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THE LUMINOSITY FUNCTION OF THE STARS EMBEDDED IN THE CHAMAELEON I AND IN THE RHO OPHIUCHI MOLECULAR CLOUDS

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RESUMO. A distribuição de luminosidade das estrelas contidas nas nuvens moleculares Cham I e Rho Ophiuchi é estudada, utilizando os dados fotomé-tricos para o visível e infravermelho próximo encontrados na literatura e os dados do satélite IRAS.

ABSTRACT. The luminosity distribution of the stars embedded in the Cham I and Rho Ophiuci molecular clouds is investigated, using visible and near-infrared photometric data available in the literature and the IRAS far-infrared data.

Key words: INTERSTELLAR-CLOUDS — LUMINOSITY FUNCTION

INTRODUCTION

The luminosity function (LF) and the mass function provide constraints on theories of fragmentation of clouds and of star formation. It is of interest to compare the LF obtained in the same way for different clouds, so as to observe evolutionary effects. The LF of the stars embedded in the Rho Ophiuchi dark clouds was investigated by Lada and Wilking (1984, hereafter LW), before the IRAS PSC became available. Since a large fraction of the total luminosity of T-Tauri stars lies in the far infrared, it is worth re-examinating the Rho Ophiuchi population taking into account the IRAS data. In the present work we construct the LF of the Rho Ophiuchi and Cham I populations and we discuss the significance of our results.

THE METHOD

We found in the literature enough optical and/or near-infrared photometric data for 39 out of 50 known members of the T-association in the Rho Ophiuchi cloud, and for 39 out of 73 members of the Cham I T-association. These objects, with their IRAS identifications, are listed in Tables 1 and 2, where the last column gives the references for the photometric data.

In order to extrapolate the energy distribution of the objects to long wavelengths, and to interpolate the data when observations are lacking in some of the bands, we fitted the energy distribution of the objects by a model. The model includes a central star represented by a blackbody with temperature T*, a spherically symmetric dust shell with an internal radius R_e and temperature T_e, and with density decreasing outwards like $r^{-1.5}$ and temperature decreasing like $r^{-0.4}$. The adjustable parameters are T*, T_e, R_e and the optical depth of the circumstellar shell. Since in this work the purpose of the model was to fit the data by a smooth curve, there was no need to consider the existence of additional components, like for instance a disk. Quite good fits were obtained with the simple model; two examples are shown in Figures 1 and 2.

able 1. Embedded sources in Chamaeleon 1 dark cloud.

o.	Name	IRAS	L/L⊙	references
1	SW CHA		0.07	f
2	SX CHA	10548-7708	0.59	a,d,e,f,g
3	SY CHA	10552-7655	0.54	a,d,e,f,g
4	SZ CHA	10570-7701	1.23	b,e,f
5	TW CHA	10577-7706	0.51	a,d,e,f,g
6	Sz6, HM4	10578-7645	1.95	a,d,e,f,g
7	Sz7, HM5	10589-7628	0.91	a,d,e
8	Sz9, HM7	11011-7717	1.07	a,d,e,f,g
9	CT CHA	11027-7611	1.10	a,d,e,f,g
0	Sz12, HM10		0.16	a,d,e,f,g
1	UV CHA		0.39	f
2	Glass#F	11048-7606	3.87	b,f
3	UY CHA		0.75	a,d,e,f,g
4	Sz18, HM12	11057-7546	0.21	a,d,e,f,g
5	CD 76486	11059-7721	4.52	a,d,e,f,g
6	VV CHA		0.23	a,d,e,f,g
7	Sz21, HM15		0.37	a,d,e,f,g
8	VW CHA		1.48	a,d,e,f,g
9	HD97048	11066-7722	15.00	a,d,e,f,g
0	Glass#Ia (*)	11068-7717	2.20	b
1	Glass#Ib (*)	11068-7717	2.20	b
2	Sz26, HM19		0.15	a,d,e,f,g
3	Sz27, HM20		0.21	a,c,d,f,i
4	VY CHA		0.25	a,d,e,i
5	VZ CHA	11078-7607	0.57	a,d,e,f,g
6	HD97300	11082-7620	8.39	f,i,g
7	Sz32, HM23		1.66	a,c,d,i
8	WW CHA	11083-7618	7.35	a,d,e,f,g,i
9	WX CHA	11085-7720	0.63	f
0	WY CHA	11085-7613	0.55	a,d,e,f,g,j
1	TT* #19 (+)	11091-7716	0.65	i
2	Sz37, HM27	11093-7701	0.28	a,c,d,g
3	WZ CHA		0.14	a,d,e,f,g,j
4	XX CHA	11101-7603	0.33	a,d,e,g
5	Sz41	11108-7620	1.11	a,i
6	Sz42, HM30	11108-7627	2.97	a,d,e,f,g,i
7	Sz43, HM31		0.22	a,d,e,f,g
8	HM'ANON'	11111-7705	1.28	b,f
9	Sz45, HM32	11159-7648	0.38	a,d,e,f,g

eferences
. Schwartz (1977) - Sz
. Whittet et al. (1987)
. Appenzeller et al.(1983)
. Henize and Mendoza (1973) - HM
. Glass (1979)
. Rydgren (1980)
. Grasdalen et al. (1975)
. Appenzeller (1979)
. Hyland et al. (1982)
. Jones et al. (1985)

Table 2. Embedded sources in Rho Ophiuchi dark cloud.

