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THE γ DORADUS VARIABLE HD 19684 – A SPECTROSCOPIC BINARY

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Determining the question of duplicity is crucial for the study of γ Doradus variables. These late-A and early-F type stars are a recently discovered class of variables defined by Kaye et al. (1999). Kumar, Ao, & Quataert (1995) and Willems & Aerts (2002) showed that the presence of a close companion produces tidal effects that can induce pulsation in a star. Thus, it is important to determine whether each γ Doradus variable is a single star with intrinsic pulsation or a close binary with pulsation periods perhaps induced by tidal interactions. As an example of the latter, Handler et al. (2002) recently found HD 209295 to be the first star that has light variability periods typical of both δ Scuti and γ Doradus variables. However, they noted that its γ Doradus pulsations are tidally excited.

Recent radial velocities combined with previously-published data from the literature show that the γ Doradus variable HD 19684 (Henry & Fekel, 2002) is a spectroscopic binary.

Henry & Fekel (2002) published a mean radial velocity from three observations. The individual spectra were obtained with the Kitt Peak National Observatory 0.9-m coudé feed telescope, coudé spectrograph, and a TI CCD detector. These spectra are centered at 6430 Å, have a wavelength range of about 80 Å, and a 2-pixel resolution of 0.21 Å. The typical signal-to-noise ratio for these spectra ranged from 150 to 250. The six older spectra from Fehrenbach et al. (1987), obtained at Haute-Provence Observatory have a dispersion of 80 Å mm^{-1}.

The velocities of Fehrenbach et al. (1987) range from 3 to -23 km s^{-1}. Our three KPNO velocities add to the temporal baseline and range from 0 to 20 km s^{-1}, enabling us to establish that this star is indeed a binary and determine a preliminary orbit.

With a total of nine velocities (Table 1) we searched for periods between 1 and 40 days. The results indicate several possible periods between 31 and 33 days. With weights of 1.0 and 0.2 for the KPNO and Fehrenbach et al. (1987) velocities, respectively, orbital solutions were obtained starting with the four best periods. An orbit with the eccentricity fixed at zero and a period of 31.9456 days resulted in the smallest sum of the squared residuals, and so we adopt it as the current best preliminary orbit of HD 19684. Table 2 lists the orbital elements of this solution and Figure 1 shows the velocities compared with the calculated orbit.

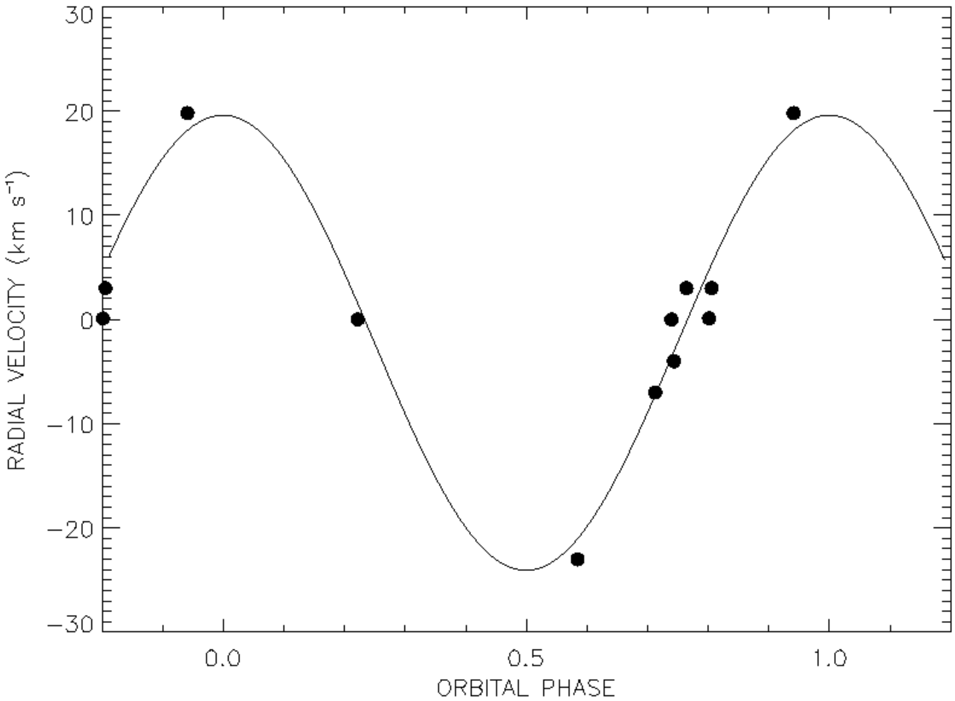

Figure 1. A phased radial-velocity curve of the primary star comparing the nine velocities with the computed orbit. Phase zero is the time of maximum radial velocity.

Table 1: Radial Velocities of HD 19684

HJD − 2,400,000	Phase	Velocity ($km\ s^{-1}$)	O−C ($km\ s^{-1}$)
45697.3549	0.2211	0.0	−1.3
46001.5229	0.7425	−4.0	−0.4
46003.5118	0.8048	3.0	−1.7
46032.4868	0.7118	−7.0	0.7
46060.3410	0.5837	−23.0	−1.8
46321.6451	0.7634	3.0	3.8
52013.605	0.9400	19.8	2.3
52326.620	0.7384	0.0	4.2
52328.610	0.8007	0.1	−4.1

Table 2: Preliminary Circular Orbital Elements of HD 19684

Orbital Element	Value
Period (fixed)	31.9456 days
Time of maximum velocity	2,452,015.5 ± 0.7 days
Center of mass velocity	-2.3 ± 3.1 km s^{-1}
Semi-amplitude	21.8 ± 3.3 km s^{-1}
Mass Function	$0.03 \pm 0.02\ M_{\odot}$
$a \sin i$	0.06 ± 0.01 AU
σ	4.3 km s^{-1}

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