

# A SEARCH FOR H I IN NINE SOUTHERN GALACTIC CLUSTERS

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**Abstract.** The results of a search for H I features in nine galactic clusters are reported. In six of the clusters the earliest spectral types represented are in the range B0–B9. On the whole, twelve H I features (nine maxima and three minima) were detected, of which seven were disregarded as they were not related to any cluster. The conclusion is that at least in six clusters (Cr 121, Cr 140, Cr 132a, b, Ru 3 and Ru 106) no related H I could be detected. For the remainder (NGC 5460, Cr 135 and Cr 394), the evidence was inconclusive. Our results are in agreement with the qualitative conclusion from earlier work that interstellar H I should be expected only in relatively young clusters.

## 1. Introduction

It is generally accepted that stars tend to form in clusters or in groups (Kerr, 1977). Therefore, it seems important to test the presence of gaseous hydrogen in galactic clusters.

Over ten years ago Schwartz (1967) obtained 21-cm profiles in the direction of eleven galactic clusters and their surroundings; he concluded that all clusters with an age of  $2.5 \times 10^7$  years or less contain interstellar hydrogen gas, while no detectable amounts appear to exist in clusters older than  $1.5 \times 10^8$  years. On average, the detectable gas occupies a region of three to four times the apparent optical diameter of the cluster. Gordon *et al.* (1968) investigated the neutral hydrogen content in a number of clusters. The result of this work and their own estimations of the dust associated with each cluster led D'Odorico and Felli (1970) to conclude that clusters where spectral type B3 or earlier are represented, show, in general both the presence of dust in the form of interstellar grains and the presence of neutral hydrogen. Sixteen young open clusters, very close to the galactic plane, have been observed by Tovmassian *et al.* (1973) in their emission continuum and at the 21-cm line, and in several of them related hydrogen, ionized as well as neutral, was detected. On the other hand, Arnal

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(1979) secured 21-cm line profiles of seven galactic clusters with estimated ages between  $3 \times 10^7$  and  $5 \times 10^9$  years with negative results.

From the observations referred to, it appears as a qualitative fact that interstellar hydrogen should be expected only in relatively young clusters. However, the number of investigated galactic clusters is not large enough to permit a more definite statement at the present time. Besides, many of the radio observations are not clearly conclusive due to the well-known difficulties inherent in the separation of background radiation. Therefore, further research in this field is necessary.

In this paper we report on recent 21-cm line observations made in the direction of nine southern open clusters which were selected from the catalog of Alter *et al.* (1970); they were chosen with latitudes  $|b| \gtrsim 8^\circ$  in order to reduce the galactic background. The clusters are listed, together with their optical data, in Table I, where columns 1, 2 and 3 are self-explanatory. The remaining columns give: 4, cluster distance; 5, mean angular diameter; 6, mean color excess; 7, the cluster's radial velocity referred to the LSR\*; 8, radial velocity that corresponds to circular motion, defined by

$$v_c = Ar \sin 2l \cos^2 b, \quad (1)$$

where Oort's constant  $A = 15 \text{ km s}^{-1} \text{ kpc}^{-1}$ ; 9, earliest spectral type present; 10, age; and 11, references.

## 2. The Observations

All the observations were carried with the 30-m radiotelescope of the Instituto Argentino de Radioastronomía (IAR), originally provided by the Carnegie Institution of Washington, constructed in Argentina by members of both institutions and operated by the staff of the IAR. This telescope has a HPBW of  $30'$  in the 21-cm line and filter passbands of 10 kHz, equivalent to  $2 \text{ km s}^{-1}$ . The overall receiver system has been described by Filloy (1974).

In order to detect any hydrogen structures centered at the clusters, a set of points was defined on the sky for each of them. These points were distributed along two equal arms, one of constant  $l$  and the other of constant  $b$ , forming a cross centered on the cluster. The sets included 17 points spaced  $0.5^\circ$  for each of the three clusters with a diameter less than the antenna's HPBW, and 21 points for each of the other clusters. In the latter cases, the five inner points were more closely spaced. At every point at least six-minute profiles were obtained on different dates. These profiles were averaged together and the resulting profiles had a mean noise of 0.4 K plus 3% of the brightness temperature  $T_b$  due to gain uncertainties.

The observations of the clusters Cr 394, NGC 5460 and Ru 106 were made from December 1974 to February 1975, those of Cr 135, Cr 121 and Ru 3 from March to September 1977, and those of Cr 140 and Cr 132a, b during October 1978. The total

\* Throughout this paper radial velocities are referred to the LSR unless otherwise stated.

