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CI AQUILAE*

CI Aql (=AN 23.1925) was discovered due to a $\Delta m \approx 4.6$ mag outburst recorded on two Heidelberg plates in June 1917 (Reinmuth, 1925). It was much fainter on 6 other pairs of Heidelberg plates taken between 1909–1920 (Reinmuth, 1925), as well as 6 Moscow plates taken between 1909–1929 (Parenago, 1931). This and the small outburst amplitude led to the classification as a nova or dwarf nova with long cycle length (Duerbeck, 1987).

Though there are three objects of 16^m–18^m with $10''$ separation at the position of the outburst object, the identification was possible due to the large scale of the discovery plates (as shown in Duerbeck, 1987). A spectrum of the candidate object, taken in the 4300–8000 Å range on May 31, 1990, did not reveal the expected Balmer emission lines (Szkody and Howell, 1992) and casts doubts on the identification. Similarly, two spectra taken on May 20, 1991 and August 3, 1991 between 5000–8500 Å only showed an absorption line spectrum (Mennickent and Honeycutt, 1995). The resolution of these spectra was too low to determine the spectral type of this object, but Na D and KI λ7696 Å lines as well as the TiO bands suggested a K–M type star.

We observed spectroscopically all three objects (the candidate star plus the two neighbouring objects) on two occasions in 1992 and 1993 with the 3.5 m telescope at the Calar Alto Observatory. On September 28, 1992 the Cassegrain spectrograph equipped with a 1024×640 RCA chip (pixel size 15 μm) was used with a 240 Å/mm grating, resulting in a mean resolution of 10 Å (FWHM), in the 3800–7200 Å range. The exposure time was 20 min. and 30 min., respectively, starting at UT = 20:02 and 20:35. On September 29, 1992 we used a 60 Å/mm grating which allowed to cover the 6200–7100 Å with a resolution of 2.5 Å (FWHM). The exposure time was 30 min. starting at UT = 21:36. On June 15, 1993 the double spectrograph was used with 36 Å/mm gratings for both the red and blue arm which results in a resolution of slightly above 1 Å (FWHM), and a coverage of 3500–6000 Å and 5500–9000 Å. The detectors were 1080×1024 TEK mosaics with 24 μm pixel size. The exposure time was 30 min. starting at UT = 2:15. Helium-Argon spectra were taken immediately after the science exposures, and the stars Feige 110 (September 1992) and Wolf 1346 (June 1993) were used for the flux calibration. Standard MIDAS procedures were applied for the reduction of the data.

The two objects near the candidate object of CI Aql are late-type stars and do not show any emission lines. In contrast, all three spectra of the candidate object marked in Duerbeck (1987) show the high-excitation lines HeII λ4686 and NIII/CIII λ4650 in emission (see top and bottom panel of Figure 1) while Balmer emission lines are not present.

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*Based on observations collected at the German-Spanish Astronomical Centre, Calar Alto, operated by the MPI für Astronomie, Heidelberg, jointly with the Spanish National Commission for Astronomy.

