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GRAVITATIONAL RADIATION AND SPIRALLING TIME OF CLOSE BINARY SYSTEMS (II)

(Letter to the Editor)

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Abstract. Power-output by gravitational radiation (P_B) and spiralling time (τ_0) for individual systems of twelve early (B) type binary systems have been evaluated. A new relation between P_B and τ_0 obtained. It is found that most of these systems lie in the spiralling time range $\sim 10^9$ years.

1. Introduction

In our previous paper (Padalia, 1987), we have evaluated P_B and τ_0 values for sixteen typical eclipsing binary systems and a relation between P_B and τ_0 was established. Here, the study includes twelve early-type binary systems all earlier than A-type. The systems included are: V 701 Sco, V Pup, AH Cep, IU Aur, μ Sco, SV Cen, SX Aur, Y Cyg, V 478 Cyg, V 337 Aql, CW Cep, and σ Aql.

The masses, period, and radii of relative orbits adopted in the present paper are given in Table I.

2. Discussions and Results

Equations for determining P_B and τ_0 and assumptions used are the same as mentioned in our (Padalia, 1987) earlier paper, viz.,

$$P_B = \left(\frac{\mu}{M_\odot}\right)^2 \left(\frac{M}{M_\odot}\right)^{4/3} P^{-10/3}\, 3.0 \times 10^{26}\, W, \tag{1}$$

$$\tau_0 = \frac{5c^5 a_0^4}{256 G^3 \mu M^2}\,. \tag{2}$$

The values of P_B and τ_0 thus determined are reported in Table I. Like our earlier findings, it is interesting to note that P_B is inversely proportional to τ_0. It is found that spiralling time for all these systems is of the order of $\sim 10^9$ years as against 10^{10} to 10^{12} years for 16 typical binary systems as earlier reported.

Gravitational radiation P_B (in watts) along the X-axis and spiralling time τ_0 (in years) along the Y-axis have been plotted in Figure 1. It is found that X and Y follow the

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TABLE I

Gravitational radiation and spiralling time of twelve early-type binary systems[a]

Name of the binary systems	Sp. type	M_1 ($M_\odot$)	M_2 ($M_\odot$)	Period in days	Radius of relative orbit a_0 ($R_\odot$)	Power output (P_B) (W)	Spiral time (τ_0) (years)	X ($\log P_B - 23$)	Y ($\log \tau_0 - 9$)	Remarks
V 701 Sco	B1, B1	9.1	9.1	0.762	9.24	184.5×10^{23}	0.72×10^9	2.266	−0.143	
V Pup	–	19.1	11.3	1.455	16.05	103.1×10^{23}	1.50×10^9	2.013	0.176	
AH Cep	B0.5V, B0.5V	16.1	13.9	1.775	18.05	57.6×10^{23}	2.35×10^9	1.760	0.371	
V Pup	B1, B3	14.80	7.8	1.454	15.27	35.9×10^{23}	3.10×10^9	1.555	0.491	
IU Aur	B0P, B0.5	16.0	11.0	1.811	18.77	35.7×10^{23}	3.88×10^9	1.553	0.588	
μ Sco	B1.5V, B3	12.8	8.4	1.446	14.90	33.2×10^{23}	3.22×10^9	1.521	0.508	
SV Cen	B1, B4.5	9.3	11.1	1.659	16.10	20.0×10^{23}	4.72×10^9	1.302	0.674	
SX Aur	B3.5, B6	9.4	4.3	1.210	11.66	17.2×10^{23}	3.99×10^9	1.235	0.601	
Y Cyg	O9.8, O9.8	16.7	16.7	3.000	28.20	14.5×10^{23}	10.10×10^9	1.161	1.004	
V 478 Cyg	B0V, B0V	15.6	15.6	2.881	26.90	13.2×10^{23}	10.26×10^9	1.122	1.011	
SV Cen	B1V, B6.5III	7.7	9.6	1.659	15.30	11.3×10^{23}	6.37×10^9	1.055	0.804	
V 337 Aql	B0.5V, B2V	17.0	10.0	2.734	24.80	88.4×10^{23}	12.24×10^9	0.924	1.088	
CW Cep	B0.4, B0.7	11.8	11.1	2.730	23.30	5.6×10^{23}	14.62×10^9	0.748	1.165	
σ Aql	B3V, B3V	6.8	5.4	1.950	18.95	2.1×10^{23}	42.80×10^9	0.322	1.631	

[a] The systems are mostly taken from a paper by Nakamura and Nakamura (1987).

