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ON THE ORBITAL PERIOD OF KQ Mon

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KQ Mon was detected as a variable star by Hoffmeister (1943). It received a first classification as an irregular variable with the spectral type of a carbon star (Cameron & Nassau 1956), which was changed to a cataclysmic variable of UX UMa subtype by Sion & Guinan (1982) who discussed IUE spectra of this object. The latter authors also discuss parallel high speed photometry, which showed variation in the form of low amplitude flickering, but no apparent orbital modulation. This classification was later confirmed by Zwitter & Munari (1994) whose optical spectrum of KQ Mon shows a blue continuum and a strong Hα emission line. Hoard et al. (2002) identified the object in the 2MASS survey and found that it is a close visual triple star which was resolved in the 2MASS images. This might explain the earlier ambiguous spectral classification.

In the framework of the REU (Research Experiences for Undergraduates) observation campaign at CTIO (Cerro Tololo Inter-American Observatory) in February 2004, we performed time-resolved medium resolution spectroscopy of KQ Mon with the aim of obtaining its orbital period.

We observed the object in two nights with the R-C spectrograph at the 1.5 m telescope at CTIO, covering about 8.5 h in total (see Table 1 for details on the observations). Standard data reduction was performed with IRAF including bias and flatfield correction and wavelength calibration. The spectra have a FWHM resolution of 0.26 nm and a spectral range of 590–710 nm, thus including the Hα emission line. No flux calibration has been performed. All subsequent analysis of the data has been done using MIDAS.

We have averaged the individual spectra, for each pixel disregarding the ten values farthest from the median value. The resulting average spectrum of KQ Mon is plotted in Fig. 1. It mainly shows a narrow (FWHM = 1.068(2) nm) Hα emission line with an

Table 1: Observational details of the individual spectra.

Date & UT at start of first exposure		number of exposures	individual exposure time [s]
2004-02-08	01:18:38	5	600
2004-02-08	02:17:59	41	300
2004-02-11	00:19:49	23	300

equivalent width of -0.46(3) nm. Some absorption features might be due to the secondary star. No low excitation emission lines are found in the spectrum, thus confirming the previous classification as UX UMa type star.

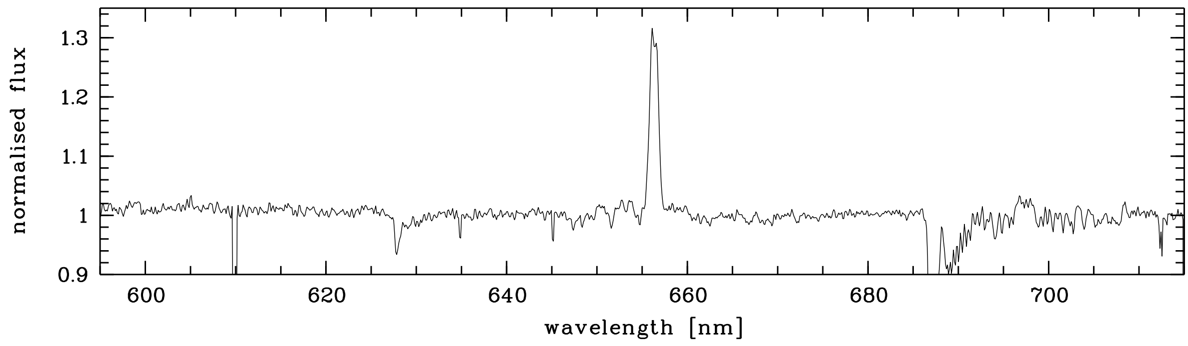

Figure 1. The average spectrum of KQ Mon.

