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NGC 2169-12, a photometric and spectroscopic Silicon variable *

In the course of a *Durchmusterung* of open clusters for the presence of chemically peculiar ('CP') stars of the upper main sequence using $\Delta\alpha$ photometry, the object No. 12 (numbering according to Hoag et al., 1961) in the young open cluster NGC 2169 has been identified as peculiar (Maitzen, 1993). Moreover, its $\Delta\alpha$ -index turned out to have a large scatter.

Table 1 gives the log of 7 observations obtained at ESO-La Silla both at the 1m-ESO and the 61cm-Bochum telescopes (description of the equipment: Maitzen, 1993). Since such a low number prevents us from applying the usual period search codes we have relied on visual inspection of phase diagrams in order to single out possible periods.

An important starting point for period search is the *uvby*-photometry of Delgado et al. (1992) who discovered photometric variability of NGC 2169-12 through two extended night series (duration: about 7 hours each) separated by 3 days. Since they observed in both nights a decline in brightness in all colours (with decreasing range from blue to red) at roughly the same level, they conclude that the period should be larger than two times the duration of the observing run, hence about 14 hours. Delgado et al., however, retreated to the suggestion of Perry et al. (1978) who concluded from their 2 spectrograms (taken with a 0.9m telescope) that the star is a spectroscopic binary and ascribed the light variation to a binary system with components of rather different type. Had they taken into account that Young and Martin (1973) already classified it as Silicon star both the possible period length and the amplitude increase from *y* to *u* would have appeared to them as typical features of a hot CP2 star.

Fig. 1 shows the variation of the $\Delta\alpha$ -index with phase for $P = 1.56$ days yielding the smoothest picture. While $P = 0.77$ has still to be retained as possible period, our photometry renders a period near 3 days improbable although it has shown up *prima facie* from the *uvby*-photometry of Delgado et al.

* based on observations collected at the *European Southern Observatory (ESO)* on La Silla, Chile, and at the *Leopold-Figl-Observatorium für Astrophysik* on Mount Schöpfl, Austria. This research has made use of the SIMBAD database, operated at *CDS*, Strasbourg, France.

NGC 2169-12, P=1.56 d

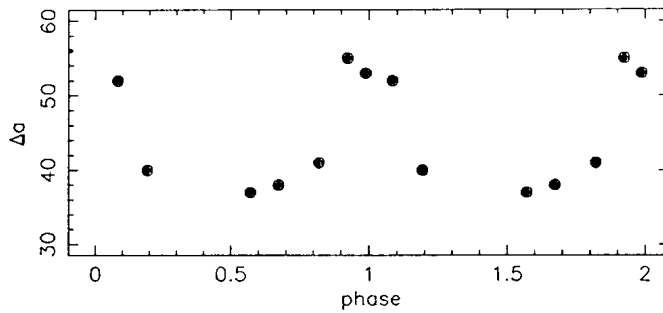


Fig. 1: Δa in mmags versus phase (elements of the variation: Tab. 1)