TABLE I  
Optical data of the nine galactic clusters

1	2	3	4	5	6	7	8	9	10	11
Cluster	<i>l</i> (deg.)	<i>b</i> (deg.)	<i>r</i> (pc)	<i>D</i> (min)	<i>E(B-V)</i>	<i>v<sub>oi</sub></i> (km s <sup>-1</sup> )	<i>v<sub>c</sub></i> (km s <sup>-1</sup> )	<i>S<sub>p</sub></i>	<i>τ</i> (yr)	Notes
Cr 394	14.8	-9.6	860	23			+6.2			a
Ru 3	238.8	-14.8		3			>0			b
Ru 106	300.9	+11.7		3			<0			b
NGC 5460	315.8	+12.7	780	64	0.14		-11.2	~B3	4 × 10 <sup>7</sup>	c
Cr 121	235.4	-10.4	760	60	0.02	+18	+10.2	B0 IV	1 × 10 <sup>7</sup>	d, e, f, g
Cr 132a	}243.3	}	560	}85	0.02		+6.6	~B3	6 × 10 <sup>7</sup>	}h, a
Cr 132b			330		0.03	+3.9	B9	1.6 × 10 <sup>8</sup>		
Cr 140	245.0	-8.0	365	92	0.05	-2	+4.1	~B3	2 × 10 <sup>7</sup>	i
Cr 135	248.8	-11.2	325	45	0.03		+3.1	B5-B6	~5 × 10 <sup>7</sup>	j

Notes

- a Collinder, P.: 1931, *Lund An.* 2.
- b Alter, G., Ruprecht, J. and Vanýsek, V.: 1970, *Catalogue of Star Clusters and Associations* (2nd ed), Akadémiai Kiadó, Budapest.
- c Clariá, J. J.: 1971, *Astron. J.* 76, 639.
- d Feinstein, A.: 1967, *Astrophys. J.* 149, 107.
- e Becker, W. and Fenkart, R.: 1971, *Astron. Astrophys. Suppl. Ser.* 4, 241.
- f Harris, G. L. H.: 1976, *Astrophys. J. Suppl. Ser.* 30, 451.
- g Eggen, O. J.: 1974, *Astrophys. J.* 188, 59.
- h Clariá, J. J.: 1977, *Pub. Astron. Soc. Pacific* 89, 803. (It must be remarked that Clariá (1977) interpreted Cr 132 as two separate physical groups, called Cr 132a and Cr 132b.)
- i Clariá, J. J. and Rosenzweig, P.: 1978, *Astron. J.* 83, 278.
- j Clariá, J. J.: 1976, Private communication.

net observing time was 49 hours plus an additional 30% for calibrations. The brightness temperature scale was calibrated with the use of Pöppel and Vieiras's (1973) reference points.

### 3. Methods Used for Detecting H I Structures

In order to test the possibility of 'H I features' being present in the direction of the clusters, two methods were used to search for maxima or minima  $T_b$ : (1) graphs of the variation of  $T_b$  along each cross-arm at constant velocity (a feature centered at the cluster should appear on both arms independently); and (2) profile differences,  $P_D$ , between the profile  $P_O$  observed at the center of the cluster and the expected profiles  $P_E$ . The latter profiles are averages of the profiles that result for different sets of four points (two on each cross-arms) equidistant to the cluster's center.

