 2360.4002 | 0.7340 | −0.686 | 2360.3996 | 0.7335 | −0.171 | 0.7338 | 0.515 |
| .4025 | .7359 | −.686 | .4020 | .7355 | −.176 | .7357 | .509 |
| .4183 | .7486 | −.713 | .4178 | .7482 | −.181 | .7484 | .532 |
| .4193 | .7494 | −.711 | .4187 | .7490 | −.194 | .7492 | .517 |
| .4346 | .7618 | −.693 | .4359 | .7628 | −.191 | .7623 | .501 |
| .4366 | .7634 | −.709 | .4371 | .7638 | −.193 | .7636 | .516 |
| 2366.4127 | 0.5828 | −0.631 | 2366.4121 | 0.5823 | −0.074 | 0.5826 | 0.558 |
| .4141 | .5840 | −.629 | .4136 | .5835 | −.074 | .5838 | .555 |
| .4212 | .5897 | −.628 | .4221 | .5904 | −.074 | .5900 | .554 |
| .4235 | .5915 | −.624 | .4240 | .5919 | −.066 | .5917 | .558 |
| 2367.4032 | 0.3816 | −0.739 | 2367.4027 | 0.3812 | −0.203 | 0.3814 | 0.536 |
| .4050 | .3831 | −.734 | .4044 | .3826 | −.206 | .3828 | .528 |
| 2387.3096 | 0.4352 | −0.764 | 2387.3103 | 0.4357 | −0.190 | 0.4354 | 0.574 |
| .3193 | .4430 | −.716 | .3189 | .4427 | −.170 | .4428 | .546 |
| .3272 | .4494 | −.731 | .3266 | .4489 | −.160 | .4491 | .571 |
| 2393.3735 | 0.3254 | −0.786 | 2393.3744 | 0.3261 | −0.231 | 0.3258 | 0.555 |
| .3908 | .3394 | −.747 | .4055 | .3512 | −.191 | .3453 | .556 |
| .4207 | .3635 | −.755 | .4196 | .3626 | −.225 | .3630 | .530 |
| .4285 | .3698 | −.748 | .4269 | .3685 | −.228 | .3691 | .520 |
| .4365 | .3762 | −.736 | .4374 | .3769 | −.218 | .3766 | .518 |
| .4423 | .3809 | −.737 | .4438 | .3821 | −.187 | .3815 | .550 |
| 2394.3627 | 0.1231 | −.858 | 2394.3610 | 0.1218 | −0.382 | 0.1225 | 0.477 |
| .3632 | .1235 | −.857 | .3648 | .1248 | −.370 | .1242 | .487 |
| .3833 | .1398 | −.842 | .3825 | .1391 | −.376 | .1394 | .466 |
| .3843 | .1406 | −.845 | .3852 | .1413 | −.374 | .1409 | .471 |
| .3957 | .1498 | −.849 | .3975 | .1512 | −.356 | .1505 | .493 |
| .3968 | .1506 | −.844 | .3984 | .1519 | −.357 | .1513 | .487 |
| .4071 | .1590 | −.844 | .4053 | .1575 | −.343 | .1582 | .502 |
| .4080 | .1597 | −.838 | .4062 | .1582 | −.351 | .1590 | .487 |
| .4230 | .1718 | −.838 | .4216 | .1706 | −.346 | .1712 | .492 |
| .4242 | .1727 | −.839 | .4251 | .1735 | −.345 | .1731 | .494 |
| .4381 | .1840 | −.824 | .4372 | .1832 | −.334 | .1836 | .490 |
| .4402 | .1856 | −.836 | .4393 | .1849 | −.333 | .1853 | .503 |
| .4523 | .1954 | −.830 | .4539 | .1967 | −.340 | .1960 | .490 |
| .4562 | .1985 | −.832 | .4550 | .1976 | −.336 | .1981 | .496 |
| 2395.3546 | 0.9231 | −0.851 | 2395.3526 | 0.9215 | −0.425 | 0.9223 | 0.426 |
| .3599 | .9273 | −.876 | .3537 | .9223 | −.426 | .9248 | .451 |
| .3609 | .9281 | −.856 | .3616 | .9287 | −.392 | .9284 | .464 |
| .3719 | .9370 | −.895 | .3626 | .9295 | −.417 | .9333 | .478 |
| .3730 | .9379 | −.897 | .3736 | .9384 | −.411 | .9381 | .486 |
| .3743 | .9390 | −.893 | .3749 | .9394 | −.408 | .9392 | .486 |
| .3787 | .9425 | −.871 | .3791 | .9428 | −.411 | .9427 | .460 |
| .3802 | .9437 | −.868 | .3797 | .9433 | −.406 | .9435 | .462 |
| .3878 | .9498 | −.875 | .3871 | .9493 | −.416 | .9496 | .459 |
| .3894 | .9511 | −.874 | .3890 | .9508 | −.425 | .9510 | .449 |
| .3982 | .9582 | −.887 | .3987 | .9586 | −.427 | .9584 | .460 |
| .3998 | .9595 | −.883 | .4004 | .9600 | −.437 | .9598 | .445 |