No.	Name	IRAS	L/L⊙	references
1	gss 9		36.09	c,e
2	sr 22		0.23	e
3	sr 4	16229-2413	4.28	c,e,g
4	gss 23		3.39	c,e,f
5	sr 3	16231-2427	4.04	c,e,f
6	gss 26		0.80	b
7	gss 29		0.78	c,e,f
8	gss 28		0.87	b,c,e,g
9	vssg 1	16233-2421	1.54	b,c,e
10	gss 30		2.50	c
11	gss 31		3.88	c,e,f,g
12	s 2		2.31	a,c,e,f
13	el 24	16233-2409	3.40	c,e
14	vssg 27		0.41	b,f
15	s 1	16235-2416	5.12	a,c,e
16	wl 8		0.27	d,f
17	wl 12	16237-2428	1.44	d,f
18	gss 39		0.46	c,f
19	wl 2		0.11	d,f
20	wl 18		0.16	d
21	el 28	16239-2438	3.83	c,g
22	wl 16	16240-2430	2.72	d,f
23	wl 17		0.29	d,f
24	wl 29		0.50	d,f
25	vssg 23		16.51	c,f
26	wl 9	16241-2412	5.17	b,c,e
27	wl 20		0.26	d,f
28	wl 5	16242-2422	1.21	b,d,f
29	wl 4		0.25	d,f
30	wl 3		0.08	d,f
31	sr 12		0.81	g
32	wl 6		1.01	d,f
33	vssg 25		0.32	b,c,d,e
34	vssg 17	16244-2421	1.50	b,c
35	sr 9	16246-2415	3.08	c,e,g
36	vssg 14		3.06	b,c,e
37	sr 10		0.59	e,g
38	sr 15		0.68	e
39	sr 20		2.38	e,g

References
a. Grasdalen et al. (1973) - gss
b. Vrba et al. (1975) - vssg
c. Elias (1978) - el
d. Wilking and Lada (1983) - wl
e. Chini (1981)
f. Lada and Wilking (1984)
g. Rydgren et al. (1976)

otes: (*) We observed that Glass#I is in fact a double star; the two components have about he same luminosities. (+) This object was a candidate to be T-Tauri star (Gregorio Hetem et 1.,1988) which nature was recently confirmed by us.

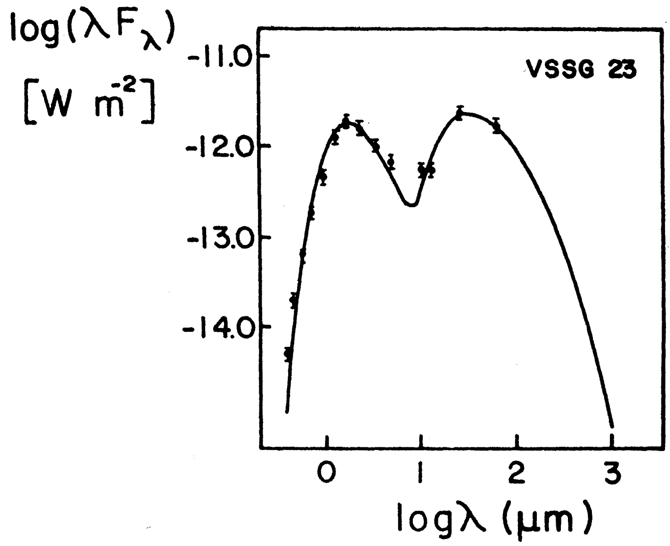

Figure 1: Energy distribution of VSSG 23

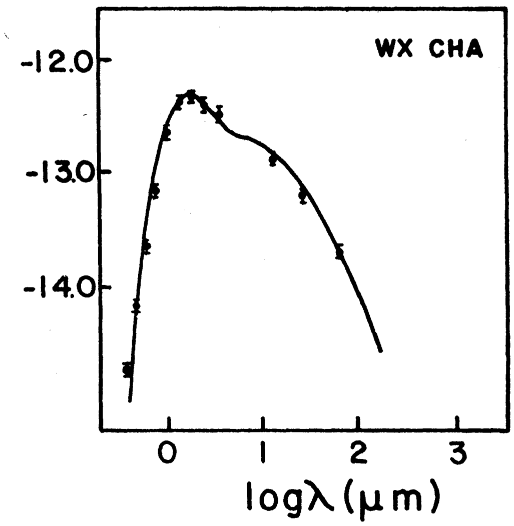

Figure 2: Energy distribution of WX Cha

The luminosity of the objects was computed by integrating the flux over the visual to far-infrared wavelength range, and assuming a distance of 140 pc to Cham I (Rydgren, 1980) and of 160 pc to Rho Ophiuchi (Bertiaud, 1958). The luminosities are given in solar units in Tables 1 and 2; the corresponding histograms are shown in Figures 3 and 4.

