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THE INVESTIGATION OF CONTEMPORARY CLASSICAL NOVAE

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The investigation of five classical novae: N Cyg 1992 = V1974 Cyg, N Aql 1993 = V1419 Aql, N Cas 1993 = V705 Cas, N Aql 1995 and N Cas 1995 is reported in this paper. The identifications of these novae with faint stars in the Palomar Sky Survey were checked. N Aql 1993 was identified with a star of 21 mag on the POSS O plate. The light curves and the colour index variation curves were obtained using original observations by the authors and other published data. The behaviour of several type classical novae and X-ray novae in the two-colour diagrams is found to be considerably different. The appearance of two light periodicities in N Cas 1992 in the late stages of outburst is confirmed, but the observations can not be fitted by any linear elements in a time interval of more than 200 d.

KEY WORDS Novae, X-ray novae, identifications, photometric observations, light curve, colours, two-colour diagrams, periods of novae

Five classical novae: N Cyg 1992 = V1974 Cyg, N Aql 1993 = V1419 Aql, N Cas 1993 = V705 Cas, N Aql 1995 and N Cas 1995 are investigated. For all the objects astrometric measurements were carried out to identify them with faint stars from the Palomar Observatory Sky Survey (POSS). The novae fields taken from the blue POSS O glass copies are reproduced in Figure 1. POSS glass copies were scanned and digitized with an automatical microdensitometer (AMD). These densitograms were reproduced on a PC screen with the help of our special computer program. The contrast has been sharpened with a numerical method. The crosses denoting novae positions have been plotted by astrometrical methods relative to reference stars from GSC and PPM catalogues (see Figure 1).

N Aql 1993 is identified with a faint star of 21 mag on the POSS O plate (see Figure 1). The star is absent on the red POSS E plate. The identifications of N Cas 1993 (Munari *et al.*, 1994) and N Cas 1995 (Williams, 1995) are confirmed. Pre-

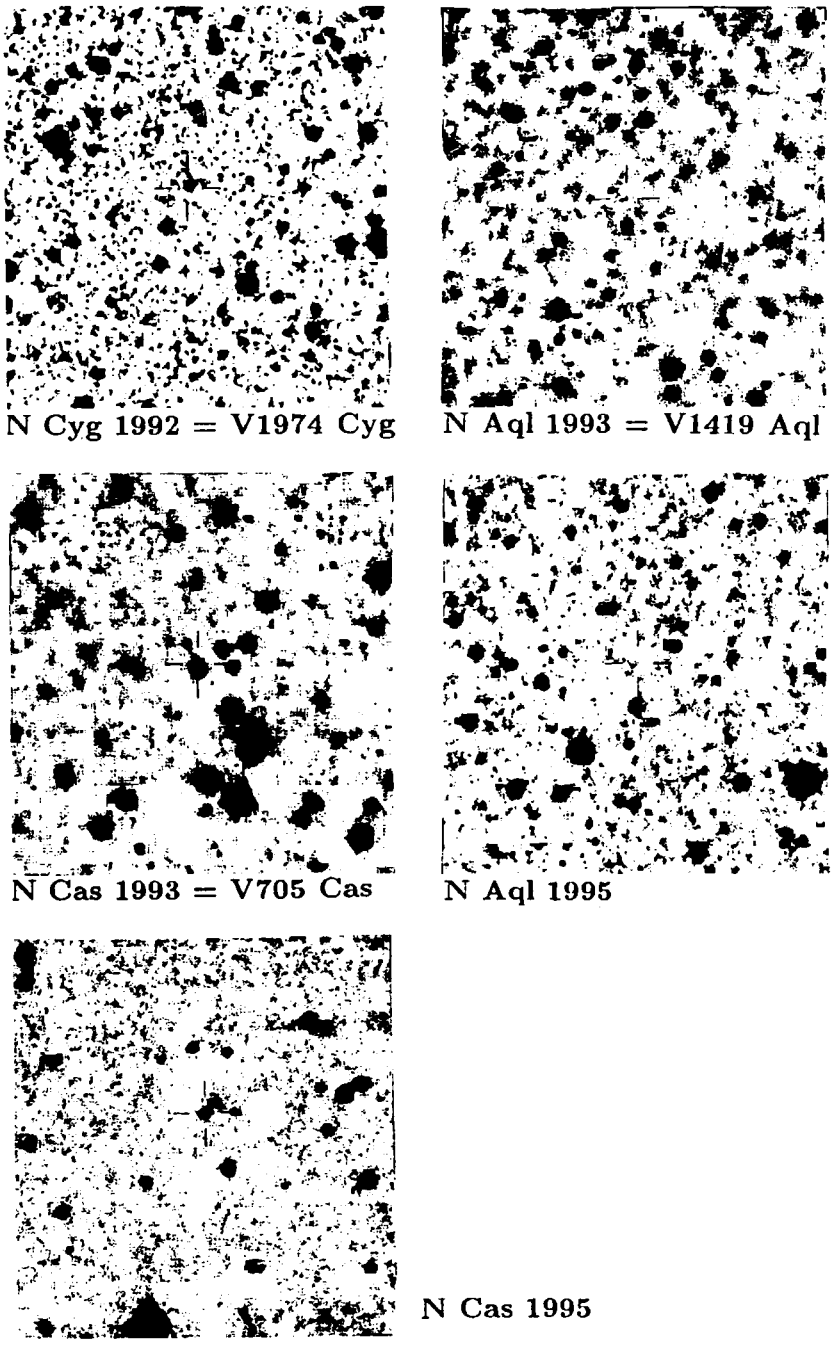


Figure 1 Reproductions of the novae fields from the blue POSS glass copies. North is at the top. Field dimensions are 4 arcmin × 4 arcmin. The calculated astrometric positions are denoted by crosses.

