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

Number 5383

Konkoly Observatory
Budapest
26 February 2003

HU ISSN 0374 – 0676

A REVISED PERIOD FOR AY Aur

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AY Aur, α:05^{h}56^{m}06^{s}; δ:+32^{d}08$^{m}_{\cdot}$5, (J2000 – FK5) is a Mira-type variable with a visual magnitude range of 10.0 – 16.0. The period according to the 4th edition of the *General Catalog of Variable Stars* (GCVS) (Kholopov et al., 1985) is 186.6 days, changed from the period of 373.6 days in the 3rd edition of the GCVS (Kukarkin et al., 1971).

In 1960, AY Aur was included as a survey of stars needing more observations commissioned by B. V. Kukarkin, who was then President of IAU Commission 27. That survey was performed by the University of Oklahoma Observatory under Balfour S. Whitney. Whitney determined the period to be 186.8 days (Whitney 1960). Regrettably, Mr. Whitney is deceased and no more information on the survey is available through the observatory.

The Third Edition of the GCVS references this survey but continues to list AY Aur with a period of 373.6 days in the tables. This was the mean value for the total number of observations available at the time (Samus, 2000). The period determined by Whitney was later used in the Fourth Edition of the GCVS.

372 visual observations covering 22 years from the AAVSO International Database were put through a Fourier analysis routine developed at AAVSO. The `CLEANEST` and `SLICK` algorithms (Foster, 1995) utilize a date compensated discrete fourier transform (Ferraz-Mello, 1981), and were developed specifically to deal with unevenly-spaced time-series measurements. A CLEANest analysis of long term visual data gives a revised period of 389.8 days. Theoretical error is ±0.3 days but experience shows it to be underestimated by a factor of 2 because it assumes a true sinusoid. A DCDFT analysis of 54 CCD V-band observations covering 3 years from the AAVSO International Database gives a period of 390.0 days.

Figure 1 shows the spectrum of the DCDFT analysis. The strongest peak is located at 389.8 days, with two higher-order Fourier harmonics at 195.4 and 129.5 days indicating a non-sinusoidal light curve. The theoretical errors of the latter two periods are both 0.3 days, though as with the dominant period, these are probably a factor of two too low.

We believe that the current GCVS period is incorrect, and is due to the window function of the data dominated by a one cycle per year alias. The GCVS period of 186.8 days is very close to the inverse sum of the 389.8 day period and one cycle per year:

$$\Pi_{\mathtt{GCVS}} \simeq \frac{1}{(1/389.8\,\mathrm{d}) + (1/365.25\,\mathrm{d})} = 188.6\,\mathtt{days}$$

This suggests that earlier Fourier analysis were confused by the large annual data gaps. This is particularly important here, given that the intrinsic period is very close to one year. Visual inspection of the earliest AAVSO data shows large gaps of six months or more, and often the minima are sparsely sampled if at all. The most recent data has much smaller annual gaps, and the shorter GCVS period is clearly ruled out.

Figure 2 is a plot of AAVSO visual and CCD V-band observations with calculated maxima and minima beginning on JD 2452272.758 and going backward using the 389.8 day period. The maxima was derived by applying a 3rd degree polynomial fit to the last cycle in the light curve.

A weighted wavelet transform (Foster, 1996) of all AAVSO optical and CCD data reveals no significant period change over the span of 1969 – 2002. Figure 3 shows a plot of the results of wavelet analysis. Error is estimated to be ± 0.0008 days based on the length of observational data.

In addition to these visual and CCD V-band observations, we conducted a survey of the Damon Series blue photographic plates at the Harvard College Observatory. Only observations near maximum were possible due to the interference of GSC 2410 799, a nearby star with a V mag of 12.5. 38 photographic observations were made from 1968 – 1989. They are plotted in Figure 2 as different symbols along with visual and CCD V-band observations. Their fit with our calculated maxima and minima acts as an independent data set confirming our new period.