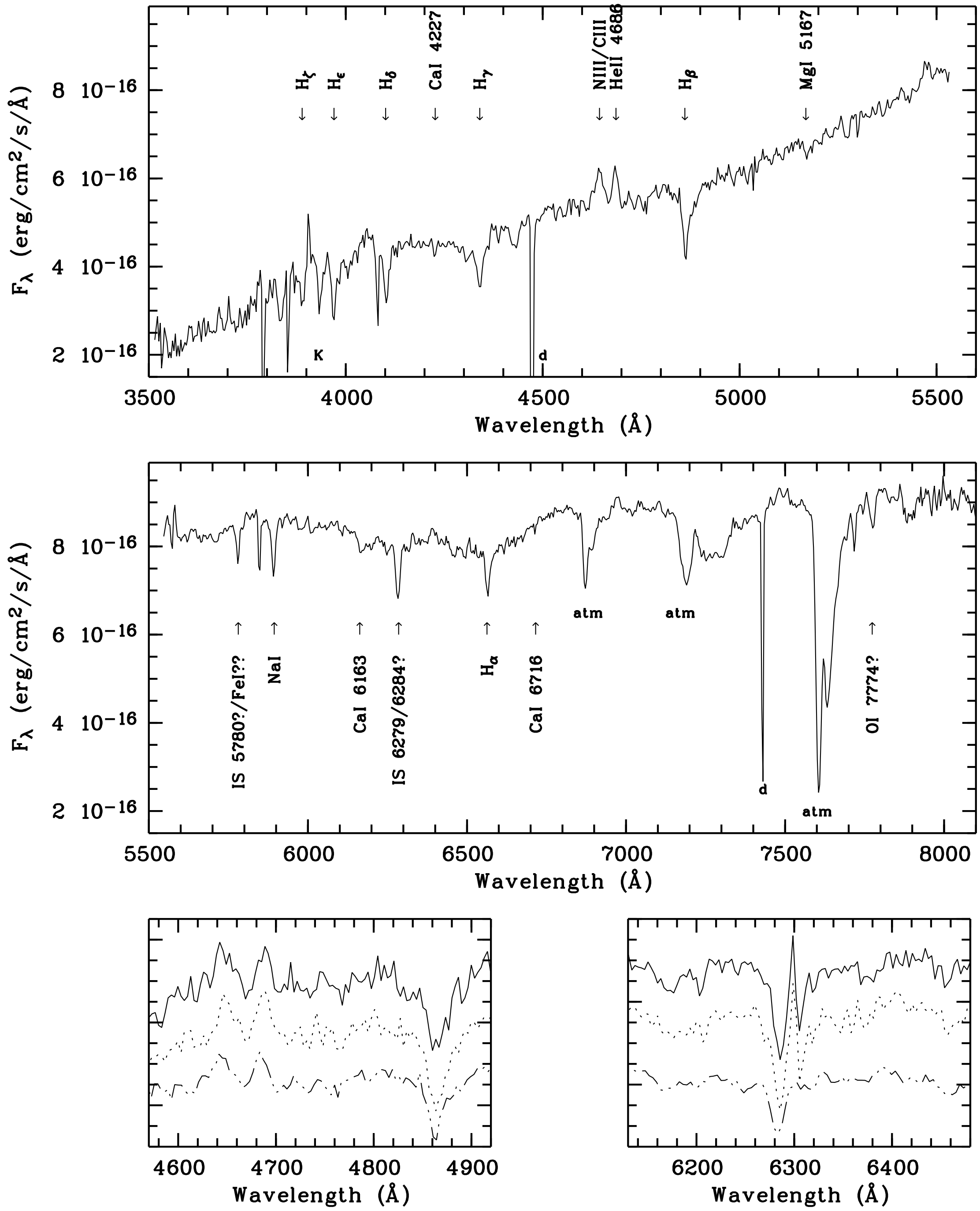

Figure 1. Medium-resolution spectra of CI Aql from June 1993 (top and middle panel). The letter K denotes the CaII K band, CaII H enhances Hϵ while the symbol "d" denotes a detector flaw and "atm" stands for atmospheric absorption bands. The bottom panel shows a blow-up of the emission line regions at the same intensity scale. Spectra are ordered in time from top to bottom. Note that the [OI] $\lambda\lambda$ 6300 line is absent in June 1993

Also, we find an emission line at 6299 Å in the two September 1992 spectra, which we interpret as [OI] ($\lambda\lambda$ 6300 Å). Even at the highest spectral resolution these emission lines only show a marginal double peak structure which implies a velocity amplitude smaller than 200 km/s. We therefore conclude that the identification of CI Aql as given in Duerbeck (1987) is correct, and that CI Aql is presently in a state of low interaction.

Recently, Mennickent and Honeycutt (1995) reported the discovery of $0\overset{m}{.}6$ deep eclipses in the lightcurve of CI Aql with a period of $0\overset{d}{.}618355(9)$ with an additional $0\overset{m}{.}2$ amplitude secondary minimum shifted by 0.5 in phase with respect to the eclipse. The shape of the light curve is typical for a contact system of two components with differing surface brightness, and excludes the presence of a compact object in CI Aql, as would be implied by the previous nova or dwarf nova interpretation. This is also supported by the shape of the spectrum which does not show any blue component down to 3500 Å and no Balmer lines in emission.

At the given orbital period and due to the weak mass dependence of the semi-major axis of the orbit ($a = 3.63 \times (M_1 + M_2)^{1/3}\ R_\odot$), a is of the order of 3–4 $R_\odot$ for a reasonable range of masses M_1 and M_2 of the two components. This excludes the presence of a giant as suggested in Mennickent and Honeycutt (1995). Thus, the binary system in CI Aql has to contain two stars with different surface brightness being either main-sequence stars or subgiants.

All our spectra were taken in the phase interval 0.3–0.6, i.e. around the secondary minimum and thus are dominated by the bright component. The determination of the spectral type of the bright component appears nevertheless to be difficult. We cannot use the hydrogen Balmer lines because they are affected by the fainter, late-type component. Similarly, the NaI D (λ 5890 Å) absorption blend is due to a superposition of the contributions of both components. The presence of the Balmer absorption lines and of CaII H,K on the one side and of CaI g and the G band on the other side confirm the existence of two bodies of differing effective temperature.

This combination of early- and late-type star might suggest some unusual RS CVn type binary. In addition to the spectroscopic observations we have therefore searched 1050 Sonneberg sky patrol plates taken mainly by Huth and Fuhrmann between 1926–1991 for additional eruptions of CI Aql. The combined impression of CI Aql and the two neighbouring stars mentioned at the beginning is visible only on the very best plates at $m_{pg} \approx 14\overset{m}{.}8$ (transformed to Mt.-Wilson system using Selected Area 110), and no further eruption was found.

CI Aql has also been in the field of view of three ROSAT PSPC pointings (at different off-axis angles) performed on 1992 October 8–12, 1993 April 2–7 and 1993 September 21 – October 5, but was not detected in any of these (energy range 0.1–2.4 keV). The deepest upper limit on the X-ray flux is 7×10^{-4} cts/s. Dempsey et al. (1993) have investigated the soft X-ray emission of 136 nearby RS CVn systems using the ROSAT all-sky survey data. Using their conversion factor of 6×10^{-12} erg/cm^2/count we get an upper limit X-ray luminosity of 5×10^{29} erg/s (D/1 kpc)^2. This would imply a rather large extinction if CI Aql is indeed a RS CVn system. This is not inconsistent with the heavy interstellar effects in this direction (Neckel and Klare 1980), but the lack of CaII (H and K) emission argues against a standard RS Canum Venaticorum type binary, and so does the contact type lightcurve.

Summarising, the lack of a blue continuum and the Balmer series as well as the shape of the orbital light curve of CI Aql clearly argue against a dwarf nova classification. As argued above, also a standard RS CVn nature seems unlikely. With the present data we cannot offer an alternative classification. Since CI Aql is an eclipsing object, time-resolved spectroscopy is needed to allow the determination of more accurate spectral types of the two components as well as the velocity amplitudes.

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