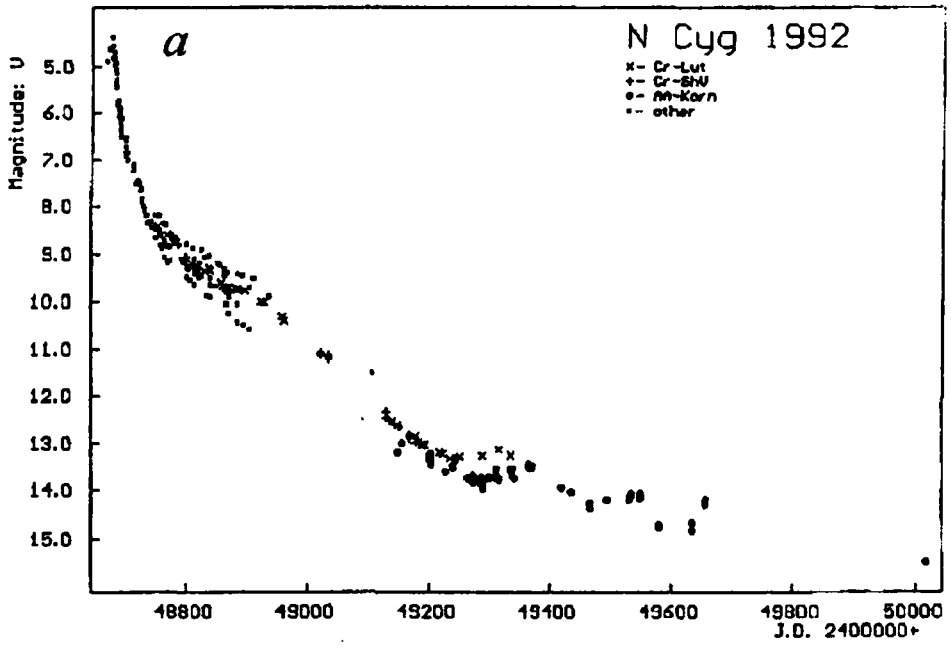
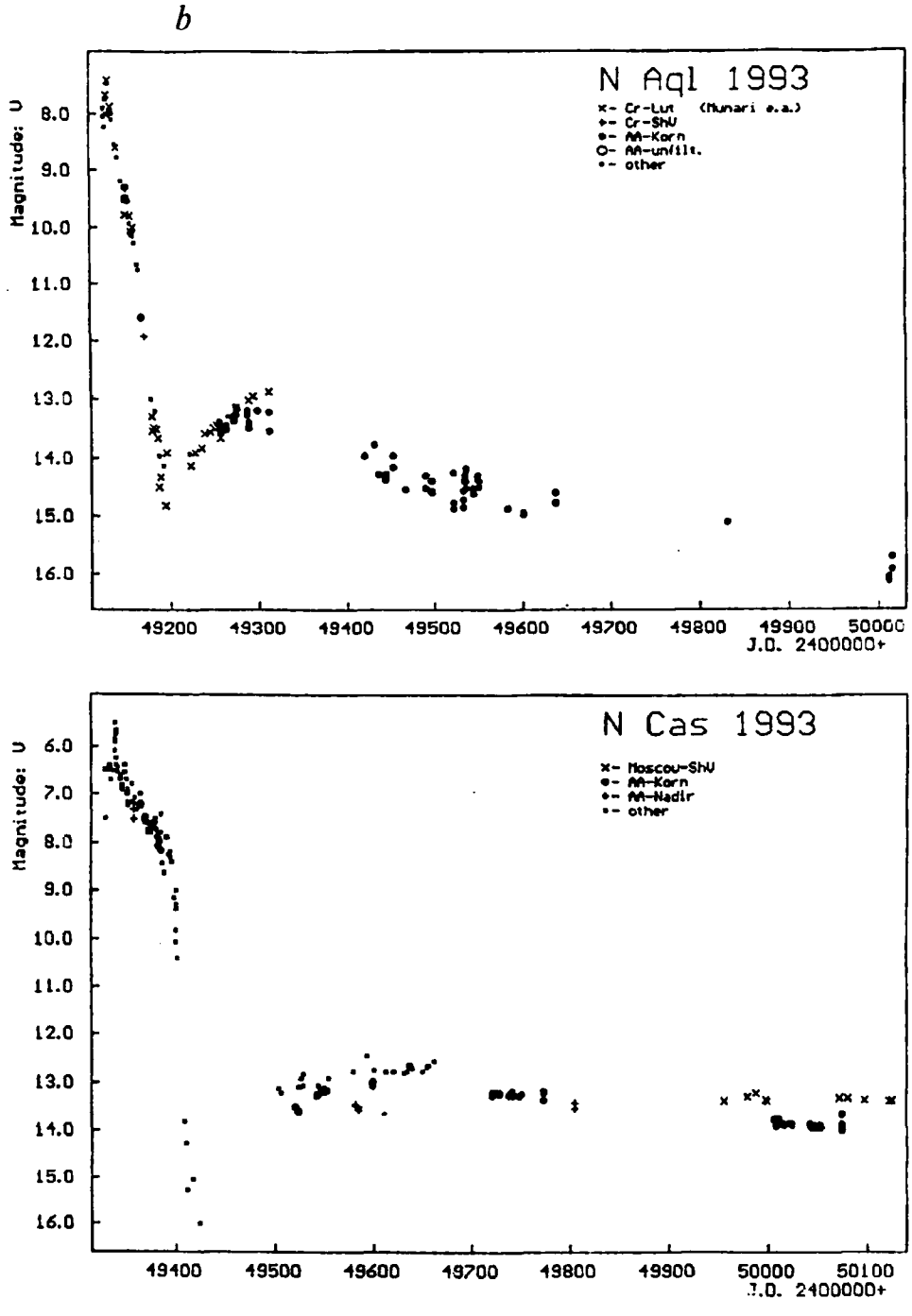


Figure 2 The light curves of five novae in V. The original observations by the authors of this paper and by other observers have been used. The different symbols correspond to original observations by the authors and other sources using different photometers: Cr-Lut, the photometer of V. M. Lutyi in the Crimea; Cr (or Moscow)-ShV, the photometer constructed by S. Yu. Shugarov and I. M. Volkov used in the Crimea (or in Moscow); AA-Korn, the photometer constructed by V. G. Kornilov used in Tien-Shan (Alma-Ata); AA-Nadir, WBVR standard plant constructed photometer; AA-unfilt, observations without filters but with dichroic plate dividers in Tien-Shan. The small dots correspond to published observations of other authors. The systematic differences of observations using different equipment have not been taken into account.

nova Cas 1993 is seen as a northern 17.0 B companion merged with the southern one in the 2 arcsec pair. N Cas 1995 is reliably identified with a star of magnitude 19.0 ± 0.2 B and 17.5 ± 0.5 R before the outburst (see Figure 1). The recent N Cyg 1992 position is situated on the edge of a 19 mag star image (see Figure 1), the centre of which is displaced by 2 arcsec according to the nova's position. It may be that the pre-nova image blends with the star's image. In the case of N Aql 1995 a faint 20 mag star is situated too far (by 2.5 arcsec) to the south-east from the recent nova position (see Figure 1). So we assume that this star is not a pre-nova.

