VIII IRAS - RESULTS

IRAS RESULTS FOR HYDROGEN DEFICIENT STARS

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ABSTRACT. The Infra-Red Astronomical Satellite, working at 12μm, 25μm, 60μm and 100μm, has observed stars in several subgroups of the hydrogen deficient stars. Observations of most known R CrB stars are reported here, as well as data for several HdC stars and other carbon-rich stars, together with some intermediate helium rich stars and related objects. Also given are LRS spectra of R CrB, RY Sgr, υ Sgr and some Carbon stars. Initial reductions of the additional observations from IRAS show an extended dust shell around R CrB, and probably also around SU Tau.

1. INTRODUCTION

The major task of IRAS was to survey the whole sky at infrared wavelengths, namely 12μm, 25μm, 60μm and 100μm. Between January 1983 and November 1983 it surveyed over 96% of the sky. This occupied about 60% of the total time, and in some of the remaining time, additional observations could be made, usually small raster scans for nominated interesting objects. As can be seen from Figure II.C.9 in the IRAS Explanatory Supplement (1984), the IRAS survey detectors make broad band photometric measurements of the sources they detect, and these values must be corrected for the spectral shape of the object. In addition to the survey detector array there was also a Low Resolution Spectrometer with two channels, covering the wavelength region between about 8μm and 23μm. Kilkenny and Whittet (1984) give UBVRIJHKLMNQ photometry for several R CrB stars, and match the energy distributions with black body contributions from the star and surrounding dust shell. At wavelengths longer than that of the L band

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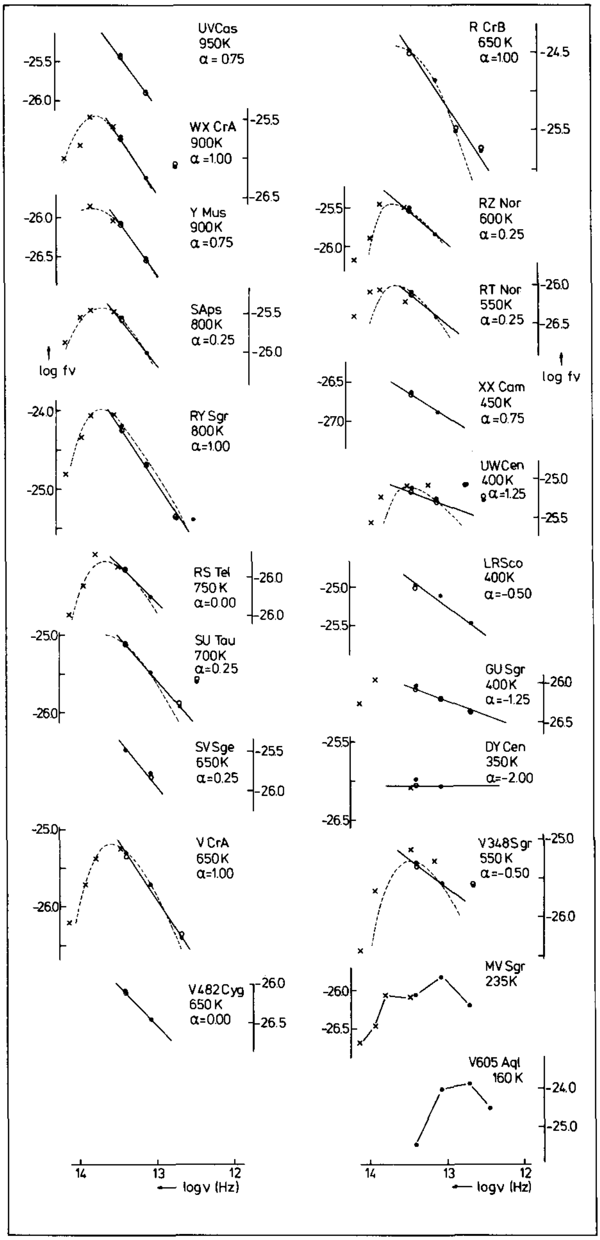

Figure 1 Energy distributions for sources found by IRAS. Filled circles (●) are IRAS colour corrected fluxes; open circles (o) are power law corrected fluxes; crosses (x) show data from Kilkenny & Whittet (1984). The solid line shows the power law fit, and the dashed line comes from the model fit of Walker (1985)

(3.5μm) there is no significant contribution to the flux observed from the stellar energy distribution. This means, for the R CrB stars, IRAS only measures the dust shells around the stars and not the stars themeselves. For some of the brighter helium strong (intermediate helium rich) stars and helium weak stars, it is the stellar flux that IRAS detects.

