A PRELIMINARY STUDY OF THE SPECTROSCOPIC BINARY GAMMA ANDROMEDAE B

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ABSTRACT

A velocity-curve has been obtained, and orbital elements have been determined for the spectroscopic binary γ Andromedae B. Some geometrical aspects of the system are discussed.

Spectrograms of the B–C components of the γ Andromedae system—ADS 1630: α (1950) = $2^h00^m.8$, δ (1950) = $+42^\circ06'$—taken by A. Slettebak in 1957 with the Perkins 69-inch telescope showed that one of the two components is itself a spectroscopic binary of short period. The separation between components B and C is small enough (about $0''.3$) that the two stars appear as one at the slit of the Perkins spectrograph. The B component is very likely the one which is the spectroscopic binary. The magnitude of C from the ADS (6.2) is fainter by 1 mag. than B; C probably does not show up at all on our plates, even though it has been called "bluish" by some observers. The spectra of this double-line binary are similar and near A0 and are characterized by wide splitting of the Ca II K line, the Mg II λ 4481 lines, and occasionally the Balmer lines. Because of the interesting nature of the system of which this spectroscopic binary is a part, we made an effort to obtain as many spectrograms as possible and reduce them for an orbital determination.

In the period from October, 1957, to February, 1959, a total of 34 plates was obtained, of which 28 were measurable. These plates were taken on Kodak 103*a*-O emulsion with the Pα camera on the prism spectrograph of the 69-inch Perkins reflector, providing a dispersion of 27 A/mm at Hγ. Only nights of fairly good seeing were usable because of the small separation and large Δm between the A and B–C components In addition, it was necessary to rotate the spectrograph slit in order to reduce the possibility of contamination of the B–C spectra by the much brighter A component.

A classification of the spectra by Slettebak yields a type of B9.5 V for the single-line stage. The individual types probably do not differ by more than 0.5 of a type from this value and from each other. There is some uncertainty in the luminosity class: the stars appear to be located near the main sequence, but a luminosity classification of IV for the single-line phase cannot be excluded. For stars of this type there are few spectral lines intense enough to be measured with confidence, especially when two spectra are visible. For this reason the velocity-curves are based primarily on measurements of the Ca II K lines, with the values from the Mg II λ 4481 and Hγ lines included only when we felt that they could be safely measured. A difference in intensity exists between the K lines, which enabled us to label the two components. The elements of the orbit are drawn from the velocity-curve for the stronger K-line measures.

Table 1 contains the plate numbers, the Julian dates of observation, the phase in days where arbitrary zero phase is JD 2436119.78, and the velocities of the Ca II lines. Also the Mg II and Hγ velocities appear for the plates on which they could be measured.

We wish to refer to our velocity-curve as a preliminary curve with corresponding preliminary orbital elements. From our curve the following elements have been calculated, using the Lehmann-Filhes method of reduction:

$P = 2\overset{d}{.}67$, $e = 0.292$, $a_1 \sin i = 4.95 \times 10^6$ km ,

$T =$ JD 2436122.18 , $K_1 = 141$ km/sec , $a_2 \sin i = 3.95 \times 10^6$ km

$\omega = 175\overset{\circ}{.}2$, $K_2 = 112.5$ km/sec, $m_1 \sin^3 i = 1.74$,

$\gamma = +2.5$ km/sec , $m_2 \sin^3 i = 2.19$.

Figure 1 contains an illustration of the velocity-curve.

Considering the spectral types given in the ADS for the components of γ Andromedae and the large Δm between component A and component B–C, we suspected for some time that the brightest component might not be physically connected with the system after all. Such a conclusion is supported by earlier parallax determinations; the ADS lists the Mount Wilson spectroscopic parallax of component A as 0″033, while presenting the Russell and Moore dynamical parallax for the orbit of B–C, which is 0″014. On the other hand, the components have common proper motion, according to entries in the *Yale Bright Star Catalogue*. Furthermore, from the few low dispersion spectrograms of γ Andromedae A which have been taken at Perkins, Dr. P. C. Keenan suggests that this star is probably as luminous as K2 II. Such a luminosity would imply a spectroscopic parallax of about 0″013, which compares favorably with the dynamical parallax of