Since 1992 we have monitored these five novae in the UBV and WBVR photometric systems. The light curves (Figure 2) and colour index curves (Figure 3) obtained in the study allowed us to investigate both the distinctions between classical novae of various types and those between classical and X-ray novae. N Cyg 1992 is a O–Ne–Mg nova and has unusual variations of colour indices. For example, it has power UV excess up to $\Delta(W - B) = -4.0$ mag (see Figure 3). N Aql 1993 and



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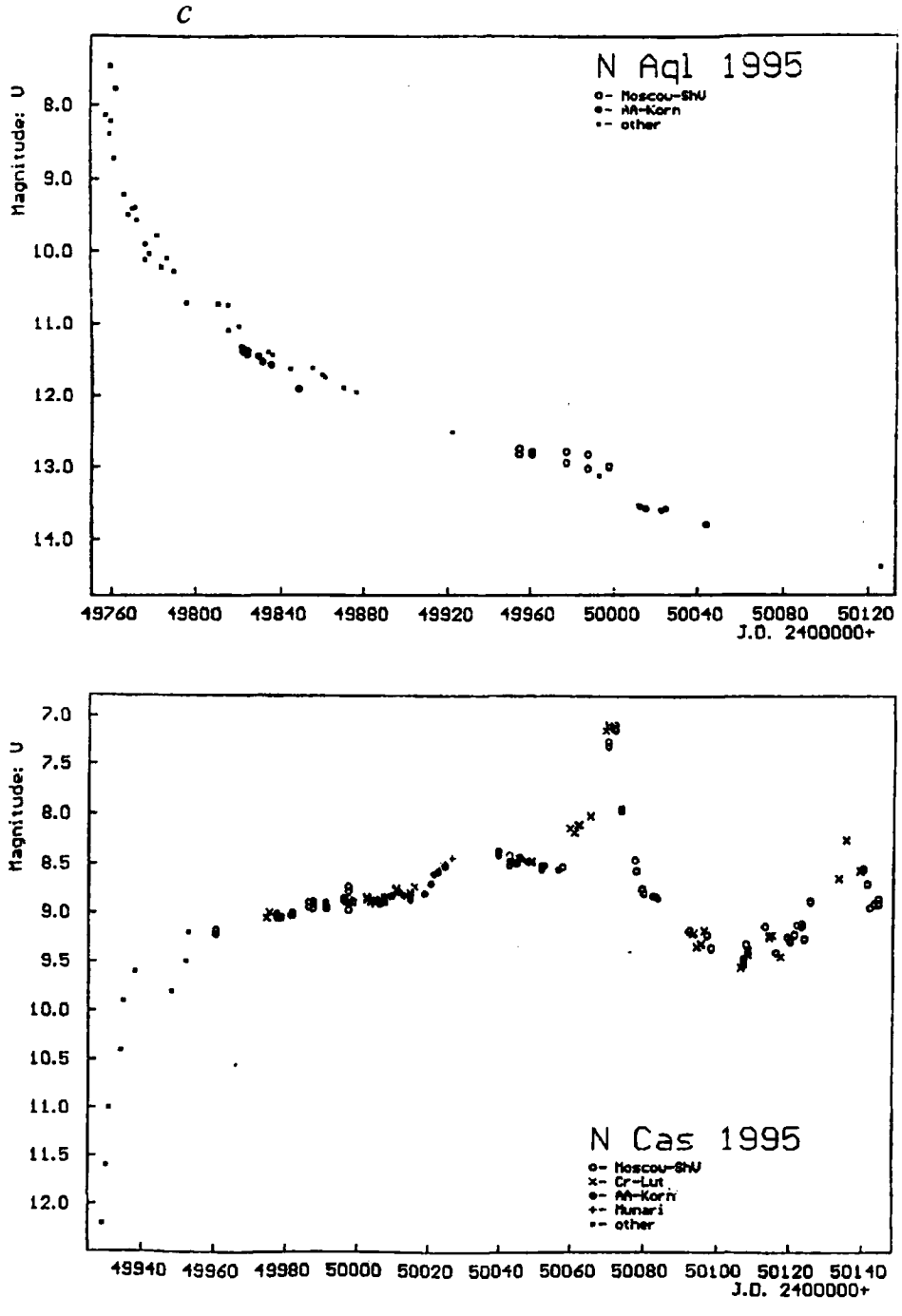