2. SURVEY RESULTS

Walker (1985) gave fluxes for 19 hydrogen deficient stars, comprising most of the R CrB stars and most of the hydrogen deficient close binaries. Table I includes 54 objects, using much relaxed criteria for flux quality, position and object type. Objects in the groups of the Am/Ap stars, helium weak and helium strong stars are included, since they are believed to be related groups of objects, with the temperature being responsible for the surface abundance anomalies observed (Osmer and Peterson, 1974). Also included are some bright Carbon stars (from the General Catalogue of cool Carbon stars by Stephenson, 1973), an interesting contrast to the hotter HdC stars and R CrB stars. XX Cam was not found in the IRAS survey, but fortunately the object was observed in the additional observation programme, so that fluxes are available, although they are of a lower quality, due to the preliminary nature of the calibration for the additional observations. None of the extreme helium stars were found in the IRAS Point Source Catalog. The fluxes in Table I are corrected assuming a black body energy distribution between 12μm and 100μm. The temperature for the correction factor was derived by taking the ratio of fluxes in two adjacent bands, and a mean correction used for the middle band where the two ratios from three bands gave different values.

Shown in Fig. 1 are the energy distributions for those sources with fluxes in two or more bands (using filled circles for the IRAS data). The energy distributions for the close binaries are shown in Walker (1985). The model fit to the energy distributions shown in Fig. 1, taken from Walker (1985), is sketched as a dashed line, and the temperature of the fit to the model curve is shown in Fig. 1 and given in Table I. Data from Kilkenny and Whittet (1984) are shown in Fig. 1 as crosses. As can be seen from Fig. 1 some energy distributions are poorly represented by a black body curve, and a power law dependence on frequency would be much more appropriate. Schaefer (1986) used this approach for modelling the IRAS data, and his approach (discussed in more detail in 2.1) is followed here. Fig. 1 shows the IRAS fluxes corrected for a power law dependence on frequency, plotted as open circles, with a suitable power law shown as a solid line.

The source MV Sgr is a source of confusion, as well as a confused source as seen by IRAS. Walker (1985) selected an IRAS source different from the one given here, on the basis of the raw data streams. When the position alone (as given in the IRAS Point

Table I Hydrogen deficient stars and related objects with IRAS fluxes

		IRAS fluxes(colour corr)(Jy)				temperature(K)			
star	IRAS name	12µm	25µm	60µm	100µm	12/25	model	(B-V)	V
R CrB stars									
XX Cam		0.23:	0.14:			450		0.85	7.35
SU Tau	05461+1903	9.50	4.14	1.52	2.78	700	700	1.08	9.77
UW Cen	12404-5415	7.81	5.57	8.46	5.38	400	400		
Y Mus	13025-6514	0.83	0.29	<1.06	<11.59	900			
DY Cen	13224-5359	1.05	0.84	<0.49	<2.21	350		0.31	12.39
S Aps	15043-7152	2.71	1.02	<0.40	<1.00	800	800	1.23	9.79
R CrB	15465+2818	33.83	13.81	3.08	1.72	700	650	0.79	10.24
RT Nor	16200-5913	0.85	0.39	<0.42	<3.04	550	550	1.14	10.72
RZ Nor	16287-5309	3.08	1.77	<5.62	<66.34	550	600		
LR Sco	17243-4348	10.72	7.75	3.41	7.06:	400		0.55	9.72
WX CrA	18054-3720	1.89	0.61	0.78	<2.93	1000	900	1.34	11.0
VZ Sgr	18119-2943	1.13	0.60	<0.40	<30.23				
RS Tel	18151-4634	1.31	0.57	<1.40	<1.48	600	750	1.05	10.0
GU Sgr	18211-2417	0.97	0.66:	0.41	<38.89	400			
V CrA	18441-3812	4.95	2.00	0.39:	<1.27	700	650	0.79	10.24
SV Sge	19059+1732	3.29	1.66	<0.45	<3.81	650		1.89	10.51
RY Sgr	19132-3336	63.88	20.80	4.12	3.99	1000	800	0.65	6.50
V482 Cyg	19577+3351	0.85	0.35	<5.57	<61.30	650			
U Aqr	22006-1652	1.12	<0.51	<0.40	<1.00				
UV Cas	23001+5920	3.81	1.28	<3.35	<48.97	950		1.46	10.65
V348 Sgr	18372-2257	5.05	2.78	2.52	<13.02	500	550	0.30	10.6
MV Sgr	18415-2100	0.86:	1.48	0.64	<3.38	235		0.26	12.7
HdC stars									
HD137613	15248-2459	0.42	<0.39	<0.40	<1.06			1.12	7.54
HD148839	not detected								
HD173409	18433-3123	0.53	<0.35	<0.40	1.89:			0.89	9.54
HD175893	18556-2934	0.44	<0.37	<0.40	<1.71			1.19	9.26
V605 Aql	19158+0141	5.83	30.39	35.70	16.59	160			
HD182040	19204-1048	0.58	<0.32	<0.40	<1.38			1.08	6.96
Close binaries									
KS Per	04453+4311	1.26	0.41	<0.40	<1.31	1000	1000	0.48	7.76
HD37017	not detected								
LSS4300	17346-3521	6.00	2.48	<8.69	<123	650	750	0.82	9.75
β Lyr	18482+3318	4.43	1.95	0.66	<1.00	650	600	0.00	3.45
υ Sgr	19188-1603	136.6	33.69	6.11	2.30	1000	1000	0.10	4.61
He strong stars									
HD37479	05362-0237	5.33	14.89	5.91:	<11.72	200		-0.19	6.65
HD93030	10411-6407	1.04	0.24:	<2.04	<24.01	>10000		-0.22	2.76
He weak stars									
HD5737	00561-2937	0.50	<0.24	<0.40	<1.05			-0.16	4.31
HD19400	03021-7205	0.32	<0.54	<0.40	<1.75			-0.14	5.53
HD120709	13489-3244	0.71	<0.31	<0.40	<1.00			-0.13	4.56
HD143699	16002-3827	0.31	<0.40	<0.52	<15.55			-0.14	4.89
HD175156	18518-1540	0.67	<0.36	<0.73	<4.02			0.17	5.10
Am/Ap stars									
HD18557	02563-0958	0.33	<0.66	<0.40	<1.00			0.22	6.14
HD24712	03529-1214	0.39	<0.25	<0.40	<1.14			0.32	6.00
HD129174	14383+1637	0.68	<0.25	<0.40	<1.00			-0.03	4.94
46 Dra	18416+5529	0.44	<0.25	<0.40	<1.00			-0.09	5.04
HD204411	21250+4837	0.41	<0.30	<0.47	<17.20			0.07	5.31
C stars									
S Aur	05238+3406	119.0	31.51	7.22	10.15:	2500		6.5	10.7
BL Ori	06225+1445	41.23	11.59	3.10	2.56	1200		2.33	6.2
U Ant	10329-3918	125.0	34.16	20.50	18.34	1900		2.95	5.63
U Hya	10350-1307	167.1	57.44	13.16	12.67	900		2.51	4.97
V Aql	19017-0545	110.2	28.96	8.56	5.03	2500		4.19	6.90
U Cyg	20180+4744	89.37	28.17	6.50	<15.78	1100		3.31	8.5
Y Pav	21197-6956	95.21	31.94	7.94	4.50	800		2.82	6.41
TX Psc	23438+0312	118.0	30.12	8.86	5.95	3000		2.60	5.04