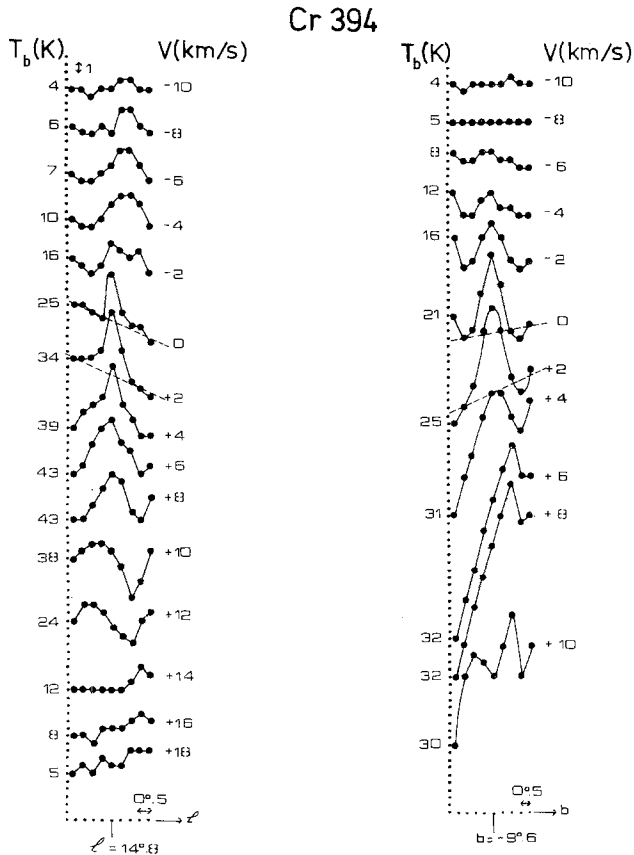


Fig. 1. Cr 394. Variation of the brightness temperature  $T_b$  along the  $l$ -arm (left) and  $b$ -arm (right) for constant values of the radial velocity  $v$ . The numbers on the ordinate scale are the values of  $T_b$  at the first point of each curve. The stippled straight lines are the adopted base lines for deriving  $\Delta l$  and  $\Delta b$ .

As a criterion for the intrinsic background fluctuations we used either the dispersion profiles  $P_\sigma$  of the four-point averages, or, if gradients were present, the profiles  $P_F$  obtained from the differences between two corresponding partial two-point averages, one on the  $l$ -arm and the other on the  $b$ -arm.

In Figures 1 and 2 we present some graphs illustrating method (1), while in Figure 3, as an illustration of method (2), we plotted for each cluster the profile  $P_O$  as well

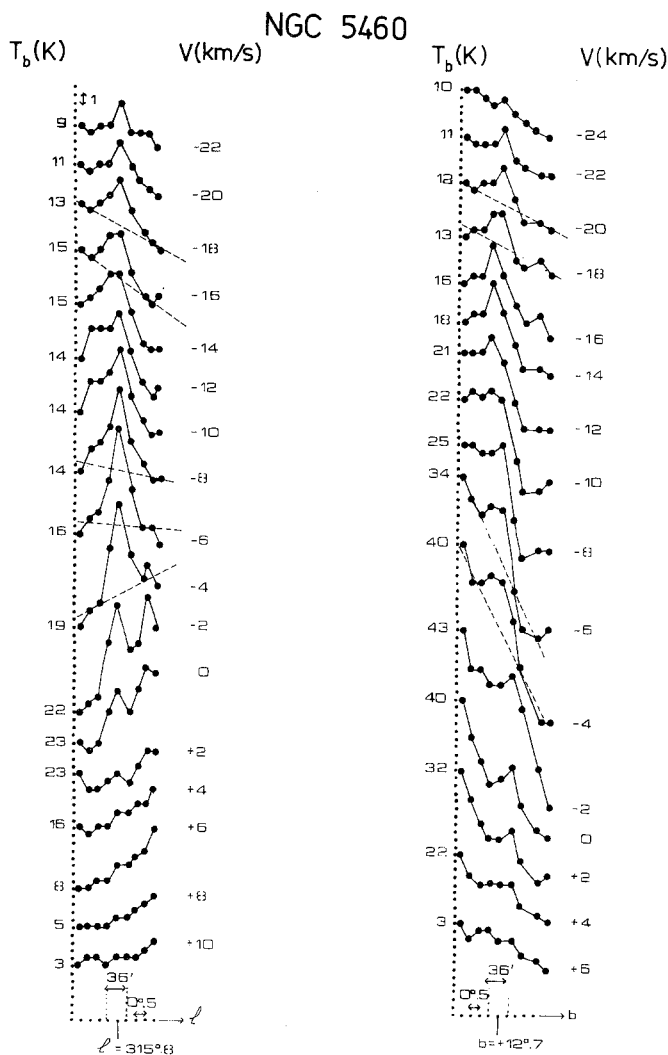


Fig. 2. NGC 5460. Variation of the brightness temperature  $T_b$  along the  $l$ -arm (left) and  $b$ -arm (right) for constant values of the radial velocity  $v$ . The numbers on the ordinate scale are the values of  $T_b$  at the first point of each curve. The stippled straight lines are the adopted base lines for deriving  $\Delta l$  and  $\Delta b$ .

as one profile  $P_E$  together with the corresponding profiles  $P_D$  and  $P_F$  or  $P_\sigma$ . We shall go into more detail when dealing with each individual cluster.

If a hydrogen structure is found in the direction  $l, b$  and is characterized by a brightness temperature  $T_b$  (K), a radial velocity  $v$  ( $\text{km s}^{-1}$ ), a distance  $r$  (pc), a radial velocity half-width  $\Delta v$  ( $\text{km s}^{-1}$ ) and angular half-widths  $\Delta l$  and  $\Delta b$  ( $^\circ$ ), then its mass,  $M_{\text{HI}}$  ( $M_\odot$ ), is derived by means of the expression (Gordon *et al.*, 1968),

$$M_{\text{HI}} = 5.4 \times 10^{-6} r^2 \cos b T_b \Delta b \Delta l \Delta v, \quad (2)$$

which assumes low optical depth and Gaussian distributions of the gas in space as well as in  $v$ .