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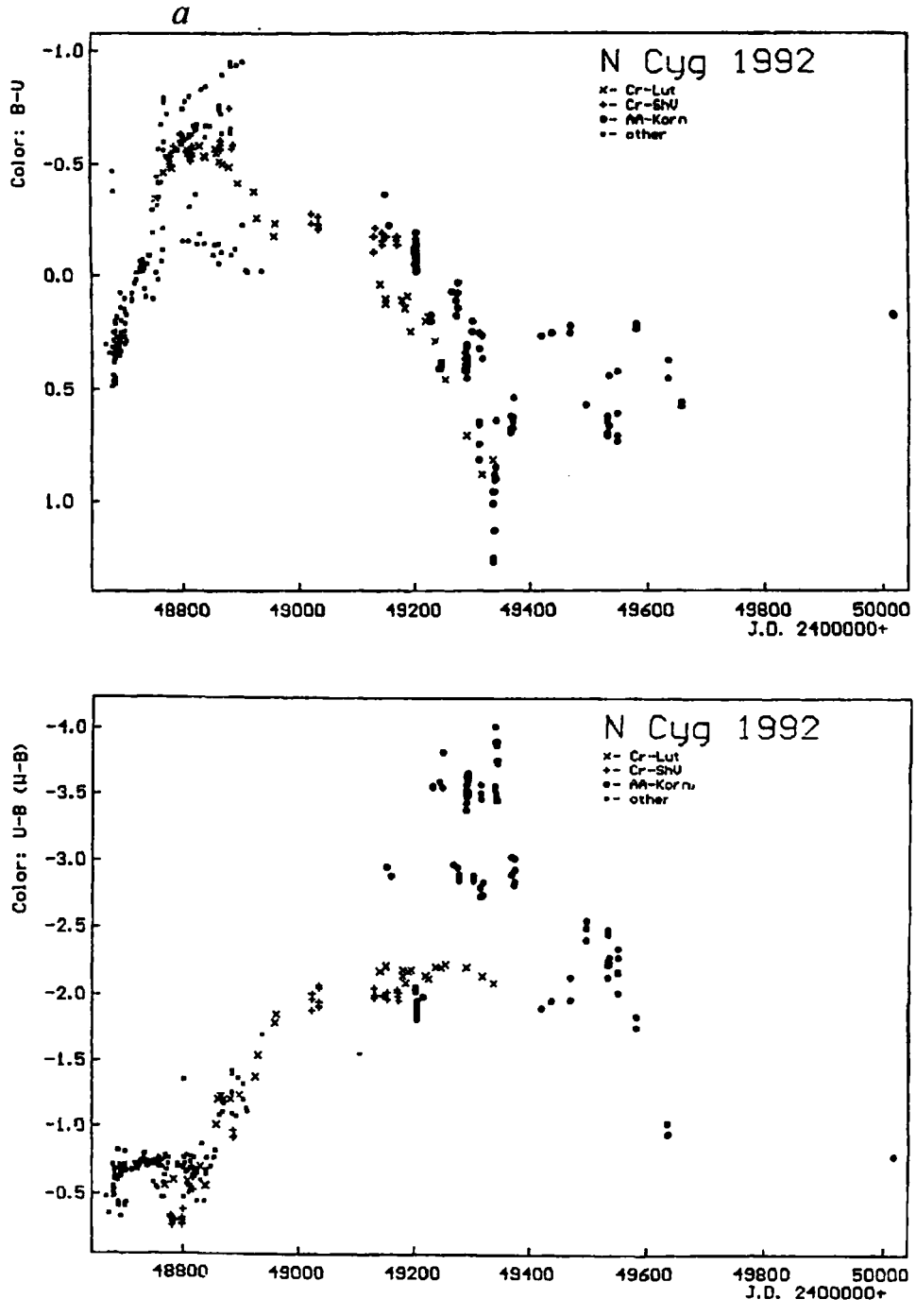
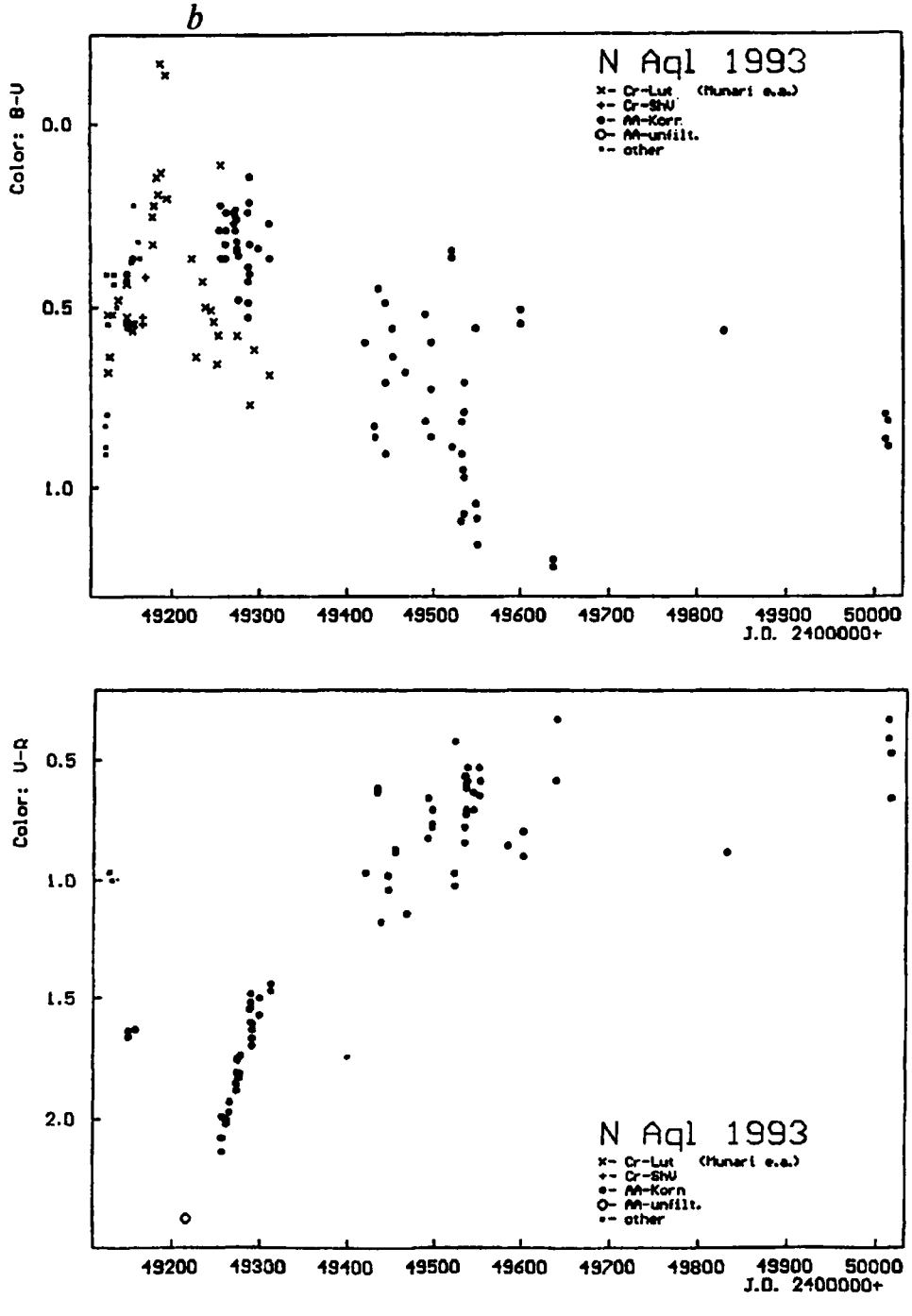


Figure 3 The colour index variation curves. Symbols are the same as in Figure 2.