Notes for Table I

Sources for V and (B-V)

Blanco et al. (1968) for: LR Sco, HD175893, HD173409

Buscombe (1977) for: HD137613, HD182040

Buscombe (1980) for: XX Cam, WX CrA, RY Sgr, S Aps, RS Tel, SU Tau, V CrA, RT Nor, SV Sge, BL Ori, U Hya, U Ant, S Aur

Fernie et al. (1972) for: R CrB, UV Cas

Hack (1967) for: HD30353

Herbig (1964) for: MV Sgr

Hoffleit + Jaschek (1982) for: β Lyr, υ Sgr, HD37479, HD93030, HD5737, HD19400, HD120709, HD175156, HD143699, HD18557, HD24712, HD129174, 46 Dra, HD204411, V Aql, Y Pav, TX Psc

Houziaux (1968) for: V348 Sgr

Drilling et al. (1984) for: LSS4300

Rao (priv. comm.) for: DY Cen

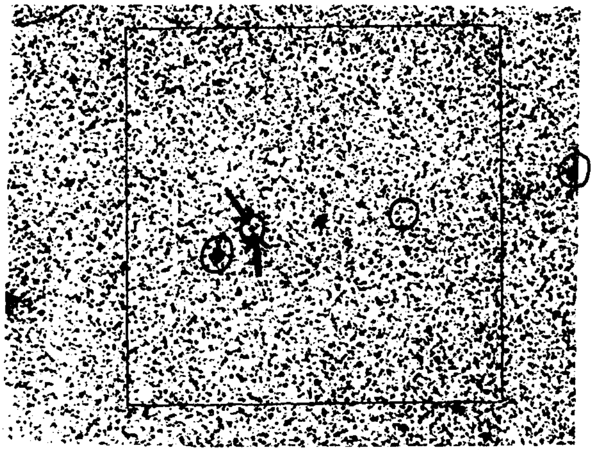

Figure 2 Palomar Sky Survey field around MV Sgr, with MV Sgr arrowed. Circles show the position of IRAS sources. The box is 16 arcmin wide.

Source Catalog) is used as the criterion, the postion agrees very well with the one expected. Lynas-Gray (private communication) provided his finding chart of MV Sgr, shown in Fig. 2, with MV Sgr arrowed. Plotted on top of this, shown as circles (the size of the circle has no meaning) are the IRAS Point Source Catalog sources. The two SAO stars in the field, furthest left and furthest right, agree excellently in position with their IRAS counterparts, as does the source associated with MV Sgr.

