VARIATIONS OF THE Ap STAR IN NGC 2169[1]

A period of $1\overset{d}{.}56$ had been determined by Maitzen & Lebzelter (1993) for the Δa and *uvby* variations of the Ap star Rns11180 (Renson 1991) = NGC2169-9 (Cuffey & Mc-Cuskey 1956) = NGC2169-12 (Hoag et al. 1961). This value has been recently questioned by Renson (1994), who favors a period of $0\overset{d}{.}606$ for the same data. However, these periods are based on only 7 Δa observations (Maitzen & Lebzelter 1993), and on two series of *uvby* data (Delgado et al. 1992) covering part of two nights.

Fortunately, four series of *uvby* CCD frames of the cluster had been secured during a four-night interval in January 94, at the 91 cm Dutch telescope of the La Silla observatory.

The amplitude of the variations decreases from about $0\overset{m}{.}15$ in u down to about $0\overset{m}{.}06$ in y, making the ultraviolet and blue channels the most interesting for the period analysis. Figures 1 and 2 show the periodograms in, respectively, u and v.

Analysis of these data yields the following possible frequencies (periods):

$$f_1 = 0.321 \text{ d}^{-1} \quad (P_1 = 3\overset{d}{.}111)$$
$$f_2 = 0.642 \text{ d}^{-1} \quad (P_2 = 1\overset{d}{.}557)$$
$$f_3 = 0.797 \text{ d}^{-1} \quad (P_3 = 1\overset{d}{.}254)$$
$$f_4 = 1.618 \text{ d}^{-1} \quad (P_4 = 0\overset{d}{.}618)$$

Examination of the lightcurves indicates that the most probable is the second one, in agreement with Maitzen & Lebzelter's (1993) results.

It appears that $f_1 = f_2/2$ corresponds to a period twice the favored period (P_2); $f_3 \approx f_4/2$; and $f_4 \approx 1 + f_2$.

Hence f_4, which had been proposed by Renson (1994), simply is a 1-day alias of f_2.

By combining the 1994 data with those of Delgado et al. (1992), using the method described by Manfroid & Renson (1994), we end up with a large series of possible values:

$$f = 0.639795 \pm 0.000012 + n \times 0.0003364 \quad \text{d}^{-1}$$

with $n \leq 10$. This corresponds to $P = 1\overset{d}{.}56300 \pm 0\overset{d}{.}00001$ and aliases.

The v periodogram around frequency f_2 is shown in Fig. 3, while Figs. 4 and 5 show the v and u complete light curves folded with $P = 1\overset{d}{.}56300$. As a comparison, the v light curve has been drawn in Fig. 6 for the best period found around $0\overset{d}{.}606$ (namely $0\overset{d}{.}61861$).

While our results do not unambiguously solve the problem of the period of NGC 2169-9, they point toward a value close to the one proposed by Maitzen & Lebzelter (1993) instead of the much shorter one favored by Renson (1994).

---

[1] Based on observations carried out at the ESO La Silla Observatory
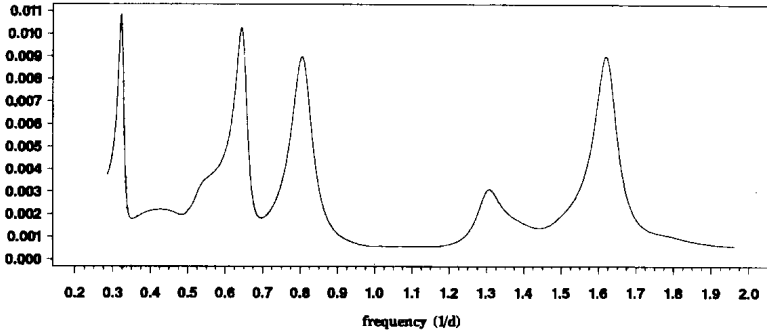
Figure 1: Periodogram in the u band for the 1994 data. The ordinate is the inverse of the chi-square calculated in a two-sine fit (see Manfroid & Renson 1994).
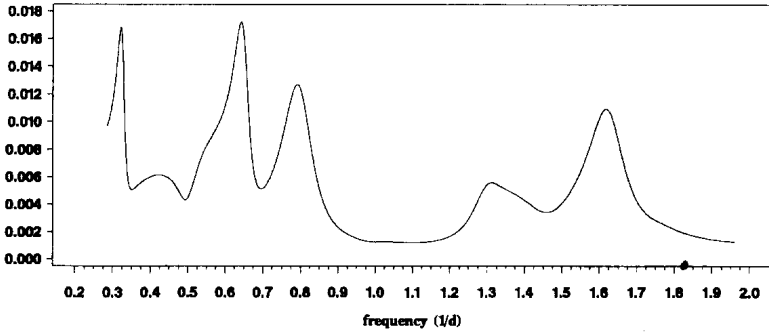

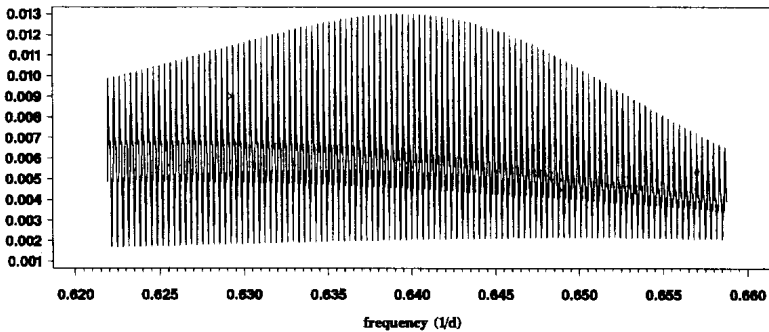Figure 2: Periodogram in the v band for the 1994 data.