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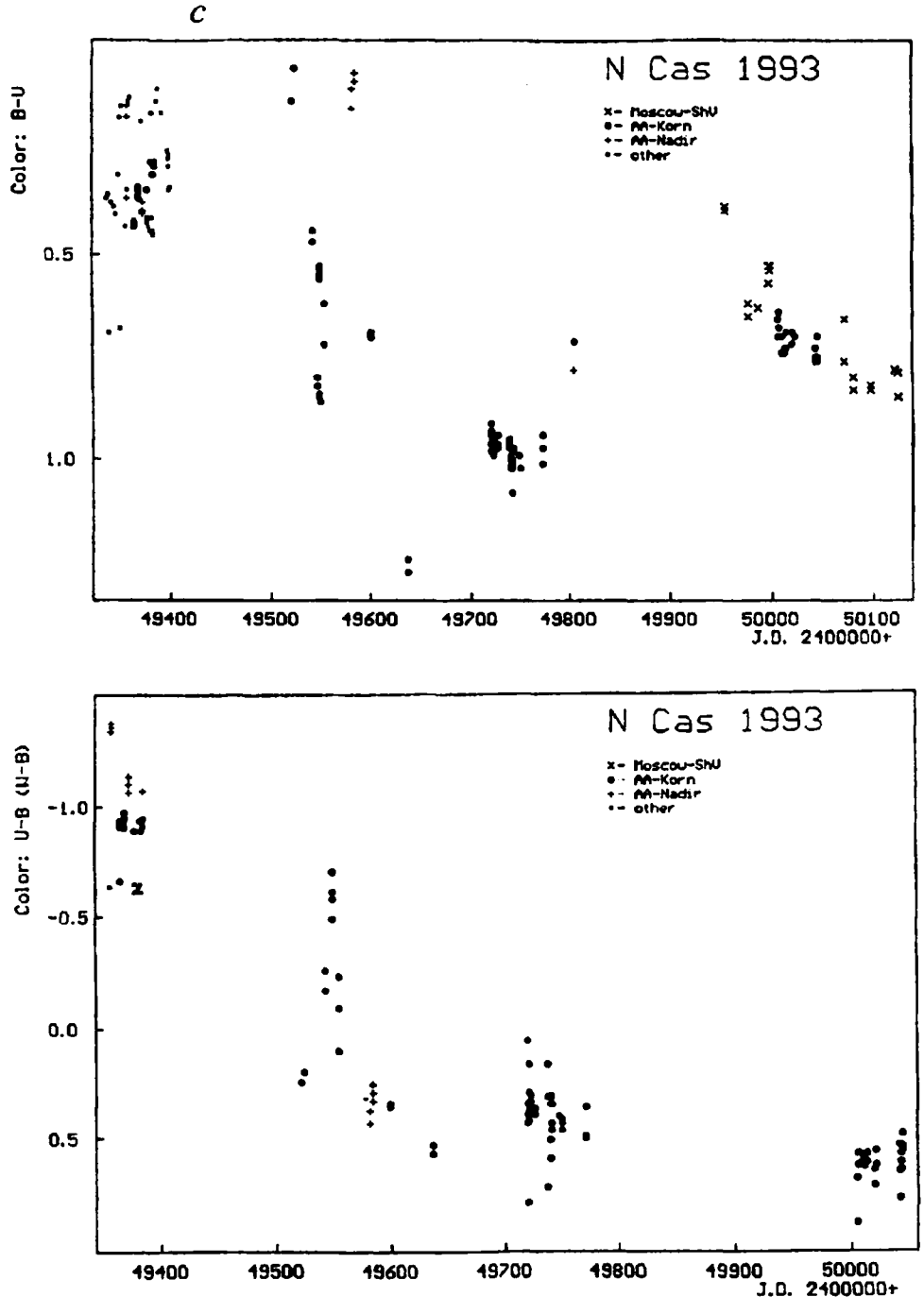

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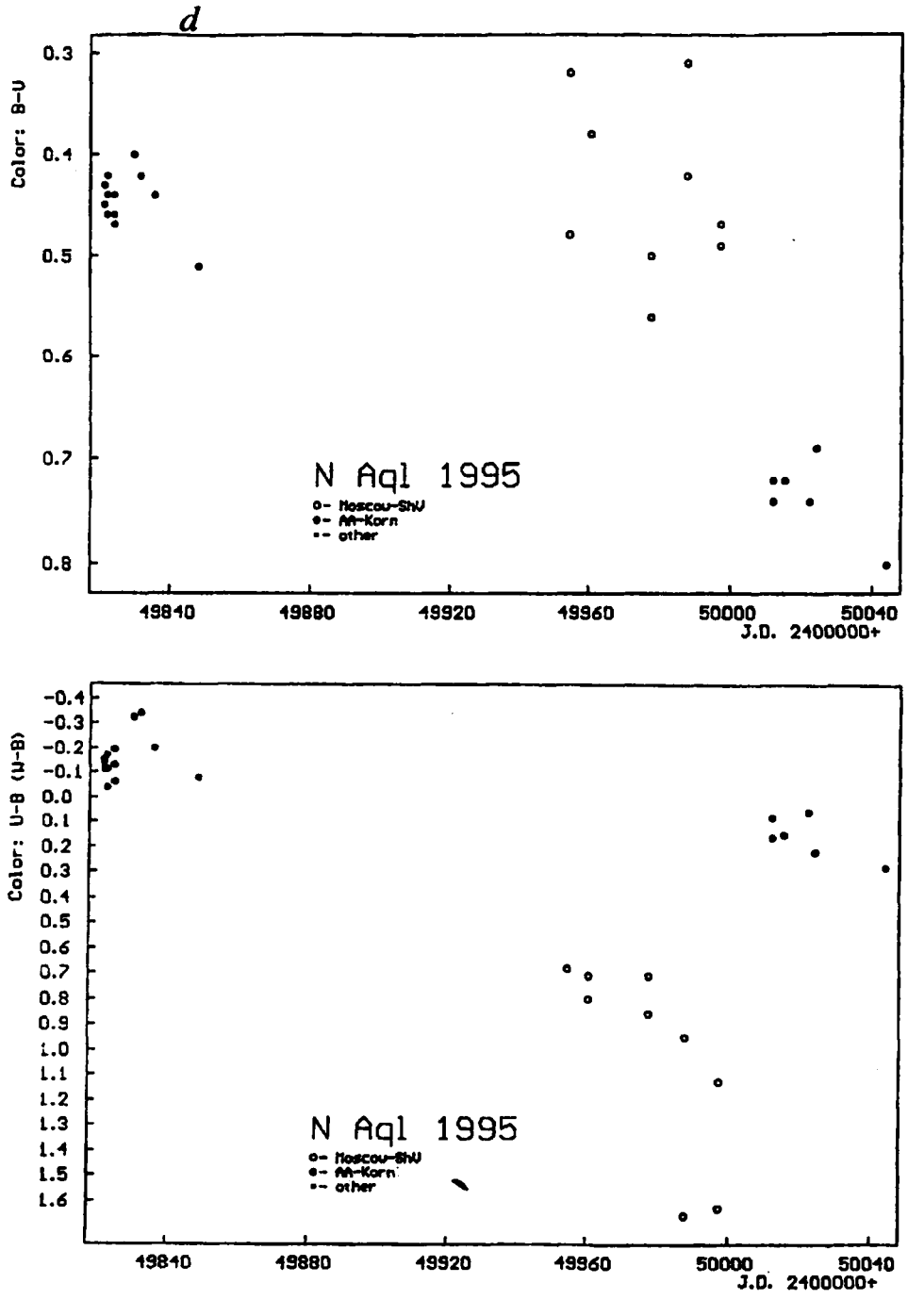