2.1 THE POWER LAW DEPENDENCE OF THE ENERGY DISTRIBUTIONS

Following the suggestion by Schaefer (1986) a power law dependence of flux with frequency is fitted to the IRAS data (shown in Fig. 1). As with Schaefer the formula by Rees et al. (1969) is used:

$$f_\nu \propto \nu^{\xi} \qquad \text{where} \qquad \xi = \tfrac{1}{2}\,[\,2 + \alpha - (4 + \alpha)\,(2 - \beta)\,]$$

with the grain number density $\rho \propto r^{-\beta}$

and the absorption coefficient $Q \propto \nu^{\alpha}$

Table II Values for the Power Law Terms

source	if $\beta = 2$ α	if $\alpha = 1$ β	source	if $\beta = 2$ α	if $\alpha = 1$ β
UV Cas	0.75	1.95	R CrB	1.00	2.00
WX CrA	1.00	2.00	RZ Nor	-0.25	1.75
Y Mus	0.75	1.95	RT Nor	-0.25	1.75
S Aps	0.50	1.90	XX Cam	-0.75	1.65
RY Sgr	1.00	2.00	UW Cen	-1.25	1.55
RS Tel	0.00	1.80	LR Sco	-0.50	1.70
SU Tau	0.25	1.85	GU Sgr	-1.25	1.55
SV Sge	0.25	1.85	DY Cen	-2.00	1.40
V CrA	1.00	2.00	V348 Sgr	-0.50	1.70
V482 Cyg	0.00	1.80			

Traditionally, for stars with steady mass loss $\beta = 2$, and for pure graphite $\alpha = 2$. The actual value for α is expected to be lower since the graphite is more likely impure and amorphous.

First, after correcting the IRAS fluxes for a power law dependence, setting $\beta = 2$, I found values for α (shown in Fig. 1 and in Table II), for each of the suitable R CrB star dust shells. The assumption of steady mass loss seems doubtful for the R CrB stars, a suspicion reinforced by the scenario that Feast suggested at this meeting, of mass loss by 'puffs', so I set $\alpha = 1$, a value often currently used, and found which value of β resulted. These values are also shown in Table II. A small change in β has a large effect on ξ, suggesting that the assumption about the dependence of the grain number density on distance from the star is very sensitive. The values derived here are also very sensitive to the flux correction applied. If a power law is fitted to the colour corrected fluxes α is changed by 0.25 in most cases.

2.2 THE (B - V) VS. (V - [12]) DIAGRAM

Following Waters et al. (1986), a colour-colour diagram was plotted for the sources with 12μm fluxes (from which the 12μm magnitude was found) and available V, (B-V), shown in Fig. 3. The values found are shown in Table I, and the source of the values is given in the notes. The parameter (B-V) shows a property of the star, whilst the (V-[12]) colour reflects the contribution of the dust shell, if present. The line followed by the normal stars, as given by Waters et al. is also shown, valid in the interval $-0.25 < (B-V) < 1.60$. The separation of the sources into several distinct groups is quite obvious. The Carbon stars are reddest in (B-V) and have the greatest excess at (V-[12]).