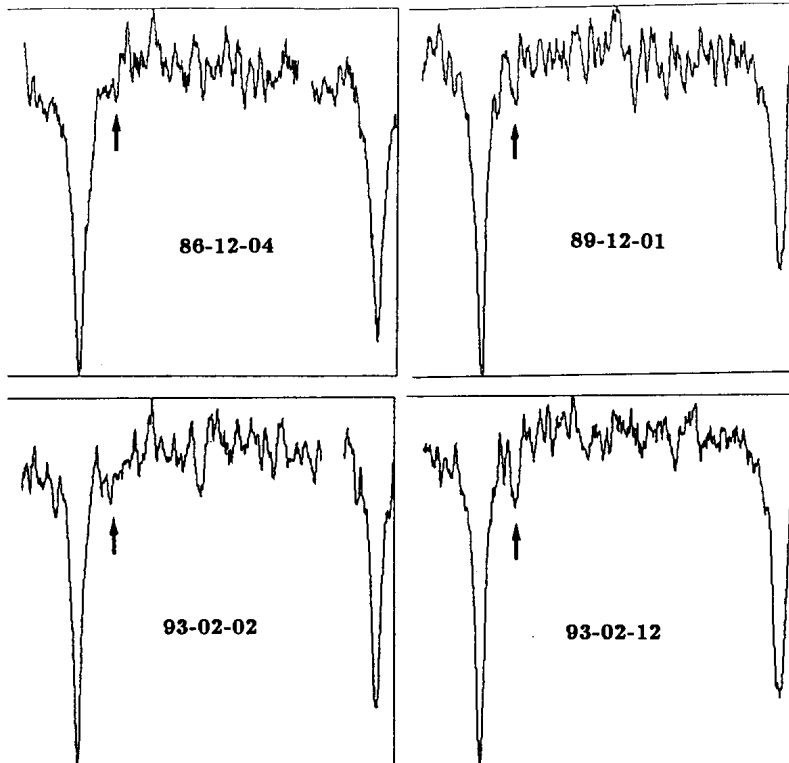


Fig. 2: Density tracings of NGC2169-12 spectrograms between $H\delta$ (left) and $H\gamma$ (right) obtained at the observing nights indicated. The location of the Si II doublet 4128-31 is marked by an arrow. Gaps in the tracings are due to emulsion defects.

TABLE 1. $\Delta\alpha$ -photometry of NGC 2169-12

HJD	ϕ	$\Delta\alpha$	n	m.e.	telesc.
2447524.70	0.08	52	4	2.7	1m ESO
25.62	0.67	38	9	1.6	1m ESO
27.67	0.99	53	4	3.2	1m ESO
30.69	0.92	55	7	5.0	Bochum
31.70	0.57	37	16	2.8	Bochum
32.67	0.19	40	5	3.9	Bochum
33.65	0.82	41	5	1.3	Bochum

Notes: the phases ϕ were calculated with $\Delta\alpha(max) = 2447524.57 + 1.56E$. The photometric quantities are expressed in mmags.

TABLE 2. Spectroscopic observations at Mt.Schöpf

Plate No.	HJD	night	exposure
S811-3	2446769.51	86-12-04	81 min.
S878-3	2447862.47	89-12-01	60 min.
S974-3	2449021.35	93-02-02	184 min.
S978-1	2449031.38	93-02-12	175 min.

Although there is triple evidence (one spectroscopic identification, our $\Delta\alpha$ -values and *uvby*-variability) for the CP2-nature of NGC 2169-12, we were worrying about the fact that 3 other spectroscopic classifications indicated normal main sequence types:

Hoag and Applequist (1965): A0V,
van Rensbergen et al. (1978) and Perry et al. (1978): B9V.

Maitzen (1993) pointed out that one reason for missing peculiarity could have been the insufficient spectrum widening forced by the fact that for the telescopes and photographic technique used the star is practically at the magnitude limit.

Since the star is at $\delta = 13^\circ$, hence observable also from the northern hemisphere we decided to resort to our home observatory, the *Leopold-Figl-Observatorium für Astrophysik* on Mt. Schöpf and to obtain spectra with its Boller&Chivens Spectrograph at dispersion 125 Å/mm on IlaO emulsion. The widening of the spectrograms on the plate was 500 microns. Table 2 contains the log of the spectrographic observations and Fig. 2 the density tracings obtained at the PDS 1000 microdensitometer of the Vienna Institute for Astronomy (step size: 2 microns, slit width: 4 microns).

From the behaviour of the Si II 4128-31 doublet it is clear that NGC 2169-12 is a spectrum variable. Our spectrograms S811-3 and S974-3 do not show any prominence of the Si feature and we would have classified the star as normal like the other sources except Young and Martin. On the other hand, S978-1 and to a lesser extent also S878-3 exhibit the Silicon doublet as outstanding. Hence, the problem of controversial classifications is resolved by the existence of intrinsic changes of peculiar spectral features.

We conclude therefore that all existing observational evidence consistently identifies No. 12 as CP2-Silicon star with strong variability in Silicon line strength, $\Delta\alpha$ and *uvby*, and rather fast rotation.

A final note is due to the appearance of an object 'No. 12' with Geneva photometry (reported e.g. in the SIMBAD database): This number refers to the designation of Cuffey and McCuskey (1956) and represents Hoag No. 15 (North, 1993).

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