In what follows we shall analyze and describe the results of our observations. We shall first refer to the clusters Cr 394, Ru 106, Ru 3 and NGC 5460, and then to the remainder.

#### 4. Clusters Cr 394, Ru 3 and NGC 5460

##### (a) Cr 394

Figure 1 suggests the presence of only one H I feature on both arms simultaneously; namely, that at  $v = +2 \pm 1 \text{ km s}^{-1}$  with half-widths  $\Delta l = 0.7 \pm 0.1$  and  $\Delta b = 1.0 \pm 0.2$ .

The profiles  $P_E, P_D$  and  $P_F$  in Figure 3 were derived from the four outermost points located at  $2^\circ$  from the center - i.e., out of the feature. They confirm this feature as being the only one which is above the fluctuations.

From Figure 3 we derive

$$T_b = 10.5 \pm 2.5 \text{ K} \quad \text{and} \quad \Delta v = 6 \pm 1 \text{ km s}^{-1},$$

having corrected the peak for the bump at  $v = 8 \text{ km s}^{-1}$ . Without further optical data of Cr 394 we cannot ascertain whether this H I feature is related to the cluster or is only a cloud located either in front of or behind the cluster. If the feature and the cluster were related, from (2) we derive a mass

$$M_{\text{HI}} = 170 M_\odot \pm 70\%$$

by assuming that the feature's distance is that of the cluster.

##### (b) Ru 3 and Ru 106

For both clusters the graphs that depict method (1) show some complex structures, but their large angular extent, of some  $3^\circ$ , rules out any association with the clusters. Since both have diameters  $D = 3'$ , we have used only the four nearest points - at  $0.5$  from the center - to derive the expected profiles and the corresponding differences (Figure 3). In both cases, the result is that no H I feature appears to be associated with the clusters, within the background fluctuations. For Ru 106 we estimate  $\Delta T < 1 \text{ K}$  and, for Ru 3,  $\Delta T < 3 \text{ K}$ , although in both cases for extensive  $v$ -intervals,  $\Delta T$