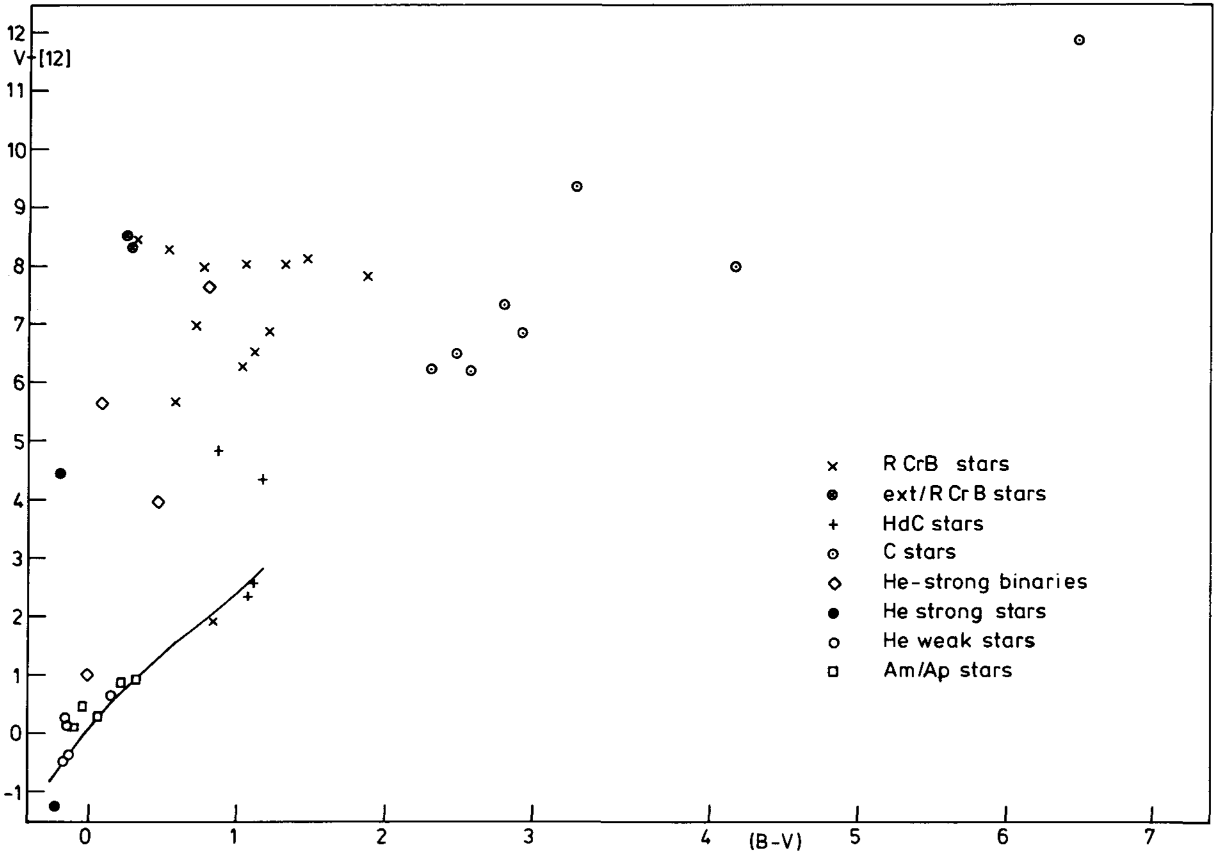

Figure 3 (B-V) vs. (V-[12]) diagram for hydrogen deficient stars and related objects, with the solid line showing the position of normal stars from Waters et al. (1986).

The Am/Ap stars and the helium weak stars follow the line for normal stars, showing that they have no dust shell present. Of the helium strong stars, HD93030 (θ Car) has no evidence of a dust shell, and HD37479 (σ Ori E) shows several magnitudes of excess, confirming the suggestion by Groote and Hunger (1982). They found a shell around HD37479 with a temperature of 270K, which is not very different from the temperature of 200K, found by the 12μm/25μm ratio from IRAS. The HdC stars tend to cluster near the normal stars line, one of the two objects to show an excess is V605 Aql, a rather unique object (Kholopov, 1985). Of the close binaries β Lyr is the star close to the normal stars line, suggesting that the system has little or no dust. This star is the group member with the most nearly normal hydrogen abundance. DY Cen is the R CrB star closest to the two hot R CrB stars, V348 Sgr and MV Sgr, which have the largest (V-[12]) excesses in the group. XX Cam is the R CrB star sitting on the normal stars line. The IRAS observations confirm that it may not be an R CrB star at all, but really an HdC star. This is supported by Rao et al. (1980) who point out that the star has undergone only one minimum between 1898 and 1980.

3. LRS SPECTRA

As reported by Walker (1985) two R CrB stars and one helium rich close binary were bright enough to have LRS spectra available. Fig. 4 shows R CrB and RY Sgr, with the spectra plotted as log (flux) against log (wavelength), together with spectra from some Carbon stars from the General Catalogue of cool Carbon stars by Stephenson (1973). These Carbon stars were retrieved with the help of R. de Grijp (Leiden) and M. de Muizon (Leiden/Paris). The R CrB stars have a very smooth decline in energy with wavelength, to be expected from carbon rich dust. The Carbon stars, characteristically, have a broad emission feature around 11μm, ascribed to SiC at 11.5μm, shown clearly in the spectra of V CrB and V Aql. TX Psc, thought by Goebel and Johnson (1984) to be deficient in hydrogen, looks very similar to the R CrB stars, until the 12μm/25μm ratio is checked, and that reveals that the LRS spectrum is the tail of the stellar energy distribution. U Hya and Y Pav are closest to the R CrB stars with very weak 11μm features. υ Sgr, at the bottom right of Fig. 4, shows an emission feature around 9.5μm, which is attributed to silicates.

4. IRAS ADDITIONAL OBSERVATIONS

Three groups had independently applied to the UK Guest Observer programme for time to observe R CrB stars with IRAS. These groups were led by Evans (Keele), Hill (St. Andrews) and Nandy (ROE), including about twelve people in the proposals, and time was awarded in both observing rounds for the R CrB stars. The group led by Hill was also awarded some observations of the hotter hydrogen deficient