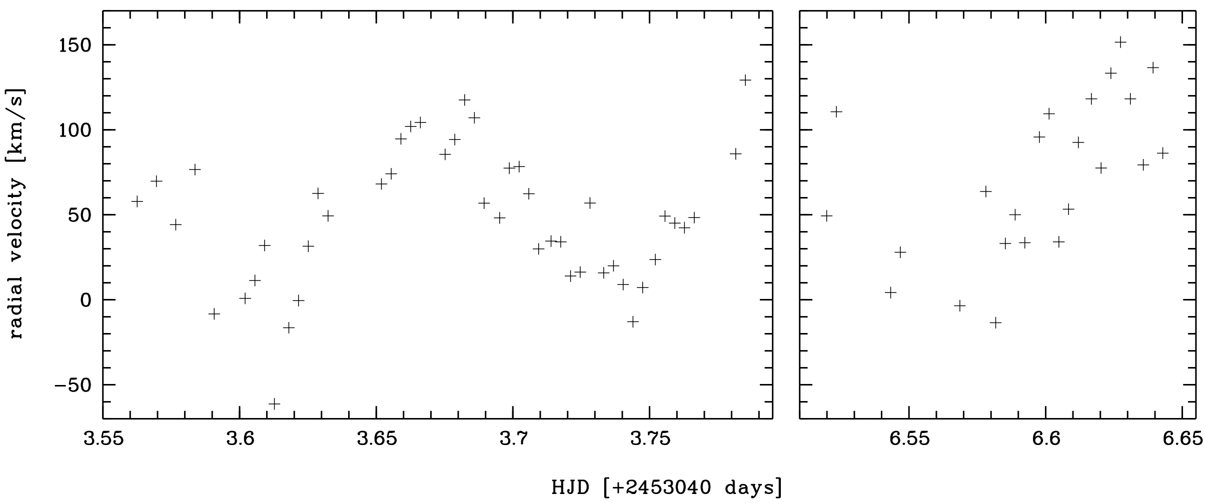

Figure 2. The radial velocities are plotted against the time of their observation.

The radial velocities have been determined by fitting a broad Gaussian to the Hα emission line in the individual spectra. They have been corrected for the motion of the observer towards the object. In Fig. 2 the radial velocities are plotted against the heliocentric Julian date. A clear sinusoidal variation is seen in the data.

We have used the Scargle algorithm (Scargle, 1982) and the analysis-of-variance method (Schwarzenberg-Czerny, 1989) as implemented in MIDAS, to find the period in the radial velocities. The resulting periodograms are plotted in Fig. 3. From these we derive four possible values for the orbital period at 2.83(4) h, 2.95(4) h, 3.08(4) h, and 3.22(5) h, the most probable alias being the period $P = 3.08(4)$ h.

Using this value for the orbital period and arbitrarily setting the first data point (HJD = 2453043.5626) to $\phi = 0$, we have derived the orbital phase for the time of the observations. In Fig. 4, the radial velocities are plotted against this orbital phase.

They were fitted using a minimum of variance method on the sinusoidal fitting function

$$v(\phi) = \gamma + K_1 \cdot \sin\left(2\pi\left(\phi + 0.5 - \phi_0\right)\right) \tag{1}$$