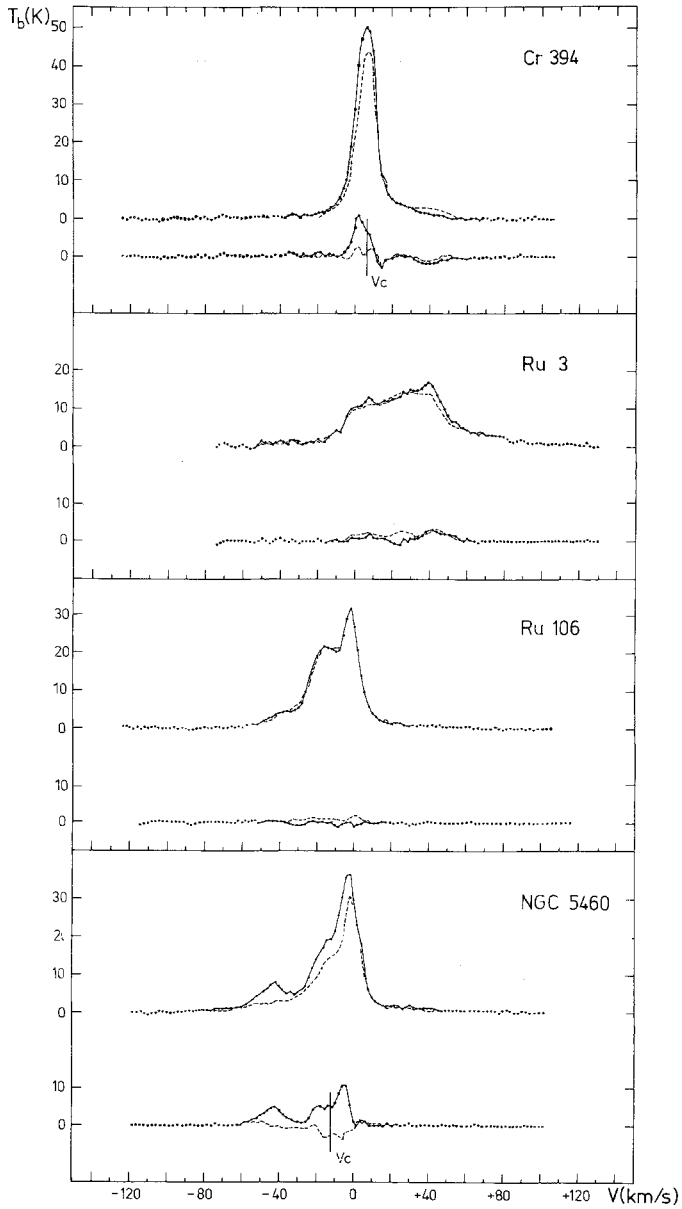


Fig. 3. Observed and computed profiles for the clusters Cr 394, Ru 3, Ru 106 and NGC 5460. Upper curve:  $P_O$  (full line),  $P_E$  (dotted line). Lower curve:  $P_D$  (full line),  $P_F$  (dotted line, for Cr 394 and NGC 5460),  $P_s$  (dotted line, for Ru 106 and Ru 3).

is very much lower. Taking  $\Delta l$ ,  $\Delta b \sim 0.5$ , that corresponds to the antenna beam width. Application of (2) yields the upper boundaries

$$\begin{aligned} M_{\text{HI}}(M_{\odot}) &< 1.3r^2 \text{ (kpc)} \Delta v \text{ (km s}^{-1}\text{)} && \text{for Ru 106,} \\ M_{\text{HI}}(M_{\odot}) &< 4r^2 \text{ (kpc)} \Delta v \text{ (km s}^{-1}\text{)} && \text{for Ru 3.} \end{aligned}$$

For neither of these clusters is a distance or a spectral type known. A typical diameter of 5 pc would locate them at several kiloparsecs from the Sun. Both clusters were described by Ruprecht (1966) as 'probable clusters' according to their appearance. The existence of Ru 106 was recently confirmed by Holmberg *et al.* (1977) by examining the ESO (B) *Atlas*. More recently, the existence of Ru 3 has been also confirmed (Holmberg *et al.*, 1978b). Holmberg *et al.* (1977) described Ru 106 as a star cluster obscured by interstellar matter, with the possibility of being globular.

### (c) NGC 5460

Inspection of Figure 2 suggests the existence of two maxima, *A* and *B*, with partial overlapping. With the aid of the profiles of Figures 3 (from points at 93' to the center) we derive the following parameters:

For *A*,

$$\begin{aligned} v &= -6 \pm 1 \text{ km s}^{-1}, & T_b &= 10.5 \pm 2 \text{ K}, & \Delta l &= 1 \pm 0.3, \\ \Delta b &= 1^\circ \pm 0.2, & \Delta v &= 9 \pm 2 \text{ km s}^{-1}. \end{aligned}$$

For *B*,

$$\begin{aligned} v &= -20 \pm 1 \text{ km s}^{-1}, & T_b &= 5 \pm 1 \text{ K}, & \Delta l &= 1 \pm 0.2, \\ \Delta b &= 1.3 \pm 0.5, & \Delta v &= 8 \pm 2 \text{ km s}^{-1}. \end{aligned}$$

A third feature is clearly distinguishable at  $v = -42 \pm 1 \text{ km s}^{-1}$  (not given in Figure 2), with  $\Delta l = 1 \pm 0.2$ ,  $\Delta b = 1.1 \pm 0.2$ ,  $T_b = 5 \pm 1 \text{ K}$ ,  $\Delta v = 12 \pm 2 \text{ km s}^{-1}$ . Owing to its high velocity, this feature probably does not relate to the cluster and we shall disregard it.

From the available information we cannot decide if either or both of features *A* and *B* are related to the cluster. If they were, their masses would be

$$M_{\text{HI}} = 300 M_{\odot} \pm 90\% \quad \text{for feature } A$$

and

$$M_{\text{HI}} = 170 M_{\odot} \pm 100\% \quad \text{for feature } B.$$

## 5. Clusters Cr 121, Cr 132a, b, Cr 140 and Cr 135

We shall now describe the possible HI features related to these clusters. The HI profiles look rather complex, showing two or more maxima. In Figure 4 we have plotted, for each of the clusters, the observed profile  $P_O$ , the expected profile  $P_E$  (derived by averaging the four points located at  $1^\circ 45'$  from the center), and the difference profiles  $P_D$  and  $P_F$ . Besides, inspection of the contour maps  $l-v$  and  $b-v$  (Figures 5 to 8) was