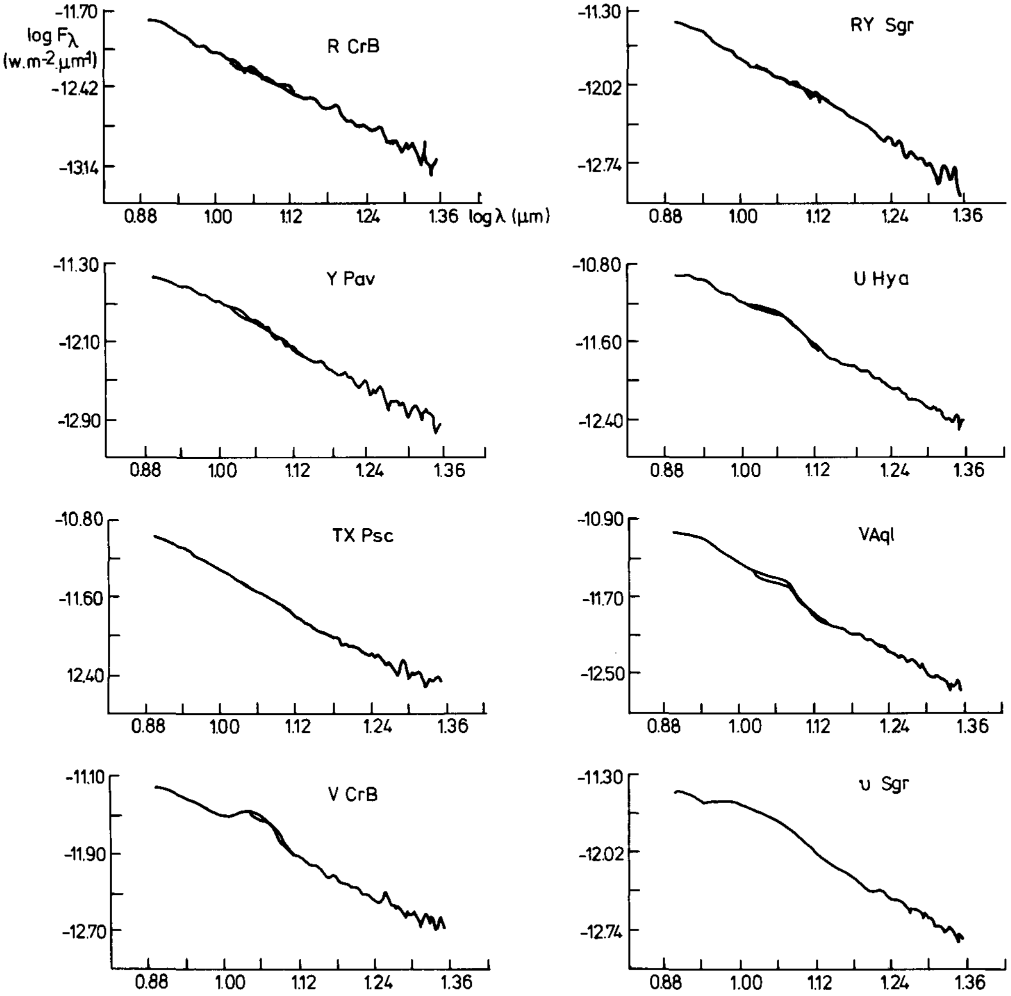

Figure 4 LRS spectra for some hydrogen deficient stars and Carbon stars

stars. As stated earlier, the fluxes derived from the additional observations made with IRAS are not as reliable as the fluxes from the IRAS catalog, so they will not be used here, except in the case of XX Cam where no other fluxes at the IRAS wavelengths are available. The fluxes shown for XX Cam in Table I and Fig. 1 have been corrected using the updated correction factors released in late 1985, but the values may change in the future as the calibration of the additional observations is improved.