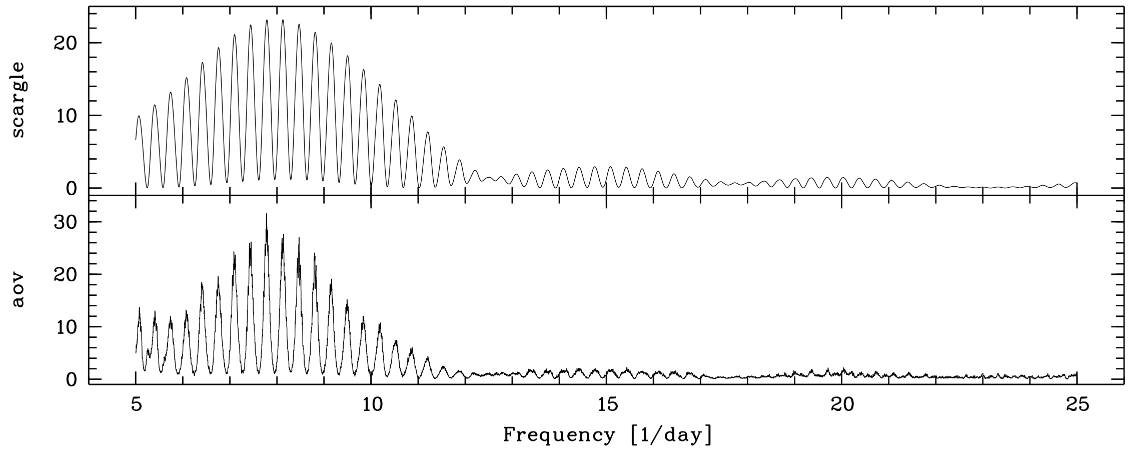

Figure 3. The periodograms of the radial velocities are calculated by Scargle and AOV method, see text for details.

where v is the measured radial velocity and ϕ the orbital phase as derived above. The fitting parameters are the system velocity γ, the semi-amplitude K_1 of the radial velocity, and the phase shift ϕ_0 for the red-to-blue crossing on the velocity curve which in the absence of discrete emission sources in the disc corresponds to the inferior conjunction of the secondary.

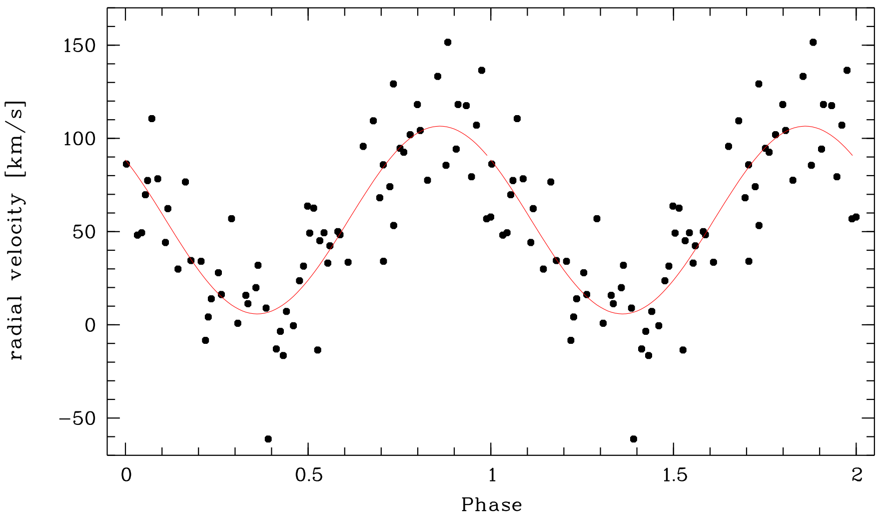

Figure 4. The radial velocities are plotted against the orbital phase with respect to the period $P = 3.08\,\mathrm{h}$, the first data point being arbitrarily set to phase zero. The best sinusoidal fit is overplotted.

The stability of the fit has been tested using Monte-Carlo simulations which also yield the uncertainties of the individual quantities. We thus derive the following parameters: $\gamma = 56 \pm 2\,\mathrm{km/s}$, $K_1 = 50 \pm 2\,\mathrm{km/s}$, and $\phi_0 = 0.111 \pm 0.008$.

An orbital period $P = 3.08\,\mathrm{h}$ would place KQ Mon at a position just above the period gap for cataclysmic variables. Novalike variables in this period bin tend to be strong candidates for being physical SW Sex type stars (Gänsicke, 2005; Rodríguez–Gil 2005). We did find some hints for variable high velocity wings in the individual spectra of KQ Mon which would confirm this classification, but the S/N is not sufficient for an unambiguous statement on the presence of this feature. Furthermore, the presence of absorption features in the average spectrum might hint towards KQ Mon being a magnetic system.

We conclude that further data are needed to a) confirm the present choice of the orbital period and b) to ascertain a possible magnetic and/or SW Sex type nature of KQ Mon.

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