IRAS OBSERVATIONS OF CLASSICAL CEPHEIDS

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ABSTRACT. IRAS observations of sources identified with cepheid variables are used to give estimates of observed mass-loss rates for those stars.

In this note we make a comparison, using the IRAS Point Source Catalogue (1985), between Cepheid variable stars and similar non-variable stars as they may be detected in the 12 micron, 25 micron, 60 micron and 100 micron bands of the IRAS detector system. 33 classical Cepheids and 38 non-variable supergiants were identified. The selection criteria required $E(B-V) < 1.0$ and $0.4 < (B-V)_o < 1.0$ in order to permit reasonable reduction, using an interstellar extinction curve (Savage and Mathis, 1979), of measured infrared colours to intrinsic values.

The results for comparison of Cepheids with non-variable stars are shown in Fig.1. There is evidence that some long-period Cepheids have infrared excesses associated with them. The reddening correction to the infrared colour index [12] - [25] = 2.5 Log $(F(25\mu)/F(12\mu))$ is only $\simeq$ 0.02 E(B-V), permitting the use of this ratio also, when available, for comparison with a supposed blackbody ratio.

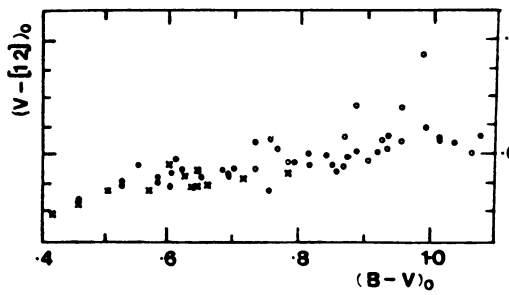

Figure 1: Intrinsic Colour-Colour Diagram
Crosses - short period Cepheids; open circles - long period Cepheids; filled circles - non-variable supergiants.

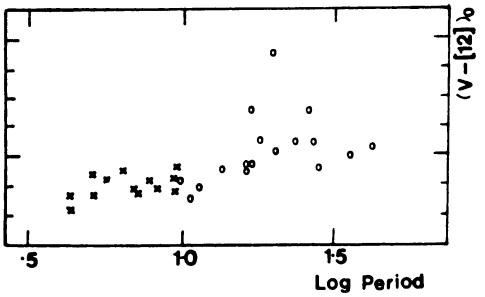

Figure 2: Period-Infrared Colour Diagram

The results show 'normal' values for short period and for most long period Cepheids with excess reddening for some Cepheids of longer period. It is suspected (Fig. 2) that processes that produce this emission are most prevalent at periods around 20 days. The values could be produced

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either by circumstellar dust emission or be due to free-free emission from a hot corona. Radiatively-driven mass loss is not indicated, because this would be most effective for the largest stars and the suspected dependence on period makes pulsation-driven processes more likely.

The few 60/100 micron values show, for δ Cephei, nearly blackbody behaviour, but for RS Puppis and RV Scuti systematic departure is indicated. For RS Puppis, associated with nebulosity detected optically by Havlen (1972), a temperature around 40° K is indicated.

A principal interest of these observations was to obtain possible values for the mass loss. This requires assumptions concerning the nature of the stellar wind. Based on the theory of Gehrz and Woolf (1971) for re-radiation of light in a thin dust shell, assumptions concerning gas density conditions outside Cepheids and possible velocities led to figures for mass loss by dust shown in Col.4 of the associated Table, evaluated for those stars with significant excesses in the infrared colours.

TABLE

Name	Period (days)	Excess (mag)	$\dot{M}$dust (10^{-8} M⊙y^{-1})	$\dot{M}$ff	$\dot{P}$ (10^{-6}y^{-1})	DMdust (M⊙)	DMff (M⊙)
V350 Sgr	5.154	(0.18)	(0.32)	(2.2)			
RX Cam	7.912	0.43	0.84	2.8			
S Mus	9.659	(0.10)	(0.24)	(1.5)			
XX Cen	10.956	(0.39)	(1.1)	(3.8)			
RW Cam	16.413	0.57	2.4	8.3	<50 p	>.00048	>.0017
CD Cyg	17.071	0.76	3.8	20	3.73f	.010	.054
RU Sct	19.698	1.12	8.0	70	5.93e	.013	.12
X Pup	25.961	0.32	1.8	6.9	10.9 e	.0018	.0063
RY Vel	28.125	0.37	2.2	12			
RS Pup	41.388	0.22	1.7	10	29.5 e	.00056	.0034

Notes: Col.6: Rate of period change with sources indicated - p = Parenago (1956), e = Erleksova & Irkaev (1982), f = Fernie (1983).

Alternatively, mass-loss rates could be calculated on the basis that the infrared excess is from free-free emission of hot ionised gas, following the plasma equations of Wright and Barlow (1975), (Col.5).

Using information on likely crossing-times for the Cepheids in the instability strip, based on observed rates of period change, the integrated mass loss for these figures, given in Cols. 7 & 8, are relatively small in comparison with total masses around 5 M⊙.

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