COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 3752

Konkoly Observatory
Budapest
21 July 1992
HU ISSN 0324 - 0676

10 Aquilae revisited: rapid photometry in the IR and visible bands

The star 10 Aql (HR7167, HD176232) was initially reported as a rapid oscillating Ap (roAp) star by Heller and Kramer (1988). It is one of the two known roAp stars with positive declinations (m_V=5.89, α=19 h, δ=13.°9). The class of roAps is currently formed by cool, magnetic, Ap SrCrEu stars, which undergo oscillations with periods from 4 to 15 minutes and amplitudes of a few millimagnitudes (mmag) in blue light. This group was first described by Kurtz (1982) and several searches for new members have been conducted since then (see e.g. Martinez *et al*, 1991; Nelson and Kreidl, 1992), with over 20 discovered so far. A magnificent review covering all topics on roAp stars can be found in Kurtz (1990).

Over the past few years, a controversy has been produced on the possibility of detection of the oscillations at infrared (IR) wavelengths. According to Matthews *et al* (1990), the amplitude should decrease with increasing wavelength, following a certain criterium. However, quite contradictory results have been obtained so far. Several campaigns have yielded significant, negative results (see e.g. Matthews *et al*, 1992; Belmonte *et al*, 1992). However, excited by the marginal positive detection reported by Weiss *et al* (1991) in α Circini, Belmonte *et al* (1991) conducted a rapid IR photometry search for oscillations in 10 Aql. The outcomes were surprising, since some frequency peaks, just at the limit of credibility, were located in the amplitude spectra, at almost exactly the same frequencies reported by Heller and Kramer (1990) for observations in the blue band. Unfortunately, on that occasion, no simultaneous visible photometry series were available, hence, they were unable to give a correct answer to the problem.

One year later, new observations were undertaken, this time simultaneously in b, y and H bands. The IR observations were made at the 1.54*m* Carlos Sánchez Telescope (TCS) of the Teide Observatory (OT) on the Island of Tenerife (Canary Islands, Spain). The instrument was a liquid nitrogen cooled photometer with an InSb solid state detector, and a focal plane chopper. This instrumentation allowed to make continuous 10s integrations on the star, performing simultaneous sky background corrections. In this case, we chose to observe in the H filter because, at the time of the observations, the system was showing its best performance at this wavelength. The journal of observations is presented in Table 1. Weather conditions were quite good over most of the observing period. However, some dust was present in the air during 3 nights (June 28, 29 and 30), thus increasing extinction at IR wavelengths, this fact is clearly reflected in Table 1. Globally, some 32 hours of useful data were obtained. The observations in the visible were performed at two places, OT itself and Lowell Observatory (LO). At OT, an on-line small photometer was attached to the TCS, using a blue/red beam splitter, which reflected 5% of the blue light into the photometer aperture. This was the first time this configuration was used. As expected, data quality was not very good and useful data was only obtained for June 27 (σ=7.7 mmag). Simultaneous b and y rapid photometry series were obtained at LO with the 1.1*m* Hall telescope. Unfortunately, weather conditions were quite humid over most of the run. Only 3 short data series of relatively good quality were obtained for the last 3 nights (see Table 1).

Date (1991)	Σ	t_H (hours)	K_H	σ_H (mmag)	t_{LO} (hours)
25/6	948	4.0	0.095	4.5	
26/6	574	2.6	0.160	2.6	
27/6	1853	6.1	0.110	6.1	5.5*
28/6	1118	3.7	0.237	3.7	
29/6	1928	6.6	0.266	6.6	3.4
30/6	1256	4.1	0.337	4.1	2.9
01/7	1485	5.1	0.044	5.1	2.3

Table 1: *Journal of observations. For each date, the table lists: the number of 10 s integrations, the length in hours from the beginning to the end of the run, the extinction coefficient derived for the H filter, and the standard deviation of the airmass fit reduction procedure. The length in hours of the b and y Lowell series is reported in the last column. (*) This series was obtained at OT.*

The H photometric data series were reduced with a standard astronomical fit to airmass. This procedure yields the final time series, the standard deviation of the fit and the extinction coefficient. In this observing period, a value of K_H=0.18$\pm$0.03 *mag per airmass* has been obtained for this coefficient. This number is compatible with the K_J=0.18 *mag per airmass*, found one year before, under similar atmospheric conditions (Belmonte *et al*, 1991). All time series were submitted to a harmonic analysis via an iterative sine wave fitting. Analyses of several series (both IR and visible) were made, with an intrinsic resolution ranging from 1.65 to 3.85 μHz. Figure 1 shows the amplitude spectra yielded by them.