Figure 3: Periodogram around f_2 in the v band for the 1994 data and Delgado et al.'s (1992) data
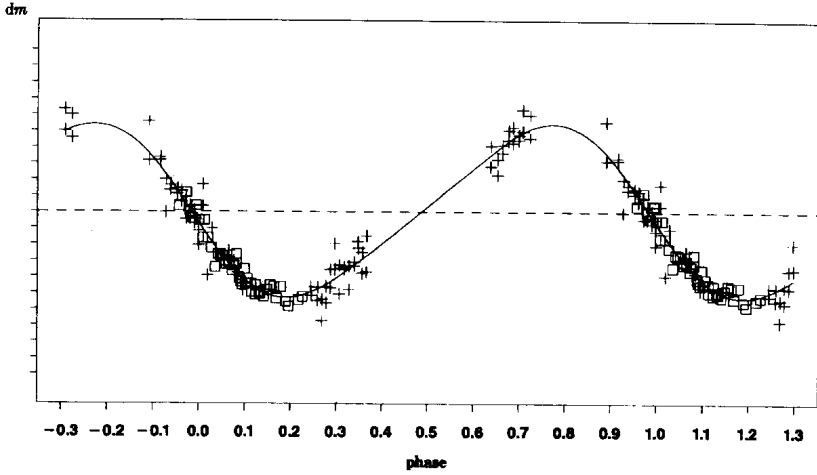
Figure 4: Lightcurve in the v band for the 1994 data (crosses) and Delgado et al.'s (1992) data (squares). $P = 1^{d}56300$ and the phase origin is JD 2449279.0. Ticks on the ordinate axis are separated by $0^{m}01$.
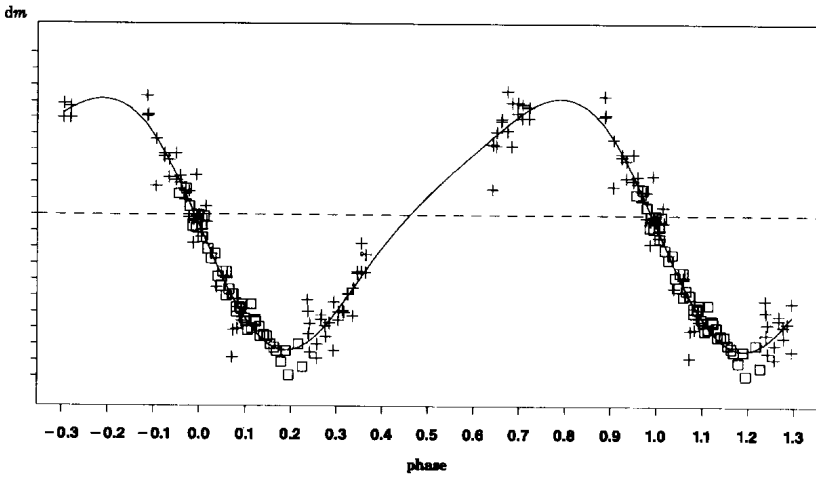

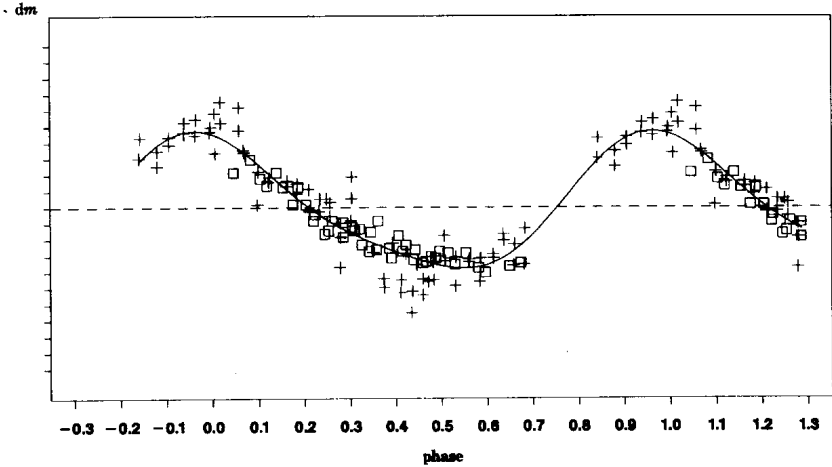Figure 5: Same as Fig. 4 for the u band.

Figure 6: Lightcurve in the v band for the 1994 data and Delgado et al.'s (1992) data. $P = 0\overset{d}{.}61861$ and the phase origin is JD 2449279.0

J. MANFROID
P. RENSON
Institut d'Astrophysique
Avenue de Cointe 5
B-4000 Liège, Belgium

References:

Cuffey J., McCuskey S.W.: 1956, ApJ 123, 59

Delgado A.J., Alfaro E.J., Garcia-Pelayo J.M.: 1992, AJ 103, 891

Hoag A.A., Johnson H.L., Iriarte B., Mitchell R.I., Hallam K.L., Sharpless S.: 1961, Publ. U.S. Naval Obs. 2nd Ser., 7, 345

Maitzen H.M., Lebzelter Th.: 1993, IBVS 3856

Manfroid J., Renson P.: 1994, A&A, 281, 73

Renson P.: 1991, Catalogue Général des Étoiles Ap et Am, Institut d'Astrophysique, Université de Liège

Renson P.: 1994, A&A, 285, 912