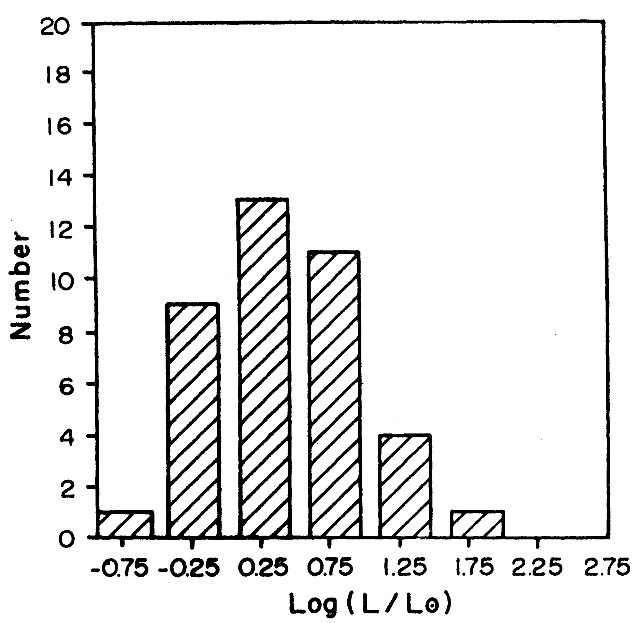

Figure 3: Luminosity function of Cham I members

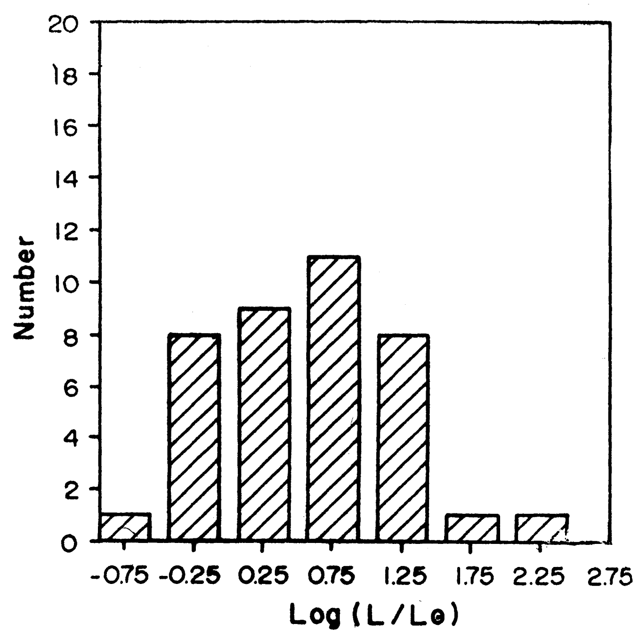

Figure 4: Luminosity function of Rho Ophiuchi members

The luminosity distribution that we obtain for Rho Ophiuchi is different from that ›f LW, in the sense that in our work the stars are more luminous. This is an expected result, ;ince we take into account the far-infrared contribution to the luminosity. It can be also ;een that the stars formed in Rho Ophiuchi are on the average more luminous than those formed .n Cham I. Using the stellar temperatures T* derived from our model, we plotted the positions ›f the stars on H-R diagrams in Figures 5 and 6. The convective-radiative evolutionary tracks, .sochrones and lines of constant stellar radius from Cohen and Kuhi (1979) are also shown. We 'emark that the objects embedded in Rho Ophiuchi are on the average younger than those in :ham I: while most of the objects in Cham I are older than 3 10^6 yr, most of the objects in :ho Ophiuchi are younger than 10^6 yr. Rho Ophiuchi contains a large fraction of relatively .uminous objects of low mass ($M < 0.4\ M_\odot$). Clearly the pre-main-sequence evolutionary tracks, .nd not a main-sequence mass-luminosity relationship, must be used to convert the luminosity .istribution of these objects into a mass distribution.