**Table 3.** Continued.

| Hel. JD 2440000+ | Phase | ΔV | Hel. JD 2440000+ | Phase | ΔB | Phase | Δ(B−V) |
|---|---|---|---|---|---|---|---|
| 2395.4103 | 0.9680 | −0.896 | 2395.4098 | 0.9676 | −0.430 | 0.9678 | 0.466 |
| .4142 | .9711 | −.903 | .4130 | .9702 | −.432 | .9706 | .471 |
| .4219 | .9773 | −.903 | .4224 | .9777 | −.456 | .9775 | .447 |
| .4239 | .9790 | −.921 | .4246 | .9795 | −.458 | .9792 | .464 |
| .4382 | .9905 | −.915 | .4392 | .9913 | −.450 | .9909 | .466 |
| .4421 | .9936 | −.908 | .4433 | .9946 | −.445 | .9941 | .463 |
| 2400.3534 | 0.9544 | −0.878 | 2400.3528 | 0.9539 | −0.424 | 0.9541 | 0.454 |
| .3550 | .9556 | −.884 | .3544 | .9552 | −.422 | .9554 | .462 |
| .3664 | .9648 | −.902 | .3658 | .9644 | −.439 | .9646 | .463 |
| .3688 | .9668 | −.898 | .3682 | .9663 | −.427 | .9665 | .471 |
| .3780 | .9742 | −.899 | .3784 | .9745 | −.429 | .9744 | .470 |
| .3796 | .9755 | −.903 | .3803 | .9760 | −.431 | .9758 | .472 |
| .3880 | .9823 | −.904 | .3875 | .9819 | −.439 | .9821 | .465 |
| .3896 | .9835 | −.902 | .3890 | .9831 | −.429 | .9833 | .473 |
| .4250 | .0121 | −.898 | .4246 | .0118 | −.442 | .0119 | .456 |
| .4265 | .0133 | −.889 | .4262 | .0131 | −.434 | .0132 | .455 |
| .4347 | .0199 | −.885 | .4351 | .0202 | −.426 | .0201 | .459 |
| .4361 | .0210 | −.884 | .4367 | .0215 | −.431 | .0213 | .453 |
| 2401.3146 | 0.7295 | −0.680 | 2401.3153 | 0.7301 | −0.164 | 0.7298 | 0.516 |
| .3166 | .7311 | −.697 | .3172 | .7316 | −.180 | .7314 | .517 |
| .3274 | .7398 | −.679 | .3267 | .7393 | −.178 | .7396 | .501 |
| .3294 | .7415 | −.685 | .3287 | .7409 | −.174 | .7412 | .510 |
| .3420 | .7516 | −.689 | .3425 | .7520 | −.177 | .7518 | .512 |
| .3439 | .7531 | −.694 | .3446 | .7537 | −.182 | .7534 | .512 |
| .3598 | .7660 | −.720 | .3591 | .7654 | −.207 | .7657 | .513 |
| .3618 | .7676 | −.714 | .3626 | .7682 | −.202 | .7679 | .512 |
| .3793 | .7817 | −.728 | .3803 | .7825 | −.212 | .7821 | .516 |
| .3821 | .7840 | −.721 | .3828 | .7845 | −.214 | .7842 | .506 |
| .3960 | .7952 | −.719 | .3952 | .7945 | −.209 | .7948 | .509 |
| .3994 | .7979 | −.720 | .3975 | .7964 | −.215 | .7971 | .504 |
| .4087 | .8054 | −.743 | .4094 | .8060 | −.236 | .8057 | .506 |
| .4110 | .8073 | −.747 | .4118 | .8079 | −.246 | .8076 | .501 |
| .4228 | .8168 | −.748 | .4232 | .8171 | −.259 | .8169 | .489 |
| .4245 | .8181 | −.756 | .4253 | .8188 | −.258 | .8185 | .499 |
| 2416.3390 | 0.8460 | −0.773 | 2416.3381 | 0.8452 | −0.300 | 0.8456 | 0.473 |
| .3416 | .8481 | −.774 | .3424 | .8487 | −.314 | .8484 | .460 |
| .3558 | .8595 | −.769 | .3563 | .8599 | −.277 | .8597 | .492 |
| .3580 | .8613 | −.764 | .3587 | .8619 | −.283 | .8616 | .481 |
| .3776 | .8771 | −.805 | .3770 | .8766 | −.336 | .8769 | .469 |
| .3798 | .8789 | −.797 | .3793 | .8785 | −.347 | .8787 | .450 |
| .4057 | .8998 | −.843 | .4050 | .8992 | −.377 | .8995 | .466 |
| .4080 | .9016 | −.847 | .4072 | .9010 | −.375 | .9013 | .472 |
| .4217 | .9127 | −.841 | .4222 | .9131 | −.388 | .9129 | .453 |
| .4236 | .9142 | −.845 | .4242 | .9147 | −.389 | .9144 | .456 |
| .4482 | .9340 | −.853 | .4468 | .9329 | −.409 | .9335 | .444 |
| .4510 | .9363 | −.867 | .4494 | .9350 | −.412 | .9356 | .455 |
| .4566 | .9408 | −.868 | .4573 | .9414 | −.412 | .9411 | .456 |
| .4587 | .9425 | −.881 | .4579 | .9419 | −.415 | .9422 | .466 |
| 2417.2568 | 0.5861 | −0.616 | 2417.2561 | 0.5856 | −0.087 | 0.5858 | 0.529 |
| .2586 | .5876 | −.633 | .2589 | .5878 | −.088 | .5877 | .545 |