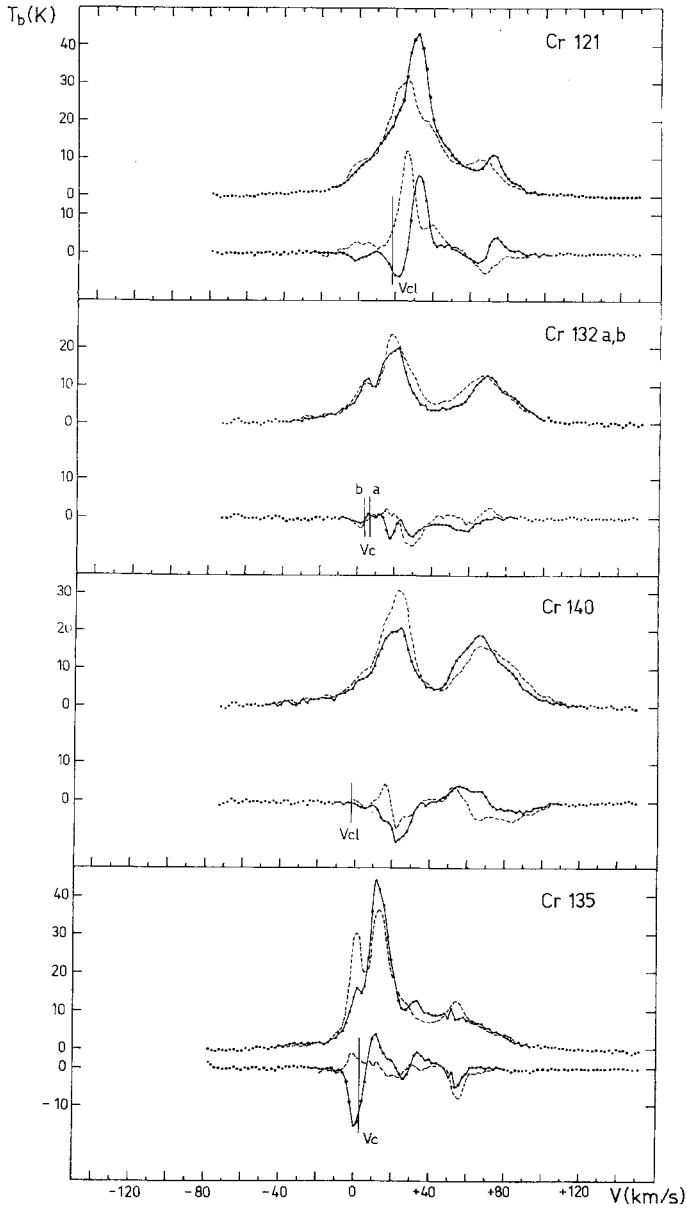


Fig. 4. Observed and computed profiles for the clusters Cr 121, Cr 132a, b, Cr 140 and Cr 135. Upper curve:  $P_O$  (full line),  $P_E$  (dotted line). Lower curve:  $P_D$  (full line),  $P_F$  (dotted line).

