ON THE RELATION BETWEEN THE AMPLITUDE OF LIGHT AND RADIAL VELOCITY VARIATIONS OF β CANIS MAJORIS STARS

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(Received 15 May, 1968)

Abstract. The relation between the amplitude of light Δm and the amplitude of the radial velocity $2K$ for β Canis Majoris stars is investigated. A linear relationship between Δm and $2K$ is found. However, the two stars BW Vul and σ Sco, which have the largest radial velocity variations, do not seem to share this relationship.

The relationship between light amplitude Δm and radial velocity amplitude $2K$ for β Canis Majoris stars was first investigated by HELLERICH (1939) for four of its members. He found that there was a linear relation between them. STRUVE (1955) interpreted β Canis Majoris stars as composed of two subgroups: stars with a single period and stars with double periods. He found a moderate correlation between their light amplitude Δm_s and radial velocity amplitude $2K_s$. (Note that the subscript s refers to Struve's designation of single-period and double-period pulsations.) KUROČKIN (1960) obtained a linear relation between Δm_s and $2K_s$ from STRUVE's (1955) materials.

It is well known that most members of β Canis Majoris stars have variable light and radial velocity curves. It is not possible to represent these variations by just two periodicities. Even with the employment of multiple periodicity, it is extremely difficult to predict the behavior of a particular cycle. Therefore, in studying the relation between Δm and $2K$ of these stars, we employ only those observations which are derived from simultaneous photoelectric and spectroscopic observations.

All the available materials to date are collected in Tables I and II. The observations listed in Table I are: (1) those derived from simultaneous observations; and (2) those known to have very small variation in amplitude of light and radial velocity curves. In Table II are the stars which have no simultaneous observations and are known to have appreciable variation in their amplitudes of light and radial velocity curves.

All the observations from Table I, together with σ Sco from Table II, are plotted in Figure 1. With the exception of BW Vul and σ Sco, all the observations lie between (or near) the dash-lines. We can see that the observations from Table II also lie within the same boundaries. The two exceptions, BW Vul and σ Sco, are the two stars which have the exceptionally large radial velocity amplitudes, 160 km/sec, and 110 km/sec respectively. This tends to suggest that the stars with very large radial velocity variation might not share the common Δm and $2K$ relation with the stars having a small radial velocity variation. (Note that in other aspects, these two stars do share the common period-luminosity and period-color-luminosity relations with the rest of the members (LEUNG, 1967).)

TABLE I

Amplitudes of light and radial velocity curves

	Δm(blue)	$2K$ (km/sec)	Sources
EN Lac			
	0.081	39	WALKER, 1952a
	.056	32	
	.060	30	
	.059	27	
	.036	22	
	.010:	22	
	.025	20	
	.078	36	
	.056	26.5	
	.065	31	
	.064	31	
	.038	23.5	
	.079	37	
	.029	25	
DD Lac			
	0.08	26	HELLERICH, 1939
	.15	57	
	.137	55	DE JAGER, 1963
	.092	40	
	.132	50	
	.125	55	
ν Eri			
	0.08	50	HELLERICH, 1939
	.98	48	WALKER, 1952b
	.088	55	
	.181	76	
	.060	22	
β Cep			
	0.056	30	HELLERICH, 1939
	.075	33	
β CMa			
	0.027	9.9	HELLERICH, 1939
BW Vul			
	0.24	150	WALKER, 1954
τ^1 Lup			
	0.026	11	PAGEL, 1956
δ Cet			
	0.032	12.6	JERZYKIEWICZ, 1965; WALKER, 1953
γ Peg			
	0.015 [a]	7	WILLIAMS, 1954; MCNAMARA, 1955
ξ^1 CMa			
	0.04 [a]	36	VAN HOFF, 1962c; MCNAMARA, 1955
15 CMa			
	0.018 [a]	7.5	WALKER, 1956; LYNDS *et al.*, 1956

[a] Amplitudes in yellow light.