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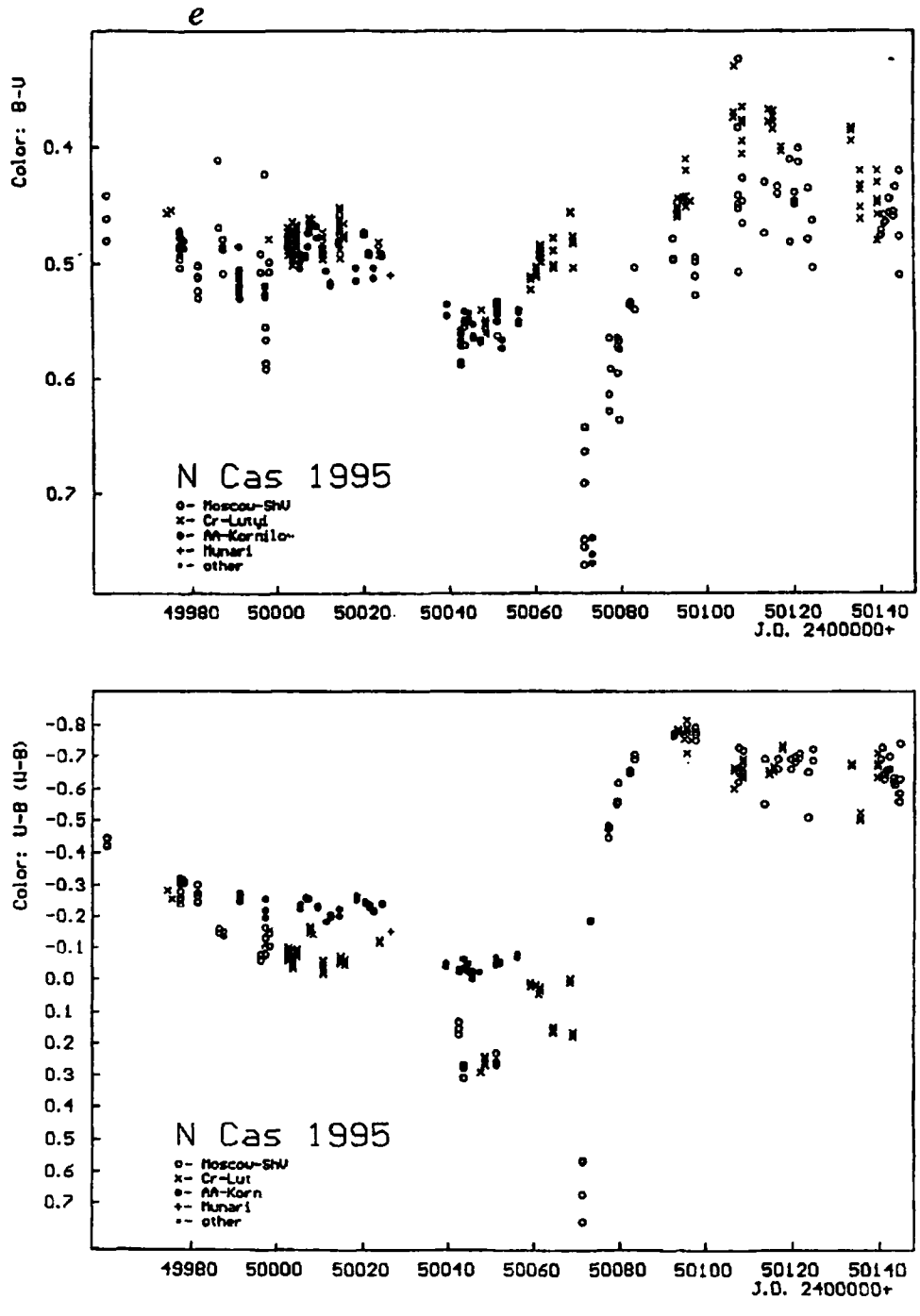

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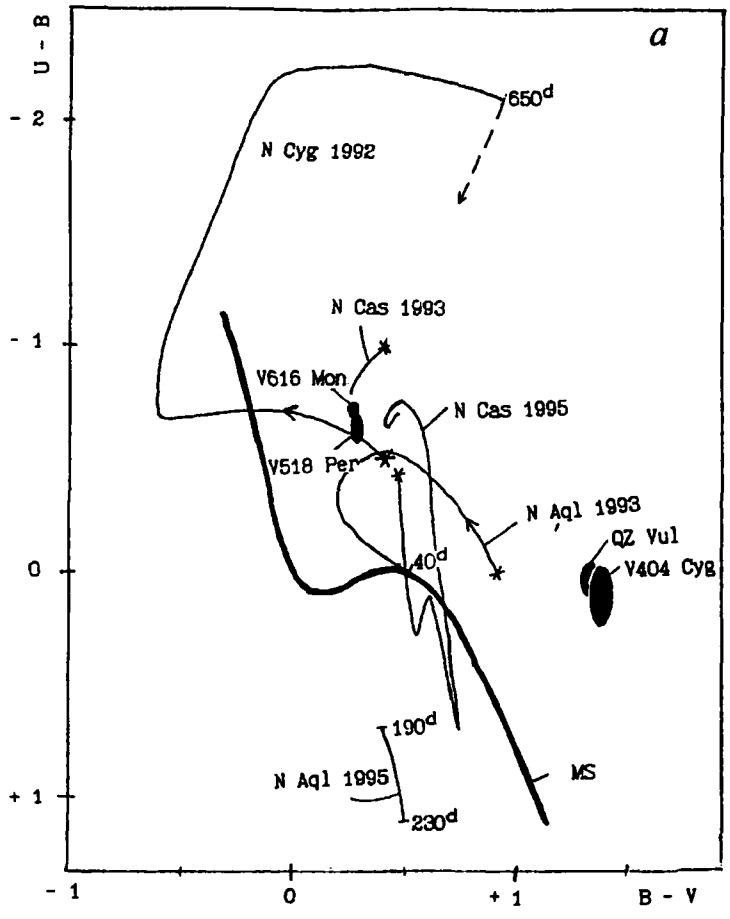

Figure 4 The drifts of five novae under research in two-colour diagrams $(U - B)$-$(B - V)$, $(W - B)$-$(B - V)$ and $(B - V)$-$(V - R)$.