TABLE 1

RADIAL VELOCITIES OF γ ANDROMEDAE B

Perkins Plate No Pa	Julian Date of Observation	Phase (days)	Ca II K Line V_r (km/sec)		Mg II λ 4481 V_r (km/sec)		Hγ V_r (km/sec)	
			Strong	Weak	Strong	Weak	Strong	Weak
11013	2435858 56	2 23	− 6 7	...	...	...		
11394	2436119 78	0 00	−123	+112	−120	+100	..	...
11414	1'4 84	2 39	−175	+133	...	..	−164	+110
11434	132 77	2 31	−156	+118	−142	+136	−200	+114
11450	140 69	2 22	−132	...			...	
11464	144 69	0 88	+ 86 0	− 98 0	...	....	−107	...
11467	148 73	2 25	−127	+ 98 0	−144	+112	−133	+ 75 0
11521	177 58	1 73	+ 36 0	...				
11529	186 55	0 02	−126	+130				...
11533	187 54	1 01	+104	− 79 3				
11559	201 51	1 63	+ 53 0	...	..			
11567	203 52	0 97	+ 93 0	− 91 0				
11571	207 56	2 34	−176	+108				
11589	212 52	1 96	− 20 0	..	...	..		
11622	238 61	1 35	+ 73 0	− 73 0	+100	− 60 0		
11678	252 52	1 91	− 7 0	..				
11689	258 55	2 60	−139	+ 65 7				
11700	260 52	1 90	− 9 5					
12131	488 50	0 26	+ 47 5	.				
12179	506 70	2 44	−180	+126				
12222	564 51	1 51	+ 32 0					
12224	565 48	2 48	−139					
12227	566 51	0 84	+ 99 0		...	...		
12230	566 66	0 99	+ 98 0		+ 73 9	−141		
12231	571 50	0 49	+ 62 0					
12232	577 48	1 13	+108					
12234	578 49	2 14	−181					
12238	580 50	1 48	+ 60 0					
12258	2436602 50	2 12	−141					

PHOTOELECTRIC AND SPECTROSCOPIC OBSERVATIONS OF OMICRON PERSEI*

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ABSTRACT

Photoelectric observations of the spectroscopic binary *o* Persei indicate a light-variation of 0.03 mag , with a period of 2 2 days or half the orbital period. The variation evidently arises from the ellipticity of the component stars, and the relation of the double-cycle light-variation to the orbital phase is such that maximum light occurs at quadrature. These results do not seem to be in complete agreement with earlier observations and suggest the possibility of changes in the photometric behavior of the system. A spectroscopic orbit determined from new material is in excellent agreement with an earlier orbit by Jordan

The binary nature of *o* Persei was discovered by Adams (1902) from five Yerkes Observatory spectrograms and was subsequently confirmed by Vogel (1903). The period is approximately 4.4 days, and the orbital eccentricity is nearly zero. A circular orbit derived by Jordan (1910) from Allegheny Observatory spectra yielded the following elements: $P = 4.41916$ days, $T_0 =$ JD 2418217.924, $\gamma = +18.46$ km/sec, and $K_1 =$ 111.92 km/sec. Jordan also succeeded in measuring on some of the spectrograms lines arising from the secondary component; the value of K_2 derived was 160 km/sec. The spectral type of the primary is B1; the spectral lines arising from the secondary are very weak, but the spectral type indicated does not seem to be very different from that of the primary. The published MK spectral classifications of *o* Persei are B1 III (Morgan, Code, and Whitford 1955) and B1 II (Hiltner 1956).

There have been many photometric investigations of *o* Persei (Lau 1912; Guthnick 1914*a*, *b*, 1917; Hertzsprung 1914; Shapley 1915; Walker 1952). There is some disagreement between the results of the earlier investigations, and it seems certain that the accuracy of the material is low in many cases. Nevertheless, these investigations served to establish the existence of light-variation and the absence of eclipses. There was also some evidence that the light-variation is related to orbital phase.

Photoelectric observations of *o* Persei were obtained during the course of a photometric investigation of early B giants. The observations were made in yellow light with a photometer attached to the 20-inch reflector at Mount Palomar. The photometer employed an EMI 6094 photomultiplier tube and the filter a Corning 3384. Two comparison stars HD 23478 (B3) and HD 23626 (G0) were used in making all observations. The observations, corrected for the effects of differential extinction, are given in Table 1. The magnitude differences, Δm_y are taken in the sense *o* Persei *minus* HD 23478. The brightness of *o* Persei was actually compared with the mean of the two comparison stars. Details of the observational procedure have been given in an earlier paper (Lynds 1959). The scatter of the comparison-star observations indicates a probable error per observation of about 0.0025 mag.

The observations define a light-variation of approximately 0.03 mag., with a period of 2.2 days or half the orbital period of the system. In such cases we expect the variation to be due to the ellipticity of the component stars of the system. Consequently, the

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