We thank 72 observers worldwide for their observations which made this study possible. We would also like to thank Ronald Zissell, Stephen O' Connor, Robert James, and Thomas Michalik for their CCD V-band observations. We acknowledge Alison Doane and the Harvard College Observatory for access to their Astronomical Photograph Collection. Finally, we thank Nikolai N. Samus, George Hawkins, Emily Lu and Elizabeth Waagen for assistance in preparation of this work.

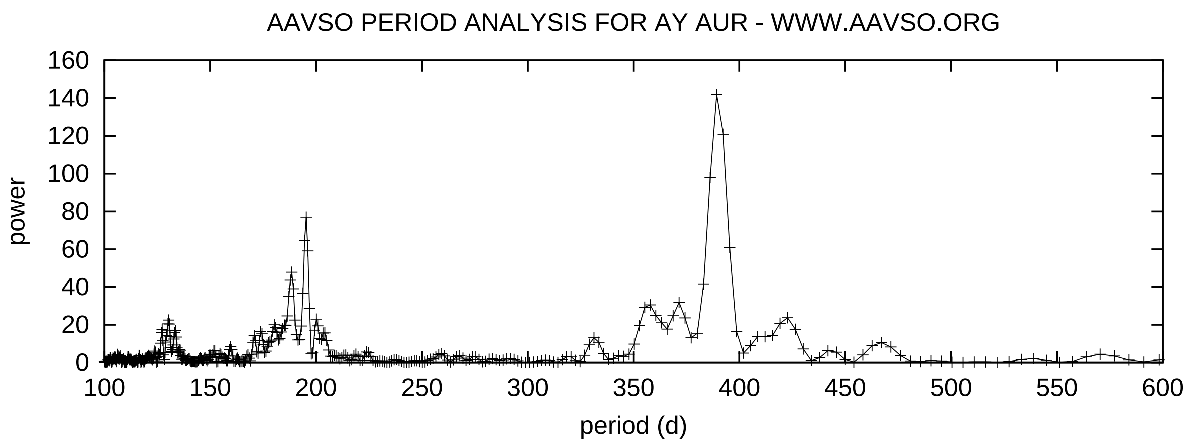

Figure 1. CLEANest Fourier transform of AY Aur visual data spanning JD 2440949.8 - 2452605.9 (December 29, 1970 – November 27, 2002).The dominant period is 389.8d. The 195.4 day period is an Fourier harmonic. We believe the source of the 188.5 day period to be an artifact of annual data gaps, but more data is needed.