N Cas 1993 are dust novae of DQ Her type. Their light curves show the typical dips connected with dust envelope formation. The disappearance of UV excess which is connected with UV light absorption by large particles of dust is a typical feature of these objects. Also, the significant red excess is observed in episodes of dust envelope formation. Dust IR radiation has been revealed in the case of N Aql 1995 but we did not observe the characteristic light curve dip of DQ Her type in this object. Nevertheless the significant R excess was observed in N Aql 1995.

N Cas 1995 shows unusual behaviour. Its outburst demonstrates very slow development and low velocity of envelope expansion (Figure 1). During seven months the star had a normal photosphere. In December 1995 a mini-outburst was observed with an amplitude of 1.5 mag, and bright Balmer H_α emission and UV excess were detected photometrically. These light and colour changes in December, 1995 sugg-

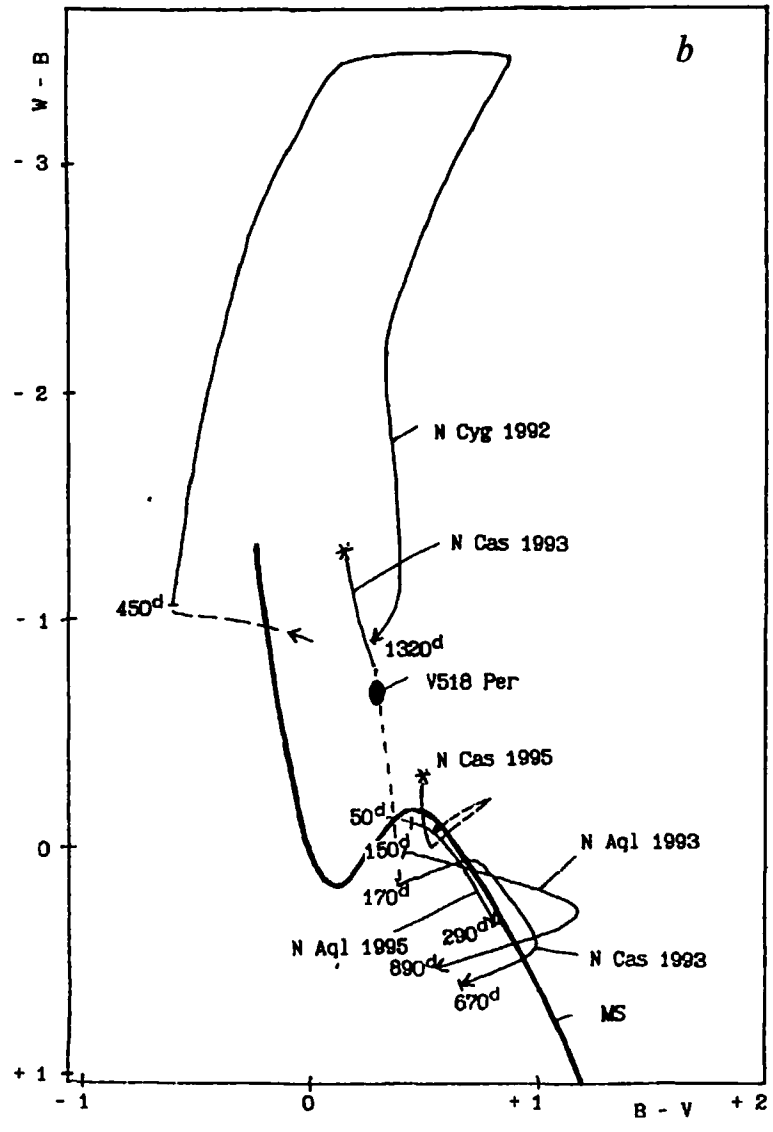

Figure 4 Continued.

est the formation of a dense atmosphere. It is interesting that the shape of the light curve of N Cas 1995 is very similar to that of slow Nova RR Pic. The last one had maxima due to three short-living mini-outbursts over the flat prolonged maximum finished with a slow fading. Upto until April, 1996 N Cas 1995 had three mini-outbursts, too. An assumption that this object is not a symbiotic nova but rather a classical nova is confirmed by spectroscopic observations (Iijima and Rosino, 1996).

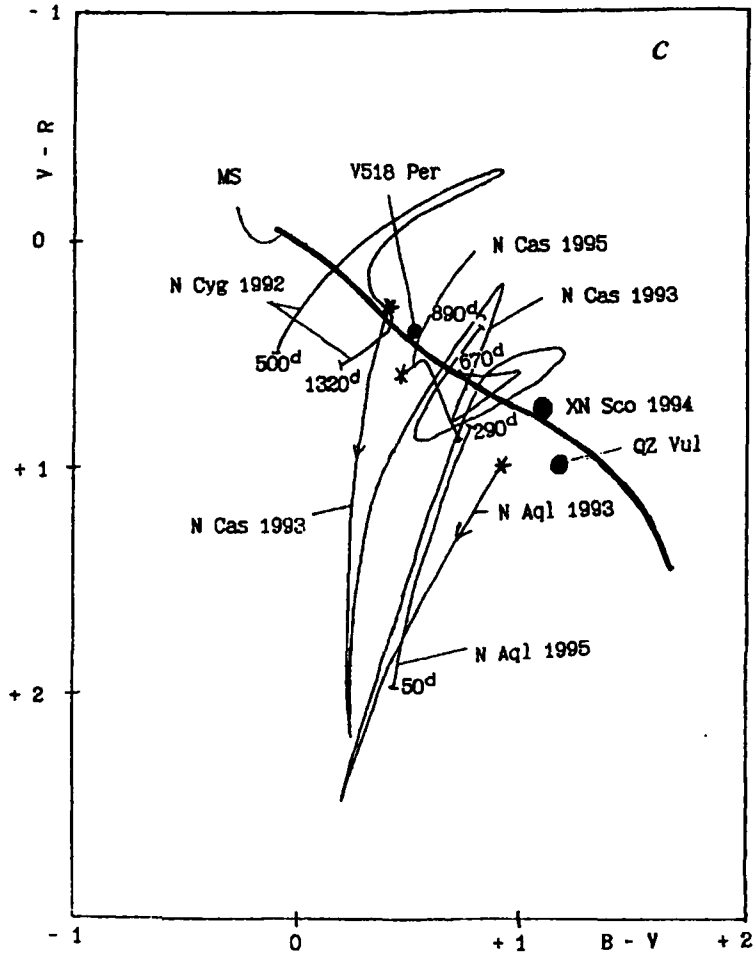

Figure 4 Continued.