**Table 3.** Continued.

| Hel. JD 2440000+ | Phase | ΔV | Hel. JD 2440000+ | Phase | ΔB | Phase | Δ(B−V) |
|---|---|---|---|---|---|---|---|
| 2417.2732 | 0.5994 | −0.653 | 2417.2754 | 0.6011 | −0.098 | 0.6002 | 0.555 |
| .2893 | .6123 | −.636 | .2888 | .6119 | −.068 | .6121 | .568 |
| .2919 | .6144 | −.625 | .2904 | .6132 | −.076 | .6138 | .549 |
| .3028 | .6232 | −.631 | .3036 | .6239 | −.069 | .6235 | .563 |
| .3054 | .6253 | −.620 | .3058 | .6256 | −.065 | .6255 | .555 |
| .3203 | .6373 | −.624 | .3197 | .6369 | −.075 | .6371 | .549 |
| .3223 | .6390 | −.627 | .3216 | .6384 | −.072 | .6387 | .555 |
| .3317 | .6465 | −.636 | .3323 | .6470 | −.084 | .6468 | .552 |
| .3338 | .6482 | −.630 | .3343 | .6486 | −.084 | .6484 | .546 |
| .3456 | .6577 | −.631 | .3445 | .6569 | −.089 | .6573 | .543 |
| .3484 | .6600 | −.638 | .3473 | .6591 | −.090 | .6596 | .548 |
| .3580 | .6677 | −.637 | .3587 | .6683 | −.081 | .6680 | .557 |
| .3605 | .6698 | −.644 | .3612 | .6703 | −.089 | .6700 | .555 |
| .3756 | .6819 | −.649 | .3749 | .6814 | −.121 | .6817 | .528 |
| .3777 | .6836 | −.653 | .3768 | .6829 | −.117 | .6833 | .536 |
| .3891 | .6928 | −.649 | .3904 | .6939 | −.111 | .6933 | .538 |
| .3924 | .6955 | −.649 | .3930 | .6960 | −.113 | .6957 | .536 |
| .4093 | .7091 | −.672 | .4087 | .7086 | −.139 | .7089 | .533 |
| .4111 | .7106 | −.675 | .4105 | .7101 | −.135 | .7103 | .540 |
| .4331 | .7283 | −.694 | .4339 | .7290 | −.169 | .7286 | .525 |
| .4357 | .7304 | −.701 | .4365 | .7310 | −.181 | .7307 | .520 |
| .4549 | .7459 | −.673 | .4541 | .7452 | −.167 | .7456 | .505 |
| .4570 | .7476 | −.682 | .4562 | .7469 | −.169 | .7473 | .512 |
| .4677 | .7562 | −.681 | .4697 | .7578 | −.197 | .7570 | .484 |
| .4711 | .7590 | −.724 | .4718 | .7595 | −.206 | .7592 | .517 |
| 2428.4319 | 0.5983 | −0.615 | 2428.4310 | 0.5976 | −0.032 | 0.5979 | 0.583 |
| .4433 | .6075 | −.627 | .4443 | .6083 | −.074 | .6079 | .553 |
| .4462 | .6098 | −.623 | .4469 | .6104 | −.066 | .6101 | .557 |
| .4614 | .6221 | −.614 | .4593 | .6204 | −.068 | .6213 | .546 |
| 2429.2875 | 0.2883 | −0.797 | 2429.2869 | 0.2878 | −0.269 | 0.2881 | 0.528 |
| .2894 | .2898 | −.793 | .2888 | .2894 | −.267 | .2896 | .526 |
| .2989 | .2975 | −.784 | .2995 | .2980 | −.266 | .2977 | .518 |
| .3008 | .2990 | −.792 | .3019 | .2999 | −.262 | .2995 | .530 |
| .3148 | .3103 | −.775 | .3140 | .3097 | −.251 | .3100 | .523 |
| .3166 | .3118 | −.771 | .3158 | .3111 | −.252 | .3115 | .519 |
| 2451.2872 | 0.0300 | −0.888 | 2451.2884 | 0.0310 | −0.410 | 0.0305 | 0.478 |
| .2908 | .0329 | −.882 | .2890 | .0315 | −.410 | .0322 | .472 |
| 2457.2996 | 0.8787 | −0.824 | 2457.2992 | 0.8784 | −0.340 | 0.8785 | 0.484 |
| .3003 | .8793 | −.822 | .3017 | .8804 | −.344 | .8798 | .479 |
| .3160 | .8919 | −.849 | .3138 | .8902 | −.352 | .8910 | .497 |
| .3169 | .8927 | −.853 | .3146 | .8908 | −.358 | .8917 | .495 |
| .3349 | .9072 | −.844 | .3326 | .9053 | −.374 | .9063 | .470 |
| .3361 | .9081 | −.852 | .3383 | .9099 | −.371 | .9090 | .482 |
| .3565 | .9246 | −.864 | .3593 | .9269 | −.403 | .9257 | .461 |
| .3571 | .9251 | −.871 | .3599 | .9273 | −.396 | .9262 | .475 |
| 2458.1991 | 0.6041 | −0.626 | 2458.1964 | 0.6019 | −0.054 | 0.6030 | 0.572 |
| .1996 | .6045 | −.630 | .1970 | .6024 | −.062 | .6035 | .568 |
| .2147 | .6167 | −.618 | .2128 | .6152 | −.063 | .6159 | .555 |
| .2153 | .6172 | −.627 | .2135 | .6157 | −.064 | .6165 | .563 |
| .2292 | .6284 | −.627 | .2271 | .6267 | −.074 | .6275 | .553 |