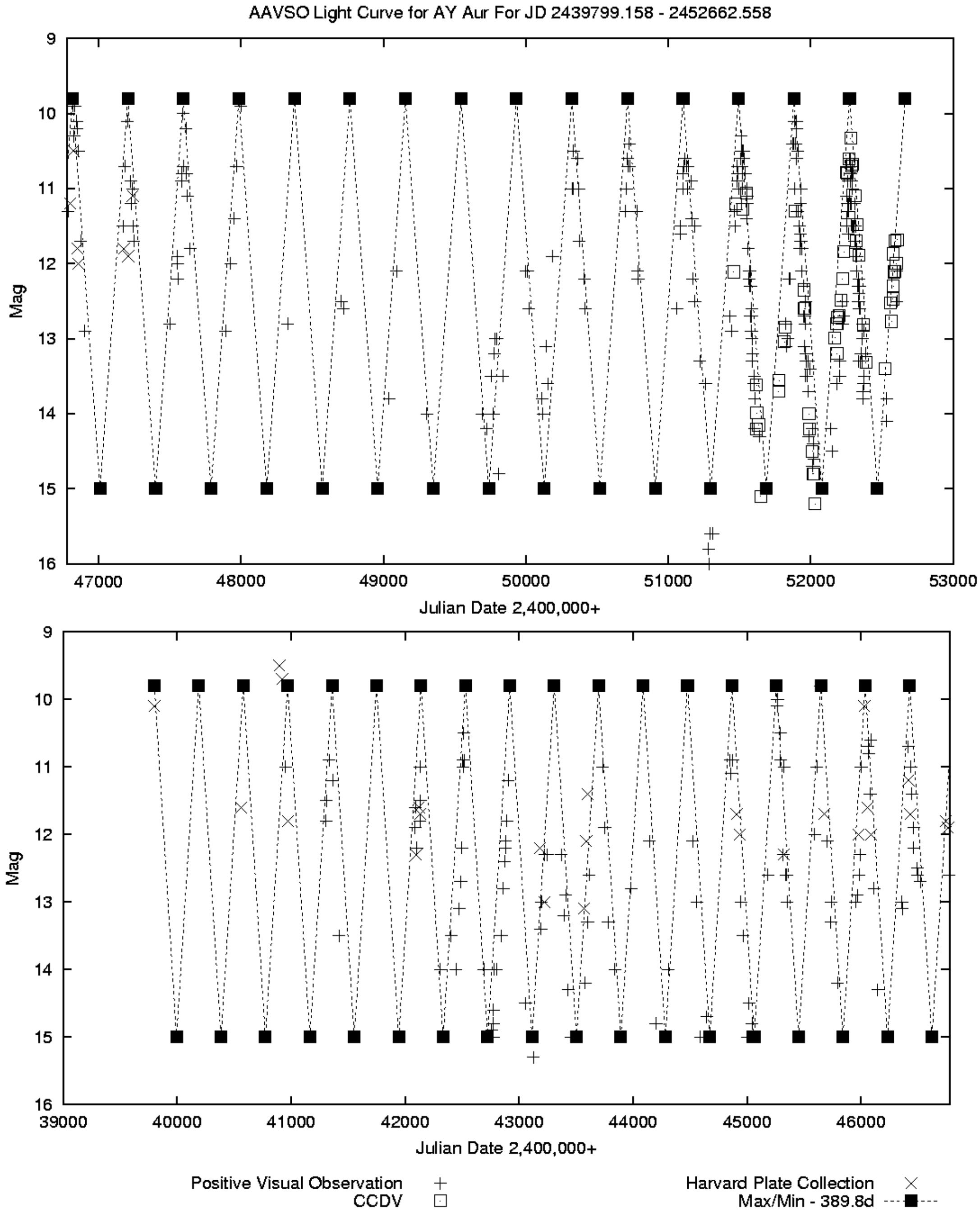

Figure 2. AAVSO Visual, CCD *V*-band, and Harvard photographic observations plotted with the 389.8 day period.

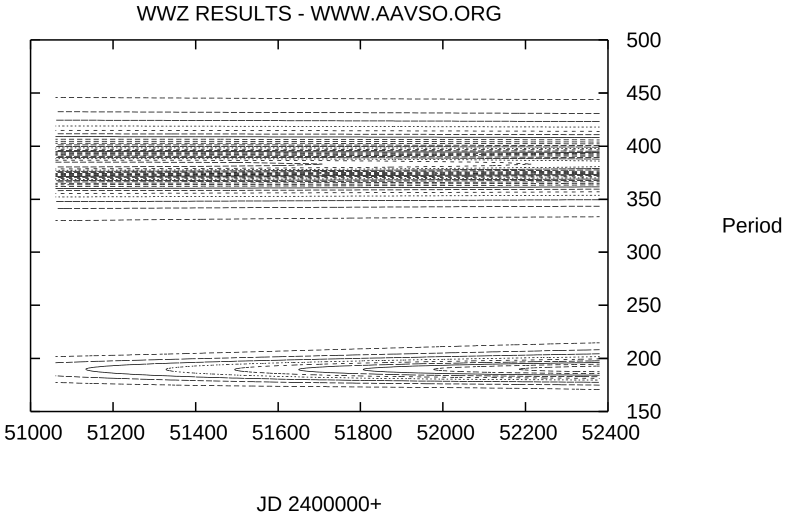

Figure 3. Contour plot of weighted wavelet transform analysis. The new period is the solid line between 350 and 450 days. The contour between 175 and 225 days is the Fourier harmonic.

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