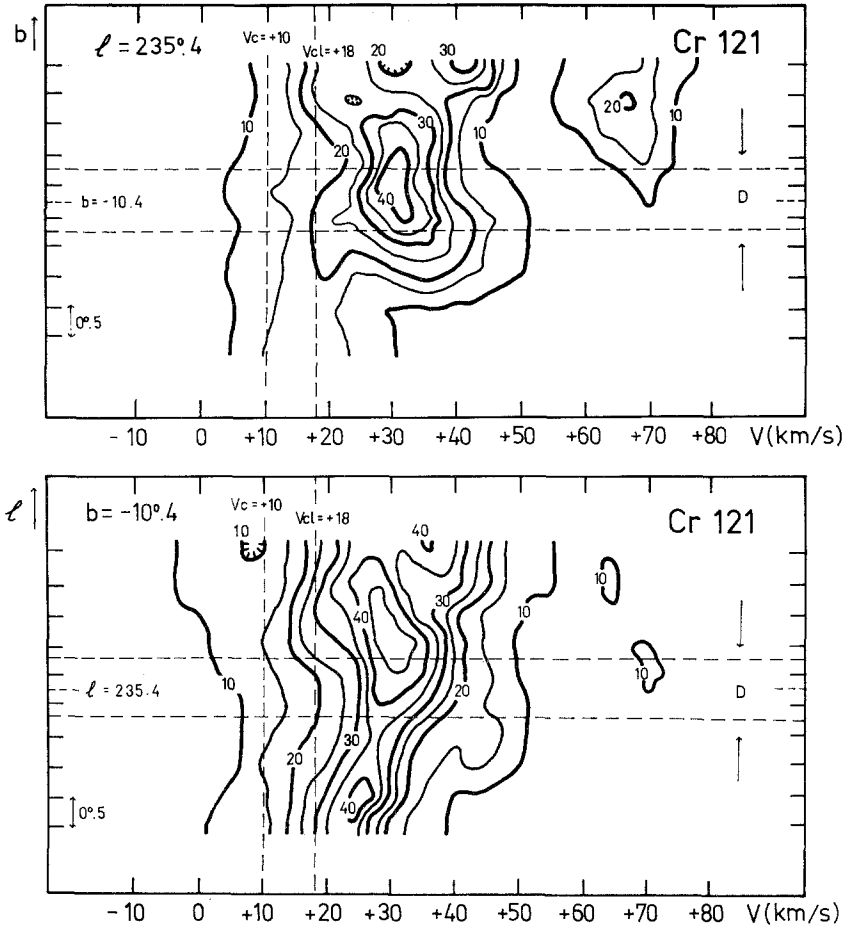


Fig. 5. Contour maps for the cluster Cr 121. The cluster's diameter  $D$  as well as the velocities  $v_c$  and  $v_{cl}$  are also indicated. The numbers on the isophotes indicate brightness temperatures in K. Contour intervals are 5 K.

found useful. The analysis of the clusters will become clearer after some remarks about them and the region in which they are located.

The clusters Cr 121, Cr 132a, Cr 140 and Cr 135 have some similarities. All are local objects of large apparent diameter and low mean color excesses, with ages not older than  $6 \times 10^7$  years. In Alter and Ruprecht's (1963) charts they appear as the most prominent clusters at  $b \leq -5^\circ$ , defining a stripe which extends from  $l = 235^\circ$  to  $l = 250^\circ$ . The stripe could be extended to  $l = 270^\circ$  if we include additional clusters of similar characteristics – namely, NGC 2451, NGC 2547, IC 2391 and perhaps Cr 173, a cluster with no available photometric data. At the other end we include NGC 2287, which could be related to Cr 121 (Feinstein *et al.*, 1978). A search for H I features in IC 2391 was made by Arnal (1979) with negative results and in NGC 2287 by Pöppel and Vieira (1972) without a definite conclusion because of the complexity of the region.

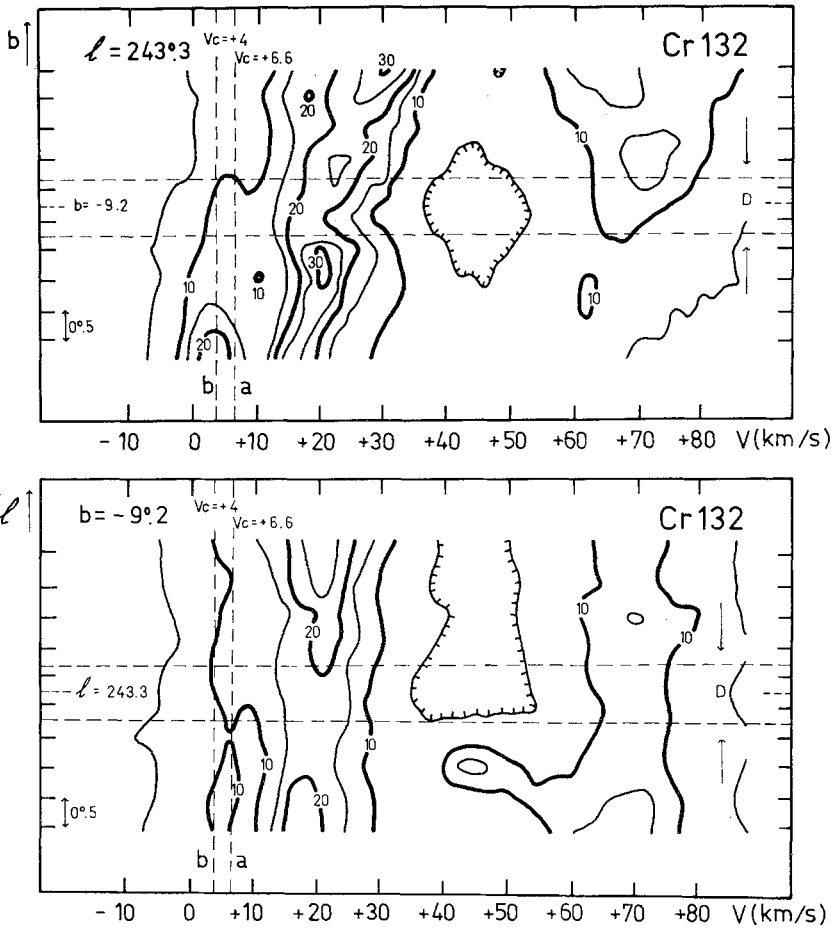


Fig. 6. Contour maps for the clusters Cr 132a, b. The diameter of the system, as well as the velocities  $v_c$  are also indicated. The numbers on the isophotes indicate brightness temperatures in K. Contour intervals are 5 K.