**Table 3.** Continued.

| Hel. JD 2440000 + | Phase | $\Delta V$ | Hel. JD 2440000 + | Phase | $\Delta B$ | Phase | $\Delta(B-V)$ |
|---|---|---|---|---|---|---|---|
| 2458.2300 | 0.6290 | −0.613 | 2458.2278 | 0.6273 | −0.082 | 0.6281 | 0.530 |
| .2379 | .6354 | −.632 | .2364 | .6342 | −.078 | .6348 | .554 |
| .2383 | .6357 | −.626 | .2369 | .6346 | −.074 | .6352 | .553 |
| 2459.1187 | 0.3457 | −0.737 | 2459.1201 | 0.3469 | −0.247 | 0.3463 | 0.490 |
| .1226 | .3489 | −.764 | .1215 | .3480 | −.224 | .3484 | .540 |
| .1380 | .3613 | −.745 | .1359 | .3596 | −.230 | .3604 | .515 |
| .1385 | .3617 | −.750 | .1367 | .3602 | −.229 | .3610 | .521 |
| .1519 | .3725 | −.763 | .1504 | .3713 | −.227 | .3719 | .536 |
| .1524 | .3729 | −.751 | .1508 | .3716 | −.223 | .3723 | .528 |
| .1642 | .3824 | −.739 | .1624 | .3810 | −.196 | .3817 | .543 |
| .1646 | .3827 | −.741 | .1629 | .3814 | −.192 | .3821 | .549 |
| .1708 | .3877 | −.725 | .1692 | .3865 | −.191 | .3871 | .534 |
| .1712 | .3881 | −.740 | .1697 | .3869 | −.193 | .3875 | .547 |
| .1835 | .3980 | −.715 | .1814 | .3963 | −.192 | .3971 | .523 |
| .1841 | .3985 | −.714 | .1822 | .3969 | −.183 | .3977 | .531 |
| .1953 | .4075 | −.703 | .1936 | .4061 | −.191 | .4068 | .512 |
| .1962 | .4082 | −.731 | .1942 | .4066 | −.182 | .4074 | .550 |
| .1969 | .4088 | −.733 | .1983 | .4099 | −.187 | .4094 | .546 |
| .2176 | .4255 | −.709 | .2185 | .4262 | −.155 | .4258 | .555 |
| .2208 | .4281 | −.731 | .2194 | .4269 | −.168 | .4275 | .563 |
| 2463.1861 | 0.6259 | −0.637 | 2463.1875 | 0.6270 | −0.077 | 0.6265 | 0.561 |
| .1897 | .6288 | −.632 | .1884 | .6277 | −.074 | .6283 | .559 |
| .2444 | .6729 | −.649 | .2474 | .6753 | −.102 | .6741 | .547 |
| .2458 | .6740 | −.645 | .2486 | .6763 | −.099 | .6752 | .546 |
| .2541 | .6807 | −.661 | .2553 | .6817 | −.099 | .6812 | .562 |
| .2575 | .6835 | −.663 | .2565 | .6827 | −.093 | .6831 | .570 |
| .2720 | .6952 | −.658 | .2706 | .6940 | −.122 | .6946 | .536 |
| .2736 | .6965 | −.653 | .2745 | .6972 | −.119 | .6968 | .534 |
| .2868 | .7071 | −.670 | .2856 | .7061 | −.123 | .7066 | .547 |
| .2880 | .7081 | −.673 | .2897 | .7094 | −.134 | .7088 | .539 |
| .3048 | .7216 | −.673 | .3061 | .7227 | −.156 | .7221 | .517 |
| .3080 | .7242 | −.685 | .3071 | .7235 | −.155 | .7238 | .530 |
| .3245 | .7375 | −.688 | .3230 | .7363 | −.162 | .7369 | .525 |
| .3254 | .7382 | −.686 | .3264 | .7390 | −.173 | .7386 | .513 |
| .3368 | .7474 | −.706 | .3381 | .7485 | −.191 | .7479 | .515 |
| .3407 | .7506 | −.709 | .3391 | .7493 | −.191 | .7499 | .518 |
| .3482 | .7566 | −.720 | .3470 | .7556 | −.207 | .7561 | .513 |
| .3493 | .7575 | −.714 | .3503 | .7583 | −.205 | .7579 | .508 |
| .3585 | .7649 | −.717 | .3596 | .7658 | −.209 | .7654 | .507 |
| .3618 | .7676 | −.723 | .3608 | .7668 | −.210 | .7672 | .513 |
| .3814 | .7834 | −.719 | .3802 | .7824 | −.224 | .7829 | .496 |
| .3826 | .7844 | −.732 | .3837 | .7852 | −.237 | .7848 | .496 |
| .3923 | .7922 | −.749 | .3907 | .7909 | −.253 | .7915 | .496 |
| .4060 | .8032 | −.754 | .4048 | .8023 | −.275 | .8027 | .479 |
| .4072 | .8042 | −.755 | .4081 | .8049 | −.282 | .8046 | .473 |
| 2464.2498 | 0.4837 | −0.680 | 2464.2488 | 0.4829 | −0.106 | 0.4833 | 0.574 |
| .2506 | .4844 | −.681 | .2520 | .4855 | −.121 | .4849 | .561 |
| .2625 | .4940 | −.674 | .2636 | .4948 | −.109 | .4944 | .565 |
| .2654 | .4963 | −.671 | .2642 | .4953 | −.112 | .4958 | .560 |
| .2782 | .5066 | −.656 | .2770 | .5056 | −.107 | .5061 | .549 |
| .2788 | .5071 | −.658 | .2801 | .5081 | −.101 | .5076 | .558 |