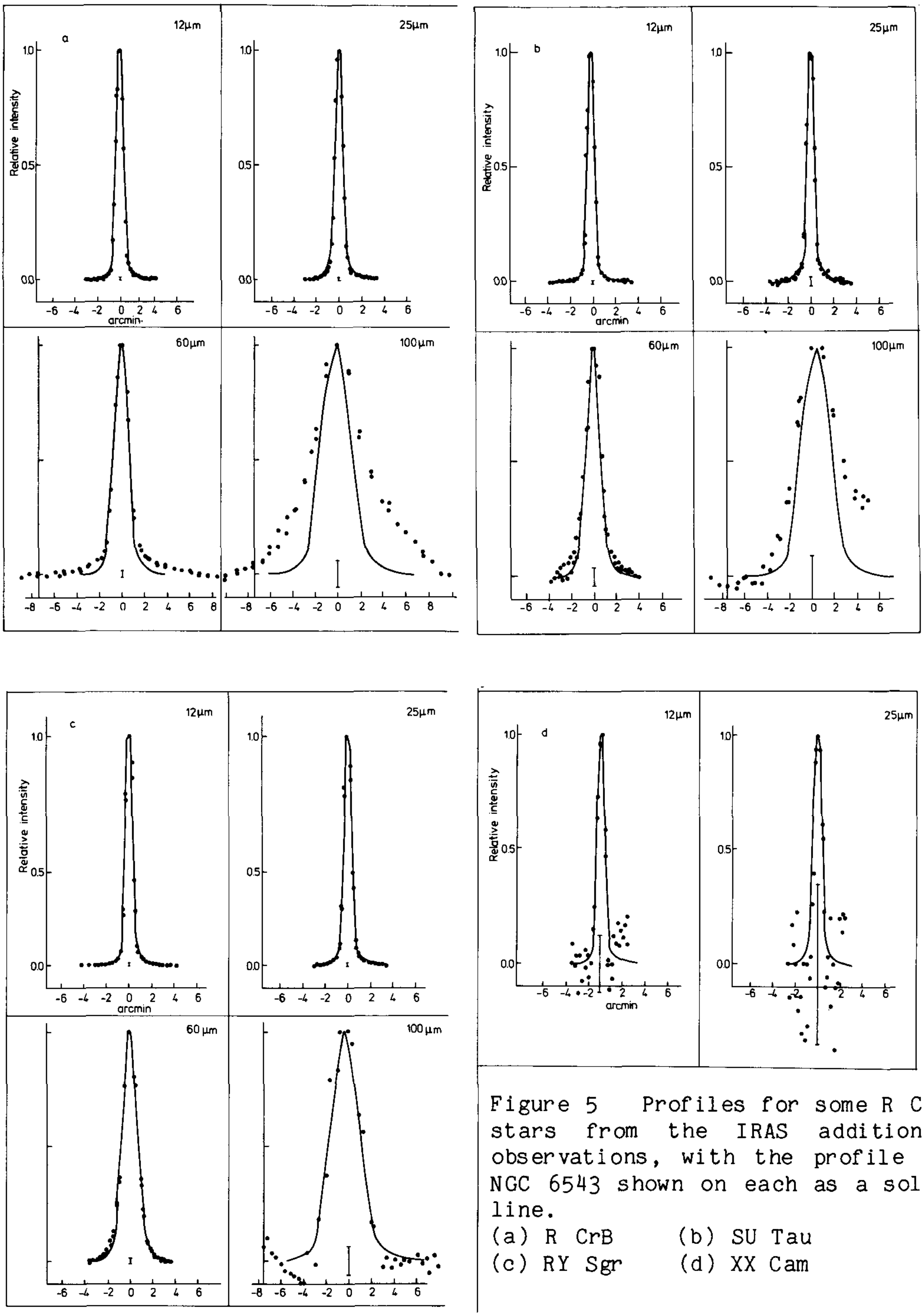

Figure 5 Profiles for some R CrB stars from the IRAS additional observations, with the profile of NGC 6543 shown on each as a solid line.

(a) R CrB (b) SU Tau

(c) RY Sgr (d) XX Cam

As someone closely involved in the IRAS mission, having written the command sequences for the additional observations and helped in the scheduling of them, it is a pleasant suprise to find that the scheduling occasionally worked better than expected. The R CrB stars were monitored on the ground during the IRAS mission, in case they went into minimum, and Evans (private communication) recently sent me a graph of the decline in R CrB in 1983, with the IRAS additional observations scheduled when the star was halfway towards minimum light.

Since the additional observations were taken using several different command sequences, involving different satellite speeds, I have reduced the data relative to the calibration source NGC 6543, a planetary nebula at the north ecliptic pole. This source is regarded by IRAS as a point source, although it does sit on a weak plateau of emission at the longer wavelengths. With the aid of P. Schwering (Leiden) I was able to plot the profiles of the sources observed in the additional observation programme, and I measured the full width at half maximum intensity, and also at zero intensity (shown in Table III). Each profile is the result of two independent observations of the source, except for β Lyr and υ Sgr where only one additional observation was taken. Fig. 5 shows the source profiles of R CrB, SU Tau, RY Sgr, and XX Cam, plotted as filled circles, with the profile of the reference point source NGC 6543 drawn in as a solid line. R CrB has a very obviously different profile at longer wavelengths when compared with the reference point source. SU Tau also deviates significantly from the reference point source at 100μm, although the source is weak at the longer wavelengths, and has a close neighbour. β Lyr is very weak at 100μm. The measurements of the full width at zero intensity obviously have a large error attached, due to the difficulty in judging where the slow decline in flux crosses the background level, but the values derived do show the radical difference in the shape of the profile of R CrB, and to a lesser extent that of SU Tau, which has a width similar to the plateau for NGC 6543. RY Sgr is the better guide to the point source profile at 100μm.

The full width at zero intensity for R CrB is almost 20 arcmin, which implies a very large dust shell. Rao and Nandy (1986) have made an analysis of this large shell and obtained a black body temperature of 30K. They found a dust mass of 4.8×10^{-5} $M_{\odot}$ (which with a gas to dust ratio of 100 implied a total mass in the shell of about 5×10^{-3} $M_{\odot}$). There is, however, still the inner extended shell to be studied at 100μm for R CrB and SU Tau. For R CrB, if it is at a distance of 2kpc (as suggested by Schonberner, 1975), the inner shell may be 1pc across, which is a considerable size for a dust shell.

5. CONCLUSIONS

As reported in previous work (for example, Feast and Glass,1973; Kilkenny and Whittet, 1984; Drilling, Landolt and Schonberner, 1984; Walker 1985) the extreme helium stars and HdC stars generally do not

Table III Values for the profile widths from the additional observations

Full-Width-Half-Maximum (arcmin)

source	12µm		25µm		60µm		100µm	
NGC 6543	0.85	± 0.02	0.84	± 0.02	1.52	± 0.02	3.03	± 0.04
RY Sgr	0.81	0.02	0.80	0.03	1.61	0.04	3.11	0.08
R CrB	0.79	0.02	0.78	0.03	1.63	0.04	5.20	0.08
SU Tau	0.84	0.05	0.79	0.08	1.71	0.10	4.31	0.20
XX Cam	0.88	0.08	0.84	0.20	----		----	
UW Cen	0.77	0.12	0.77	0.20				
S Aps	0.79	0.12	0.77	0.20				
KS Per	0.78	0.08	0.79	0.08	1.28	0.50	----	
υ Sgr	0.81	0.20	0.86	0.20	1.51	0.20	3.37	0.50
β Lyr	0.79	0.20	0.77	0.20	1.42	0.20	1.87	0.60