TABLE II

Amplitudes of light and radial velocity curves

Δm	$2K$ (km/sec)	Sources
α Lup		
~0.005 yellow	15–20	Rodgers and Bell, 1962
β Cru		
0.02–0.04 blue	3–12	Pagel, 1956; Milone, 1963
0.02–0.05 UV		Van Hoff, 1962a
KP Per		
0.06–0.10 blue	16–25	Block, 1965; Struve and Zebergs, 1959
θ Oph		
0.02–0.06 UV	20–30	Van Hoff, 1962b; Van Hoff *et al.*, 1956
σ Sco		
~0.08 yellow	90–120	Hogg *et al.*, 1951; Struve *et al.*, 1955
0.02–0.06 yellow		Van Hoff, 1966
0.05–0.10 UV		

A linear relation between Δm and $2K$ for β Canis Majoris is derived from all the observations from Table I, excepting BW Vul. It can be expressed by the following equation:

$$\Delta m(\text{blue}) = 0.0021(2K).$$

The presently derived slope of 0.0021 for stars with small radial velocity variation confirms the value of 0.0023 derived from four stars by Hellerich (1939).

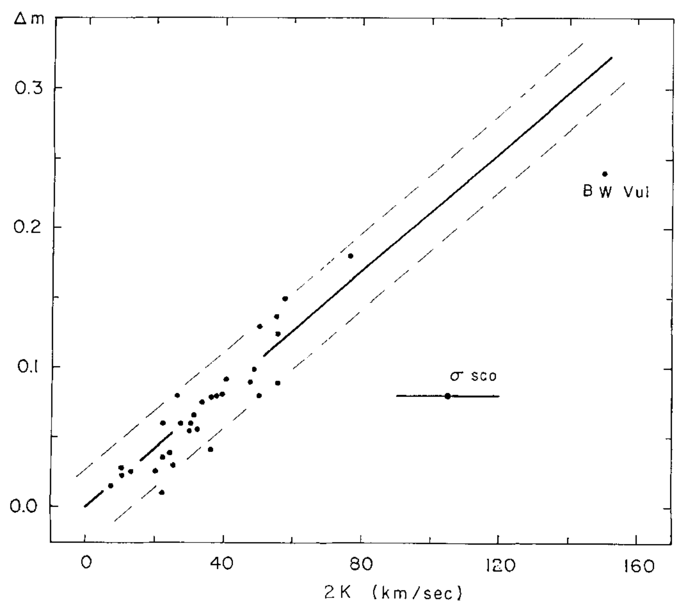

Fig. 1. Light amplitude Δm, and radial velocity amplitude $2K$ relation of β Canis Majoris Stars.

Recently, HILL (1967) discovered a number of new β Canis Majoris stars. Unfortunately their Δm (blue) are less than $0\overset{m}{.}046$. It might be unlikely that they would have large radial velocity variations. It would be of great interest to discover at least a few more β Canis Majoris stars with large radial velocity variation, so as to see where they lie in the Δm and $2K$ plane.

We notice that the slope of the Δm and $2K$ relation for β Canis Majoris stars (0.0021) is extremely small in comparison to the radial pulsating variables; Cepheids (0.029), RR Lyr stars (0.0155) and δ Scuti stars (0.0160) (see LEUNG and WEHLAU, 1967). Since the measured radial velocity indicates the motion of the outer layer of the star, a small value of $\Delta m/2K$ implies that the large motion at the outer layer of the β Canis Majoris stars has relatively little effect in varying their luminosities. This tends to favour the non-radial oscillations mechanism of LEDOUX (1951, 1958) and the ejection of thin layer of stellar surface mechanism of ODGERS (1956) and ODGERS and LEUNG (1965).

Acknowledgements

The author acknowledges the support of an NAS-NRC research associateship under the National Aeronautics and Space Administration, and would like to thank Dr. Robert Jastrow for his hospitality at the Institute for Space Studies.

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