**Table 3.** Continued.

| Hel. JD 2440000+ | Phase | $\Delta V$ | Hel. JD 2440000+ | Phase | $\Delta B$ | Phase | $\Delta(B-V)$ |
|---|---|---|---|---|---|---|---|
| 2464.2910 | 0.5169 | −0.684 | 2464.2921 | 0.5178 | −0.111 | 0.5174 | 0.573 |
| .3356 | .5529 | −.644 | .3342 | .5518 | −.078 | .5523 | .566 |
| .3363 | .5535 | −.641 | .3375 | .5544 | −.081 | .5540 | .561 |
| .3425 | .5585 | −.648 | .3435 | .5593 | −.094 | .5589 | .554 |
| .3456 | .5610 | −.643 | .3447 | .5602 | −.087 | .5606 | .557 |
| 2511.1304 | 0.2906 | −0.783 | 2511.1329 | 0.2927 | −0.246 | 0.2917 | 0.537 |
| .1312 | .2913 | −.786 | .1344 | .2939 | −.244 | .2926 | .542 |
| .1458 | .3031 | −.799 | .1453 | .3027 | −.269 | .3029 | .530 |
| .1471 | .3041 | −.791 | .1465 | .3036 | −.274 | .3039 | .517 |
| .1607 | .3151 | −.766 | .1614 | .3156 | −.234 | .3154 | .532 |
| .1619 | .3160 | −.764 | .1627 | .3167 | −.233 | .3164 | .531 |
| .1739 | .3257 | −.778 | .1746 | .3263 | −.243 | .3260 | .535 |
| .1753 | .3269 | −.779 | .1761 | .3275 | −.247 | .3272 | .532 |
| .1918 | .3402 | −.785 | .1911 | .3396 | −.245 | .3399 | .540 |
| .1932 | .3413 | −.783 | .1926 | .3408 | −.244 | .3410 | .539 |
| 2512.1086 | 0.0795 | −0.892 | 2512.1093 | 0.0801 | −0.411 | 0.0798 | 0.482 |
| .1105 | .0810 | −.892 | .1111 | .0815 | −.411 | .0813 | .482 |
| .1566 | .1182 | −.876 | .1573 | .1188 | −.386 | .1185 | .490 |
| .1586 | .1198 | −.883 | .1593 | .1204 | −.384 | .1201 | .500 |
| .1775 | .1351 | −.881 | .1769 | .1346 | −.399 | .1348 | .483 |
| .1790 | .1363 | −.878 | .1782 | .1356 | −.390 | .1360 | .488 |
| 2745.3692 | 0.1929 | −0.864 | 2745.3683 | 0.1922 | −0.362 | 0.1925 | 0.501 |
| .3722 | .1953 | −.848 | .3710 | .1944 | −.337 | .1948 | .511 |
| .3865 | .2069 | −.800 | .3895 | .2093 | −.285 | .2081 | .514 |
| 2765.3154 | 0.2785 | −0.794 | 2765.3135 | 0.2770 | −0.271 | 0.2778 | 0.523 |
| .3160 | .2790 | −.796 | .3144 | .2777 | −.272 | .2784 | .524 |
| .3306 | .2908 | −.802 | .3285 | .2891 | −.261 | .2900 | .541 |
| .3311 | .2912 | −.806 | .3294 | .2898 | −.261 | .2905 | .546 |
| .3448 | .3023 | −.786 | .3428 | .3006 | −.253 | .3015 | .533 |
| .3458 | .3031 | −.787 | .3431 | .3009 | −.254 | .3020 | .533 |
| .3681 | .3210 | −.757 | .3703 | .3228 | −.214 | .3219 | .543 |
| .3690 | .3218 | −.750 | .3711 | .3235 | −.222 | .3226 | .528 |
| 2777.3154 | 0.9560 | −0.881 | 2777.3160 | 0.9565 | −0.413 | 0.9562 | 0.468 |
| .3174 | .9576 | −.872 | .3183 | .9583 | −.420 | .9579 | .452 |
| .3319 | .9693 | −.904 | .3327 | .9699 | −.427 | .9696 | .477 |
| .3335 | .9706 | −.894 | .3340 | .9710 | −.417 | .9708 | .477 |
| .3494 | .9834 | −.897 | .3484 | .9826 | −.424 | .9830 | .473 |
| .3519 | .9854 | −.888 | .3512 | .9848 | −.428 | .9851 | .460 |
| .3655 | .9964 | −.904 | .3647 | .9957 | −.423 | .9960 | .482 |
| .3672 | .9977 | −.910 | .3665 | .9972 | −.425 | .9975 | .486 |
| .3806 | .0085 | −.884 | .3793 | .0075 | −.421 | .0080 | .463 |
| .3815 | .0093 | −.889 | .3831 | .0106 | −.423 | .0099 | .466 |
| .3956 | .0206 | −.892 | .3976 | .0223 | −.436 | .0215 | .456 |
| .3964 | .0213 | −.892 | .3985 | .0230 | −.434 | .0221 | .458 |
| .4117 | .0336 | −.889 | .4139 | .0354 | −.425 | .0345 | .464 |
| .4125 | .0343 | −.896 | .4148 | .0361 | −.426 | .0352 | .470 |
| .4318 | .0498 | −.898 | .4338 | .0515 | −.426 | .0506 | .472 |
| .4325 | .0504 | −.897 | .4346 | .0521 | −.420 | .0512 | .477 |
| .4496 | .0642 | −.881 | .4519 | .0660 | −.408 | .0651 | .473 |
| .4504 | .0648 | −.877 | .4526 | .0666 | −.403 | .0657 | .474 |