Full-Width-Zero-Intensity (arcmin)

source	12µm	25µm	60µm	100µm
NGC 6543	5 ± 1	5 ± 1	8 ± 3	11 ± 3
RY Sgr	6	5	6	7
R CrB	5	5	14	18
SU Tau	6	4	7	10
XX Cam	(1)	(1)	-	-
UW Cen	3	4		
S Aps	3	(2)		
KS Per	3	(2)	(2)	-
υ Sgr	4	4	7	9
β Lyr	5	3	3	4

show infrared excesses, and the R CrB stars do show an excess. XX Cam does not have any indication of an infrared excess, and so it is more likely to be an HdC star. MV Sgr has a very cool shell with a temperature of 235K from the 12μm/25μm ratio, in addition to the hotter shell. HD37479 (σ Ori E) has a dust shell with a temperature, from the 12μm/25μm ratio, of 200K. V605 Aql, not an R CrB star but a unique variable, according to Kholopov (1985), has a cool shell of around 160K. R CrB and probably SU Tau appear to have extended dust shells around them, at the longest IRAS wavelengths.

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DISCUSSION

HILL: I notice that two of the HdC stars stand above the normal star line in your (V-(12μ))(B-V) relation. Is that significant?

WALKER: I am not sure. One of them comes from Stephenson's Carbon star catalogue with a note in the back that says something about hydrogen deficiency. Again I think those are far above the line which make them incredibly curious and worth following up with near IR photometry.

FEAST: Could I comment on that because at least one of the HdC stars has shown excess; which one it is I don't remember.

HILL: I was wondering how many R CrB stars have been missed.

WALKER: I think there might be some that might be quiescent R CrB stars. XX Cam is one.

FEAST: XX Cam was originally classified as hydrogen deficient and somebody simply went back through the literature and found the light variation.

RAO: Bidelman found it to be HdC and later Yudin showed it to be a variable.

FEAST: It is true that you get quite reasonably good black body fits. If you look at the colors, I think there is more to it than black body fits. In the crude model I have been working on, you would expect the longer wavelength to come from further away and from lower temperatures. From the very few computations I have done for the brighter ones of the IRAS catalogue, for which we got shortward data as well from ground, I would expect λ^{-1} emissivity to fit better than black body. Clearly that warrants a detailed model. It is unrealistic to assume that the soot particles radiate as black bodies. Since the 3.5μ flux of the R CrB shells vary substantially with time, it will be important to put together the IRAS results with near simultaneous ground based data.

WALKER: I started to do some modelling along the lines of Harvey et al., 1979. As you say λ^{-1} is much better for energy distribution variation than ν^{-2}, I am using up till now.

POTTASCH: Aren't you afraid in modelling these things, for you have too many free parameters, that you can get a fit with various gradients of temperatures and densities.

WALKER: Yes, it is difficult to do with only four wave length points, when there are 5 free parameters.

WING: A comment: I think I called the temperature as 700 K for the dust shell around R CrB in 1972 in a paper published in PASP. This was based on 1 to 10μ photometry obtained during a visual minimum.

FEAST: I called it 700 K in 1969 (Laughter). This agrees very well with your IRAS result and suggests that the grain temperature may be reasonably constant.

WING: In cases where the IRAS data don't fit the same black body curve as the ground based data - which you suggest may indicate two shells at two different temperatures - couldn't the interpretation equally well be the time variability of the amount of dust in the shell? This was, I believe, the interpretation that Feast gave on Tuesday for the large, slow variations that he has observed in the L magnitude.

WALKER: Yes, It seems as though the variability gets less at the longer wavelengths. You find dramatic variations in the visual, not much in L. I am not sure whether it is reflected in the IRAS domain, but you do not expect here much variability.

RAO: The R Cor Bor dust temperature varies even at maximum light from 600 to 900 K, as shown in Forrest's thesis. But surprisingly, the IR distribution always reflected a black body.

WALKER: You do have to be careful when you make color corrections in the IRAS fluxes, it is based on the shape of the energy distribution. It shouldn't normally change very much. On occasions, you find the temperature is altered quite significantly. I think the same could happen to values of α which is more than the color corrections. This means that the fluxes themselves will get affected.

VARDYA: In the spectra that you showed of R Cor Bor I think there is no feature at 11.3µ; but around 10µ there is a small blip. I do not know whether it is in absorption or emission, what could that be?

WALKER: I think it is just noise.

POTTASCH: There may be as many as 6 individual LRS spectra, so may be that could be checked.

WALKER: I have Mane de Muizon (at Leiden/Paris) with me who is experienced with faint features. She agrees with me: these are not real features - but some spectroscopists never give up!