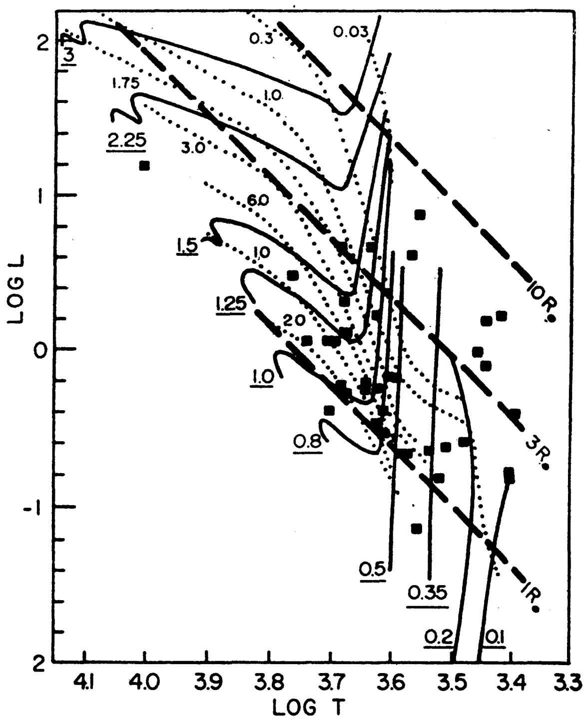

Figure 5: The H-R diagram for Cham I stars (dotted lines are the isochrones in 10^6 yr)

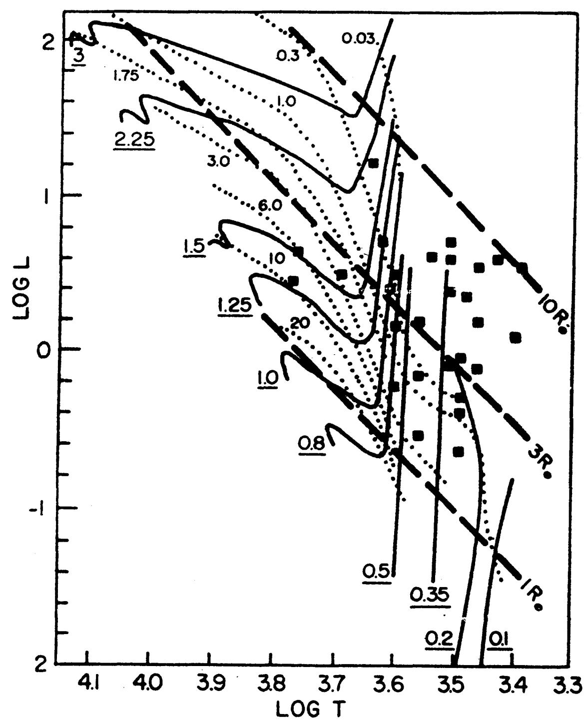

Figure 6: The H-R diagram for Rho Ophiuchi stars

.EFERENCES

.ppenzeller, I. (1979). Astron. Astrophys. 71, 305

.ppenzeller, I., Jankovics, I., and Krautter, J. (1983). Astron. Astrophys. Suppl. 53, 291

'ertiaud, F.C., 1958, Astrophys. J. 128, 533

:hini, R. (1981). Astron. Astrophys. 99, 346

.lias, J.K. (1978). Astrophys. J. 224, 453

:lass, I.S. (1979). Mon. Not. R. astr. Soc. 187, 305

:rasdalen, G.L., Strom, K.M., and Strom, S.E. (1973). Astrophys. J. Lett. 184, L53

:rasdalen, G.L., Joyce, R., Knacke, R.F., Strom, S.E., and Strom, K.M. (1975). Astron. J. 80, 117

:regório-Hetem, J.C., Sanzovo, G.C., Lépine, J.R.D. (1988). Astron. Astrophys. Suppl. 76, 347

.enize, K.G., and Mendoza, E.E. (1973). Astrophys. J. 180, 115

.yland, A.R., Jones, R.J., and Mitchell, R.M. (1982). Mon. Not. R. astr. Soc. 201, 1095

Jones, T.J., Hyland, A.R., Harvey, P.M., Wilking, B.A., and Joy, M. (1985). Astron. J. 90, 1191

Lada, C.J., and Wilking, B.A. (1984). Astrophys. J. 287, 610

Rydgren, A.E. (1980). Astron. J. 85, 444

Rydgren, A.E., Strom, S.E., and Strom, K.M. (1976). Astrophys. J. Suppl. 30, 307

Schwartz, R.D. (1977). Astrophys. J. Suppl. 35, 161

Vrba, F.J., Strom, K.M., Strom, S.E., and Grasdalen, G.L. (1975). Astrophys. J. 197, 77

Wilking, B.A., and Lada, C.J. (1983). Astrophys. J. 274, 698

Whittet, D.C.B., Kirrane, T.M., Kilkenny, D., Oates, A.P., Watson, F.G., and King, D.J. (1987). Mon.Not. R. astr. Soc. 224, 497

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