**Table 3.** Continued.

| Hel. JD 2440000+ | Phase | ΔV | Hel. JD 2440000+ | Phase | ΔB | Phase | Δ(B−V) |
|---|---|---|---|---|---|---|---|
| 2777.4666 | 0.0779 | −0.908 | 2777.4688 | 0.0797 | −0.393 | 0.0788 | 0.515 |
| .4673 | .0785 | −.897 | .4696 | .0803 | −.385 | .0794 | .511 |
| .4752 | .0848 | −.889 | .4775 | .0867 | −.404 | .0858 | .485 |
| .4761 | .0856 | −.892 | .4781 | .0872 | −.401 | .0864 | .491 |
| .4893 | .0962 | −.883 | .4912 | .0977 | −.402 | .0970 | .482 |
| .4901 | .0969 | −.883 | .4922 | .0985 | −.391 | .0977 | .492 |
| 2785.3113 | 0.4043 | −0.714 | 2785.3122 | 0.4050 | −0.183 | 0.4046 | 0.531 |
| .3138 | .4063 | −.728 | .3144 | .4068 | −.190 | .4065 | .538 |
| .3286 | .4182 | −.730 | .3277 | .4175 | −.161 | .4179 | .569 |
| .3311 | .4202 | −.726 | .3304 | .4197 | −.173 | .4200 | .553 |
| .3397 | .4272 | −.735 | .3404 | .4277 | −.168 | .4275 | .567 |
| .3421 | .4291 | −.732 | .3440 | .4306 | −.159 | .4299 | .573 |
| .3628 | .4458 | −.715 | .3621 | .4452 | −.166 | .4455 | .549 |
| 2794.3017 | 0.6546 | −0.624 | 2794.3004 | 0.6535 | −0.076 | 0.6541 | 0.548 |
| .3048 | .6571 | −.635 | .3039 | .6564 | −.072 | .6567 | .564 |
| .3185 | .6681 | −.650 | .3167 | .6667 | −.075 | .6674 | .575 |
| .3210 | .6702 | −.662 | .3193 | .6688 | −.103 | .6695 | .559 |
| .3289 | .6765 | −.654 | .3268 | .6748 | −.111 | .6757 | .543 |
| .3325 | .6794 | −.625 | .3296 | .6771 | −.116 | .6783 | .509 |
| .3442 | .6889 | −.676 | .3425 | .6875 | −.108 | .6882 | .569 |
| .3468 | .6910 | −.666 | .3449 | .6894 | −.105 | .6902 | .561 |
| .3606 | .7021 | −.653 | .3578 | .6998 | −.114 | .7010 | .539 |
| .3614 | .7027 | −.661 | .3584 | .7003 | −.110 | .7015 | .551 |
| .3639 | .7048 | −.664 | .3622 | .7034 | −.125 | .7041 | .539 |
| 2801.2742 | 0.2776 | −0.799 | 2801.2755 | 0.2786 | −0.259 | 0.2781 | 0.540 |
| .2774 | .2802 | −.790 | .2760 | .2790 | −.259 | .2796 | .531 |
| .3590 | .3460 | −.770 | .3599 | .3467 | −.207 | .3463 | .563 |
| .3617 | .3481 | −.770 | .3606 | .3473 | −.220 | .3477 | .550 |
| 2802.2639 | 0.0757 | −0.885 | 2802.2622 | 0.0744 | −0.414 | 0.0750 | 0.471 |
| .2645 | .0762 | −.899 | .2629 | .0749 | −.411 | .0756 | .488 |
| .2869 | .0943 | −.883 | .2858 | .0934 | −.405 | .0938 | .479 |
| .2875 | .0948 | −.875 | .2884 | .0955 | −.398 | .0951 | .477 |
| 2828.2195 | 0.0077 | −0.894 | 2828.2170 | 0.0056 | −0.420 | 0.0067 | 0.474 |
| .2201 | .0081 | −.900 | .2181 | .0065 | −.426 | .0073 | .474 |
| .2397 | .0240 | −.904 | .2362 | .0211 | −.430 | .0225 | .474 |
| .2410 | .0250 | −.899 | .2381 | .0227 | −.433 | .0238 | .466 |
| 2829.1825 | 0.7843 | −0.747 | 2829.1804 | 0.7826 | −0.228 | 0.7834 | 0.519 |
| .1838 | .7853 | −.745 | .1813 | .7833 | −.236 | .7843 | .509 |
| .1977 | .7965 | −.749 | .1956 | .7948 | −.250 | .7957 | .499 |
| .1995 | .7980 | −.751 | .1967 | .7957 | −.249 | .7969 | .502 |
| 2835.2053 | 0.6414 | −0.645 | 2835.2030 | 0.6395 | −0.085 | 0.6404 | 0.560 |
| .2063 | .6422 | −.639 | .2041 | .6404 | −.086 | .6413 | .553 |
| .2186 | .6521 | −.646 | .2166 | .6505 | −.080 | .6513 | .566 |
| .2198 | .6531 | −.645 | .2179 | .6515 | −.091 | .6523 | .554 |
| 2836.1568 | 0.4087 | −0.748 | 2836.1546 | 0.4069 | −0.178 | 0.4078 | 0.570 |
| .1578 | .4095 | −.738 | .1561 | .4081 | −.185 | .4088 | .553 |
| .1707 | .4199 | −.750 | .1702 | .4195 | −.179 | .4197 | .571 |
| .1729 | .4217 | −.734 | .1721 | .4210 | −.167 | .4214 | .567 |

**Table 3.** Continued.

| Hel. JD 2440000+ | Phase | ΔV | Hel. JD 2440000+ | Phase | ΔB | Phase | Δ(B−V) |
|---|---|---|---|---|---|---|---|
| 2836.1893 | 0.4349 | −0.708 | 2836.1901 | 0.4356 | −0.158 | 0.4352 | 0.550 |
| .1908 | .4361 | −.702 | .1915 | .4367 | −.156 | .4364 | .546 |
| 2844.1157 | 0.8272 | −0.788 | 2844.1172 | 0.8284 | −0.309 | 0.8278 | 0.479 |
| .1193 | .8301 | −.802 | .1182 | .8292 | −.309 | .8296 | .493 |
| .1335 | .8415 | −.800 | .1347 | .8425 | −.317 | .8420 | .483 |
| .1367 | .8441 | −.813 | .1358 | .8434 | −.316 | .8438 | .497 |
| .1508 | .8555 | −.806 | .1534 | .8576 | −.312 | .8565 | .494 |
| .1517 | .8562 | −.811 | .1545 | .8585 | −.320 | .8573 | .491 |
| 2845.1030 | 0.6234 | −0.658 | 2845.1005 | 0.6214 | −0.107 | 0.6224 | 0.551 |
| .1040 | .6242 | −.659 | .1014 | .6221 | −.100 | .6231 | .560 |
| .1046 | .6247 | −.638 | .1192 | .6365 | −.093 | .6306 | .545 |
| .1212 | .6381 | −.648 | .1199 | .6370 | −.084 | .6375 | .564 |
| .1221 | .6388 | −.658 | .1232 | .6397 | −.101 | .6392 | .558 |
| .1455 | .6577 | −.659 | .1473 | .6591 | −.105 | .6584 | .554 |
| .1491 | .6606 | −.662 | .1479 | .6596 | −.100 | .6601 | .563 |
| 2898.1308 | 0.3877 | −0.702 | 2898.1329 | 0.3894 | −0.200 | 0.3886 | 0.503 |
| .1317 | .3885 | −.719 | .1336 | .3900 | −.196 | .3892 | .522 |
| .1454 | .3995 | −.750 | .1471 | .4009 | −.202 | .4002 | .548 |
| .1460 | .4000 | −.769 | .1477 | .4014 | −.200 | .4007 | .569 |