For all the classical novae under research there are systematic deviations of observations obtained with different photometers. These deviations are changing with time and strongly increase in the later stages of the outbursts. Note, that they reach 0.6–1.0 mag in the V band in spite of the equality of colour equation coefficients to zero in all devices if the coefficients were derived using normal stars. The deviations may be due to small device-to-device and temperature changes in photometric bands which cannot be controlled with convenient methods of photometry. When the bright emissions are situated near the edge of a photometric band the systematic deviation may increase up to 1.0 mag. Having variations of power emission lines in the spectra one may expect these deviations to change. So one may observe only the major tendencies of star shifts in two-colour diagrams (Figure 4). Such behaviour of the studied novae differs considerably from the behaviour of X-ray novae which

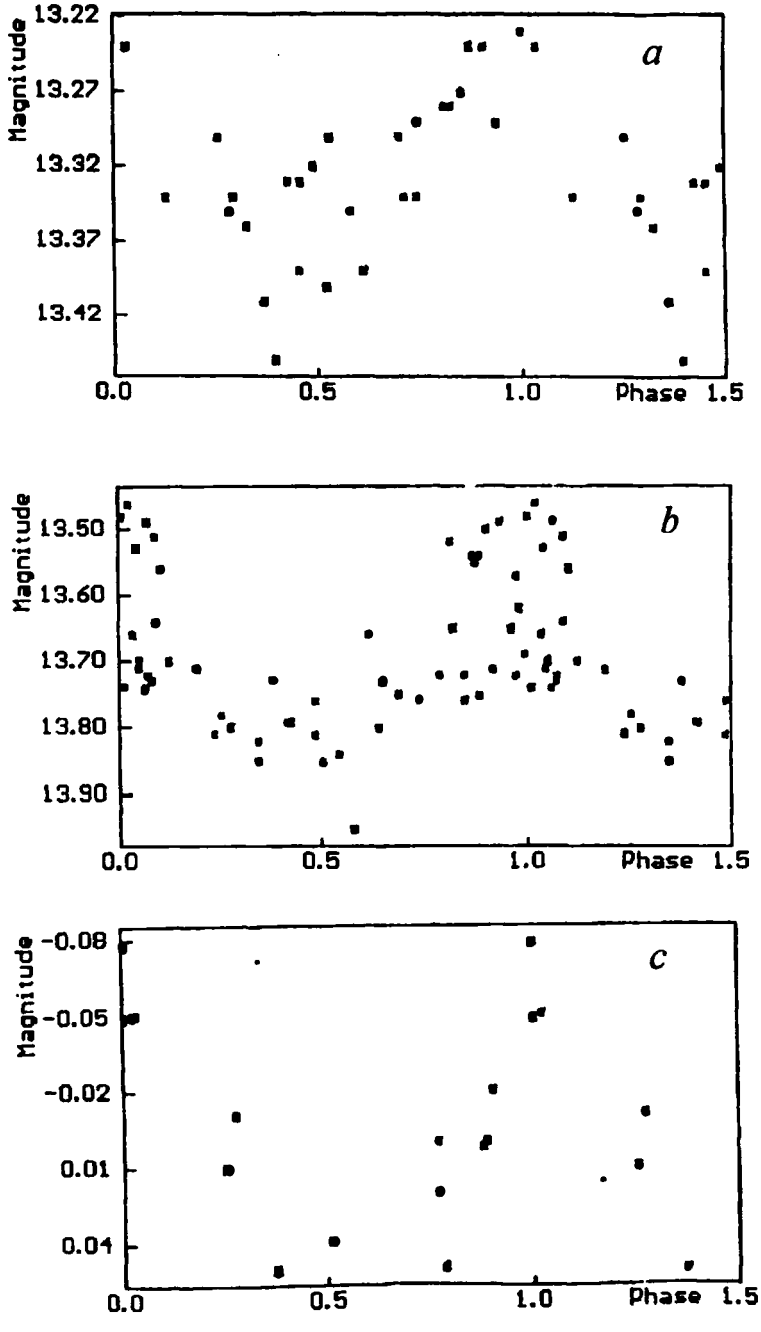

Figure 5 The folded light curves for N Cyg 1992 according to ephemerides determined in this paper for three time intervals – *a*, JD 2449202: T=HJD 2449202.356 + 0.081985 d*E; *b*, JD 2449263-369: T=HJD 2449369.085 + 0.0819853 d*E; *c*, JD 2449520-560: T=HJD 2449533.210 + 0.0851306 d*E.

have spectra similar to high-temperature blackbody or accretion discs (Bochkarev *et al.*, 1991; Goranskij *et al.*, 1996) in all the stages of outburst. X-ray novae are situated along the line of interstellar reddening. They do not change their positions in two-colour diagrams with time (Goranskij *et al.*, 1996).

Our observations confirm the appearance of two light-curve periodicities in the late stages of N Cyg 1992 outburst. For time interval JD 2449200–365 we revealed the period $P = 0.081985$ d (Figure 5). This period differs from $P = 0.81263$ d, which had been derived earlier by De Young and Schmidt (1994). In time interval JD 2449531–549 we revealed the period $P = 0.085$ d which is in agreement with the period found by Semeniuk *et al.* (1994) and attributed to superhumps similar to SU UMa. The amplitude of variation in V light is equal to 0.12–0.18 mag and increases with wavelength. Over a time interval of 200 d these oscillations are not coherent and can not be fitted by any linear elements.

Acknowledgements

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References

Bochkarev, N. G., Karitskaya, E. A., Shakura, N. I., and Zhekov, S. A. (1991) *Astron. Astrophys. Trans.* **2**, 41.
De Young, J. A. and Schmidt, R. E. (1994) *Astrophys. J.* **431**, L43.
Goranskij, V. P., Karitskaya, E. A., Kurochkin, N. E., and Trunkovsky, E. M. (1996) *Russ. Astron. Lett.* **22**, 371.
Iijima, T. and Rosino, L. (1996) *IAU Circ. No. 6365.*
Munari, U., Tomov, T. V., Hric, L., and Hazucha, P. (1994) *Inf. Bull. Variable Stars No. 3977.*
Semeniuk, I., Pych, W., Olech, A., and Ruszkowski, M. (1994) *Acta Astron.* **44**, No. 3, 277.
Williams, G. V. (1995) *IAU Circ. No. 6213.*