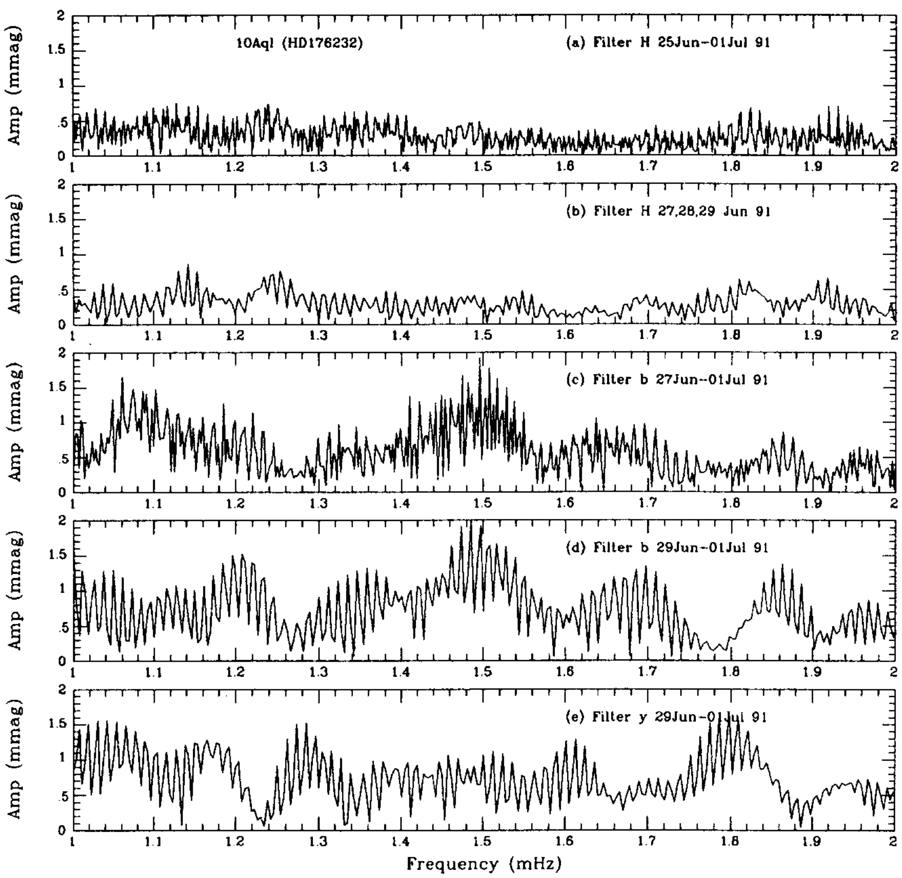

Figure 1: *Amplitude spectra, in the range of interest, of the several rapid photometry time series of the roAp star 10 Aql.* **(a)** *Global OT series in the H filter.* **(b)** *OT 3 best nights series in the H filter.* **(c)** *Global series in the blue, including OT and LO series.* **(d)** *and* **(e)** *Global Lowell series in b and y, respectively. If observable, frequency peaks of oscillation should have been located at 1.26, 1.38 and 1.44 mHz (Heller and Kramer, 1990; Belmonte et al, 1991).*

As already stated, data in the b and y filters were not as good as desired. Consequently, the noise level in their amplitude spectra (see Fig. 1) is high and the evidence of oscillations very poor. Even knowing where to look, it is difficult to define something more than upper limits for the amplitudes. It is pretty obvious that 10 Aql is oscillating with amplitudes in Δb and Δy well below 1 mmag, in agreement with previous reports (Heller and Kramer, 1990).

Regarding the IR time series, we are not able to confirm previous findings reported by Belmonte *et al* (1991). Our new data (see Fig. 1) show similar quality but not the same frequency peaks. Besides, the evidence of a peak of $\Delta H \sim 0.8$ mmag at 1.24 mHz is completely marginal, and should be considered more as an uppermost limit for the amplitude, than the actual amplitude of a frequency peak. Indeed, uppermost limits of $\Delta H \sim 0.5$ mmag might be considered for the other two frequencies reported in the literature, 1.38 and 1.44 mHz. In conclusion, we still do not have a satisfactory explanation for the strange behaviour shown by 10 Aql in July 1990. On the contrary, these new outcomes seem to confirm the theory that roAp infrared amplitudes are extremely low and, consequently, not easily detectable (Matthews et al, 1992).

Disappointingly, 10 Aql is poorly studied, due to its significantly low amplitude. Its frequency spectrum is not yet established, though over 100 hours of photometry gathered by numerous observers and analyzed by Kreidl (unpublished) do confirm the primary 1.26 mHz oscillation. In particular for IR photometry, larger telescopes, better detectors and greater coverage, both spatial and temporal, should be scheduled to reach a good signal-to-noise ratio on this star. Maybe under these conditions, the controversial oscillatory character of 10 Aql can be better understood.

J.A. Belmonte[1], T.J. Kreidl[2] and C. Martínez Roger[1]

(1): *Instituto de Astrofísica de Canarias, 38200, La Laguna, Tenerife, Spain.*

(2): *Lowell Observatory, 1400W Mars Hill Road, Flagstaff, AZ 86001, USA*

References :

Belmonte J.A., Martínez Roger C. and Roca Cortés T.; 1991. *A&A.* **248**, 541.

Belmonte J.A., Martínez Roger C. and I. Vidal; 1992. *Inf. Bull. Var. Stars.* No.3751.

Heller C.H. and Kramer K.S.; 1988. *P.A.S.P.* **100**, 583.

Heller C.H. and Kramer K.S.; 1990. *Mon. Not. R. astr. Soc.* **244**, 372.

Kurtz D.W.; 1982. *Mon. Not. R. astr. Soc..* **200**, 807.

Kurtz D.W.; 1990. *Ann. Rev. Astr. Astrophys.* **28**, 607.

Martinez P., Kurtz D.W. and Kauffmann G.M.; 1991. *Mon. Not. R. astr. Soc.* **250**, 666.

Matthews J.M., Wehlau W.H. and Walker G.A.H.; 1990. *Ap. J. Letters.* **365**, L81.

Matthews J.M., Wehlau W.H., Rice J. and Walker G.A.H.; 1992. In *Inside the stars, W. Weiss and A. Baglin (eds).* Vienna, Austria. *A.S.P. Conf. Ser.* (in press).

Nelson M.J. and Kreidl T.J.; 1992. In *Inside the stars, W. Weiss and A. Baglin (eds).* Vienna, Austria. *A.S.P. Conf. Ser.* (in press).

Weiss W.W., Schneider H., Kuschnig R. and Bouchet P.; 1991. *A&A.* **245**, 145.