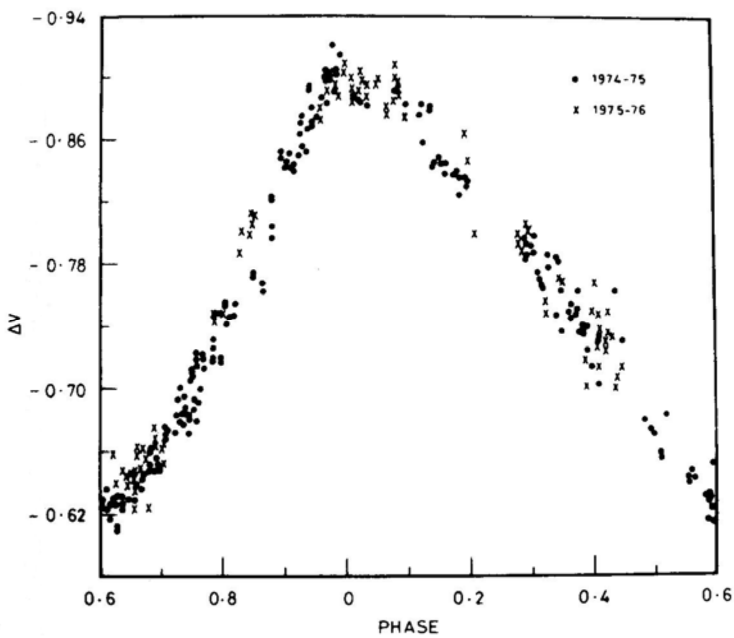


**Figure 1.** BV 690: Light variation in yellow. Filled circles represent the observations for 1974–1975 and those for 1975–76 are plotted as crosses.

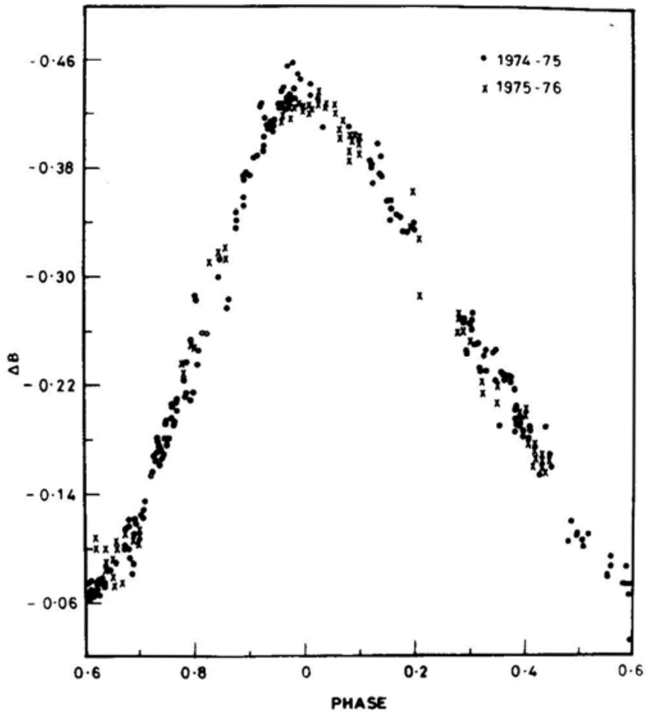


**Figure 2.** BV 690: Light variation in blue. Filled circles represent the observations for 1974–1975 and those for 1975–76 are plotted as crosses.

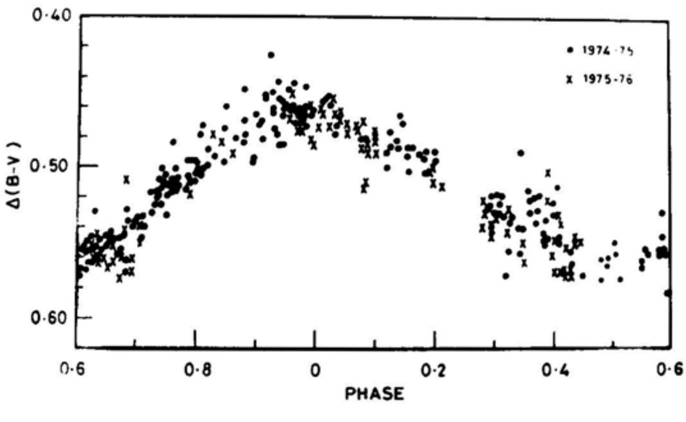


**Figure 3.** BV 690: (*B* – *V*) colour variation. Filled circles represent the observations for 1974–1975 and those for 1975–76 are plotted as crosses.

$7^m.68$ at maximum to $8^m.04$ at minimum. The $(B - V)$ colour of *BV* 690 varies by $0^m.11$, from $0^m.50$ occurring at the phase 0.92 to $0^m.61$ occurring at the phase 0.49. Thus the star reaches extremes of temperature slightly before it reaches extremes of brightness. For BV 690 the values of brightness averaged over one cycle are found to be $7^m.30$, $7^m.85$ and $0^m.55$ for $\langle V \rangle$, $\langle B \rangle$ and $\langle B - V \rangle$ respectively.

In the HD catalogue the spectral type of BV 690 is given as G0, and in Nancy Houk's reclassification of the HD stars, HD 76296 is assigned a spectral type of F3/5 III. From the calibration given by Schmidt-Kaler (1982) the $(B-V)_0$ and $M_v$ values corresponding to this spectral type are + 0.40 and + 0.90 respectively. As the $(B-V)$ colour and the $V$ magnitude of this star are known to vary by 0.11 and 0.27 magnitudes and the phase of observation of the spectral type is not known to us, we expect the mean $(B-V)_0$ of BV 690 to lie in the range + 0.34 to + 0.46 and the mean $M_v$ to lie in the range + 0.76 to + 1.04.

BV 690 has a period in the range $1^d < P < 3^d$ where one finds a mixture of different types of pulsating variables. Diethelm (1983) has classified variables in this period range into the following four classes: (i) RR Lyrae stars (RRd), (ii) W Virginis stars (CW), (iii) BL Herculis stars (BL), and (iv) Classical Cepheids ($C\delta$). In the *General Catalogue of Variable Stars,* (1985) the *W* Virginis Cepheids of periods less than eight days and the BL Herculis objects are grouped together as the type CWB.