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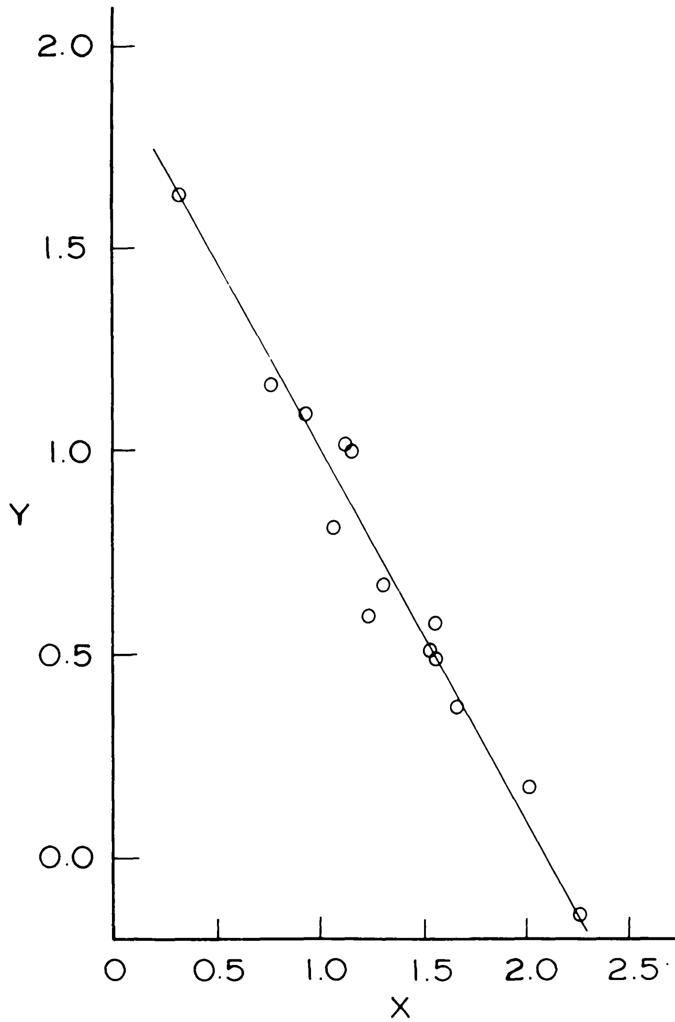

Fig. 1. Relation between spiralling time (along Y-axis) and gravitational radiation (along X-axis) for twelve early-type binary systems, where $X = \log P_B - 23$ and $Y = \log \tau_0 - 9$.

relation: viz.,

$$Y = -0.920X + 1.93 ,$$

where $X = \log P_B - 23$ and $Y = \log \tau_0 - 9$.

An inspection of Table I indicates that all the systems are massive binaries in the mass group 7 to 19 solar masses. The systems have power outputs (P_B) of the order of 10^{23} W and spiralling times $\tau_0 \sim 10^9$ years. It would be worthwhile to search out such binaries in this mass group, which are of O and B spectral types.

Attention is drawn to the anomalous position of the stars CW Cep and σ Aql (which appear to be massive) in Figure 1 of our earlier (Padalia, 1987) paper. However, the present investigation makes the situation clearer since now they appear to be members of the B-type group.

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When plotted in Figure 1 of the present paper, they fit well in the straight line. The places of CW Cep and σ Aql in Figure 1 of our earlier paper, should be taken by low-mass (1–5 solar mass) binary systems and later than B-spectral type.

It is concluded from the present findings that binary systems which are of similar spectral type and fall in a definite mass group should be related by different equations. A considerable gap is found between ZZ Cep and AO Mon in Figure 1 of our earlier paper. More data is required to explain this gap.

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