Properties of Cepheid variables are summarized by Duerbeck & Seitter (1982, hereafter DS). Cepheids differing in the form of their light curves, amplitudes, absolute magnitudes, colour indices, spectra, radial velocity curves, space motions and stability of periods can be associated with either of the two stellar populations. The low galactic latitude of BV 690 ($b$ = 13°.6) would indicate the likelihood of its being a classical Cepheid. However, according to Hoffmeister, Richter & Wenzel (1985) the classical Cepheid with the shortest period currently known in our Galaxy is *V* 473 Lyr (HR 7308) with $P = 1^d.49$. On the other hand a number of Type II Cepheids have periods smaller than this. Moreover, according to DS, a bump is generally present in the light curves of Type I Cepheids having periods greater than seven days, while a bump is present in the descending branch of the light curves of Type II Cepheids of even shorter periods.

In DS the period luminosity (P–L) and the period-colour-luminosity (P–C–L) relations are given separately for the Type I and Type II Cepheids. The mean period-colour ($P$–$C$) relation for Type I Cepheids is:

$$\langle B\rangle_0 - \langle V\rangle_0 = 0.27 + 0.47 \log P.$$

From this relation we estimate $\langle B - V\rangle_0 = 0^m.31$ for BV 690. This value is outside the range of $0^m.34$ to $0^m.46$ estimated earlier from the spectroscopic observations. Considering the possibility of error introduced in extrapolating the $P$–$C$ relation, we have adopted $\langle B - V\rangle_0 = 0^m.34$. Combining this with the observed value $\langle B - V\rangle = 0^m.55$ we estimate a colour excess of $0^m.21$ and an interstellar absorption $A_V = 3.3\,E_{B-V}$ of about $0^m.70$ and $0^m.90$ in $V$ and $B$ bands respectively.

In DS the linear P–C–L relations for Type I Cepheids in the period range $0.4 < \log P < 1.9$ is given as:

$$M_{\langle V\rangle} = -3.425 \log P + 2.52 (\langle B\rangle_0 - \langle V\rangle_0) - 2.459.$$
$$M_{\langle B\rangle} = -3.425 \log P + 3.52 (\langle B\rangle_0 - \langle V\rangle_0) - 2.459.$$

Using the above P–C–L relations we estimate $M_{\langle V\rangle} = -1.99$ and $M_{\langle B\rangle} = -1{\cdot}69$. Combining these results with the observed values $\langle V\rangle = 7.30$ and $\langle B\rangle = 7.85$ and taking into account the interstellar absorption estimated above we derive a distance of 1000 parsec and 1200 parsec from $V$ and $B$ light curves of BV 690, The estimated interstellar absorption seems to be appropriate for the mean distance of about 1.1 kpc derived for this system. However, the absolute magnitude $M_V$ derived from the P–C–L relation differs by about 3 magnitudes from the range of $0^m.76$ to $1^m.04$ for $M_V$ estimated from the observed spectral type of the system.

On the other hand if we assume BV 690 to be a Type II Cepheid, then we have the following P–C relation:

$$\langle B\rangle_0 - \langle V\rangle_0 = 0.31 + 0.18 \log P.$$

This yields an intrinsic colour of 0.33, which is also outside the range of 0.34 to 0.46 estimated from the spectral type. Again adopting $\langle B - V\rangle_0 = 0.34$, we have a colour excess of 0.21 and a total visual absorption of $0^m.70$. The P–L relation for Type II Cepheids given in DS is:

$$M_{\langle V\rangle} = -0.08 - 1.59 \log P.$$

This gives an absolute magnitude $M_{\langle V\rangle} = -0.23$, and yields a distance of about 450 parsec for BV 690. This estimate of $M_{\langle V\rangle}$ is closer to, though still outside, the range of $0^m.76$ to $1^m.04$ inferred from the spectroscopic criteria. We feel that this difference is tolerable in view of some uncertainty in $M_{\langle V\rangle}$ obtained by extrapolating the P–L relation and considering the lower accuracy of MK spectral types determined from objective prism spectra. In any case, the assumption of a Type II Cepheid results in much better agreement with spectroscopic absolute magnitude than the assumption of a Type I Cepheid.

The position and proper motion of BV 690 (SAO 176679) appear in the *Smithsonian Astrophysical Observatory* (SAO) *Star Catalogue* (1966). These have been taken from the *Transactions of the Astronomical Observatory of Yale University* (1943) where the star has the number 6884. In SAO the proper motion components of the star reduced to the FK4 system are given as $\mu_\alpha = 0^s.0005 \pm 0''.0018$ and $\mu_\delta = 0''.049 \pm 0''.018$. Combining these with the distance of 1100 parsec derived above for a Type I Cepheid, the tangential velocity of the star turns out to be about 260 km $s^{-1}$, very high for a classical Cepheid. The proper motion of BV 690 is also given in the Publications of U.S. Naval Observatory (1948), under the star number 2061 as $\mu_\alpha = 0^s.001$ and $\mu_\delta = 0''.027$ in the FK3 system, from which we derive a tangential velocity of about 160 km $s^{-1}$, also quite high for a classical Cepheid. However, if we use a distance of about 450 parsec appropriate to its being a Type II Cepheid, then the estimated tangential velocities would be about 100 km $s^{-1}$ and 60 km $s^{-1}$ for proper motions given in the SAO and USNO catalogues. It may be emphasized that in view of the large errors quoted for the proper motion, the tangential velocities derived above are highly uncertain. However, when this information is combined with conclusions based on its short period, relatively low luminosity as indicated by its spectral type, and the presence of a bump in its descending branch, it seems quite likely that BV 690 belongs to the BL Herculis group of Type II Cepheids. Several studies have been made on theoretical models for Type II Cepheids and on their comparison with observations (for example, see references given in Peterson & Diethelm 1986). As most of the stars belonging to the BL Her group are faint objects, BV 690 which is brighter than BL Herculis by about 3 magnitudes would be very useful for a detailed study of the properties of this kind of Cepheids. On the other hand if from high resolution spectroscopic studies, it is found to be a Type I Cepheid then it would be a classical Cepheid with the shortest known period and would be an important object to define the blue edge of the instability strip.

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