On the other hand, a physical relation between the clusters NGC 2451, Cr 140, Cr 135 and Cr 173 has been proposed by Williams (1967). He suggested that they are the remaining nuclei of an early-type association which has broken up. Its brightest stars would have already evolved and the nebulosity long since dissipated. The possibility still holds in view of the basic parameters derived for Cr 140 by Clariá and Rosenzweig (1978) and the confirmed existence of Cr 173 by Holmberg *et al.* (1978a). Perhaps other clusters, such as NGC 2547 and IC 2391, should also be included in the association.

Forte and Muzzio (1976) derived the birthplaces of IC 2391 and NGC 2451 relative to the spiral wave: the clusters seem to have been born between spiral arms. Palouš *et al.* (1977) considered the birthplaces of fifteen young clusters of ages less than

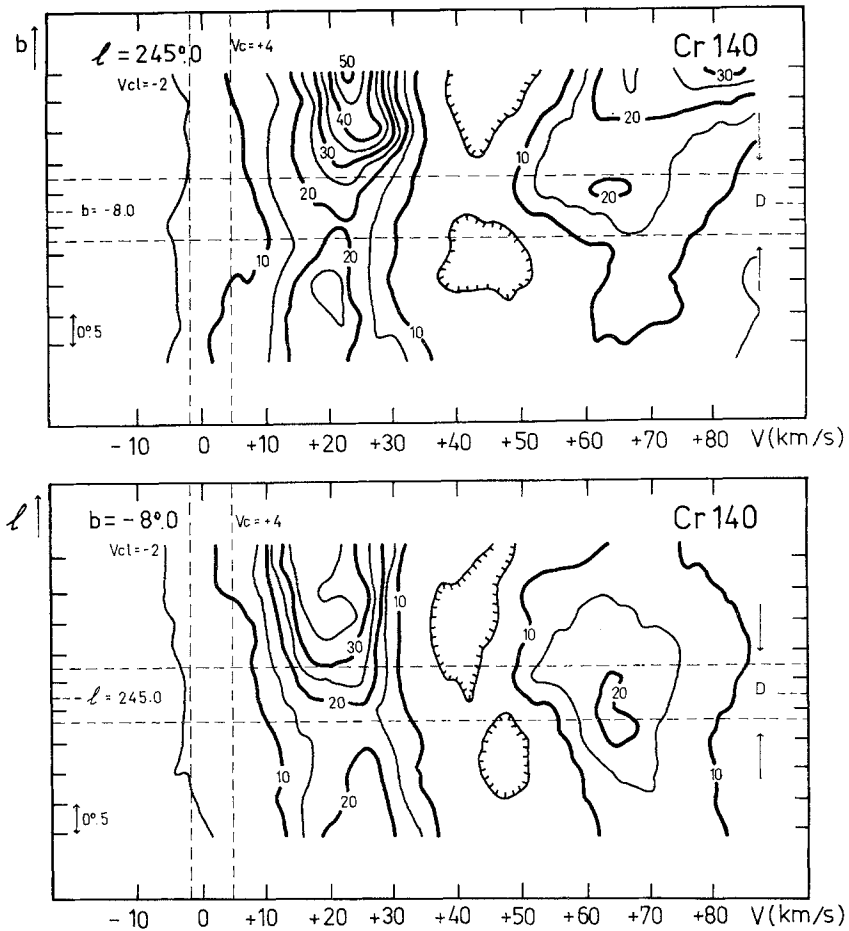


Fig. 7. Contour maps for the cluster Cr 140. The cluster's diameter as well as the velocities  $v_c$  and  $v_{el}$  are also indicated. The numbers on the isophotes indicate brightness temperatures in K. Contour intervals are 5 K.

$6 \times 10^7$  years. They found that all these clusters were concentrated in the local arm in the vicinity of the Sun. Probably, it would correspond to the local Orion interarm branch as observed in the radio and optical spiral pictures of the Galaxy. Palouš *et al.* concluded that no local interarm branch existed since more than  $6 \times 10^7$  years ago. For all these reasons, the clusters we are considering probably also originated in the interarm branch.

In addition, the region of the sky at which they are located has some remarkable objects:

(a) The best fitting plane of Gould's Belt, as derived by Stothers and Frogel (1974), extends from  $l = 233^\circ$ ,  $b = -16^\circ$  to  $l = 269^\circ$ ,  $b = -8^\circ$ , a few degrees south of the clusters. According to these authors, at that point the Belt's distance from the Sun should range from 200 to 400 pc. It is remarkable that 21-cm observations led

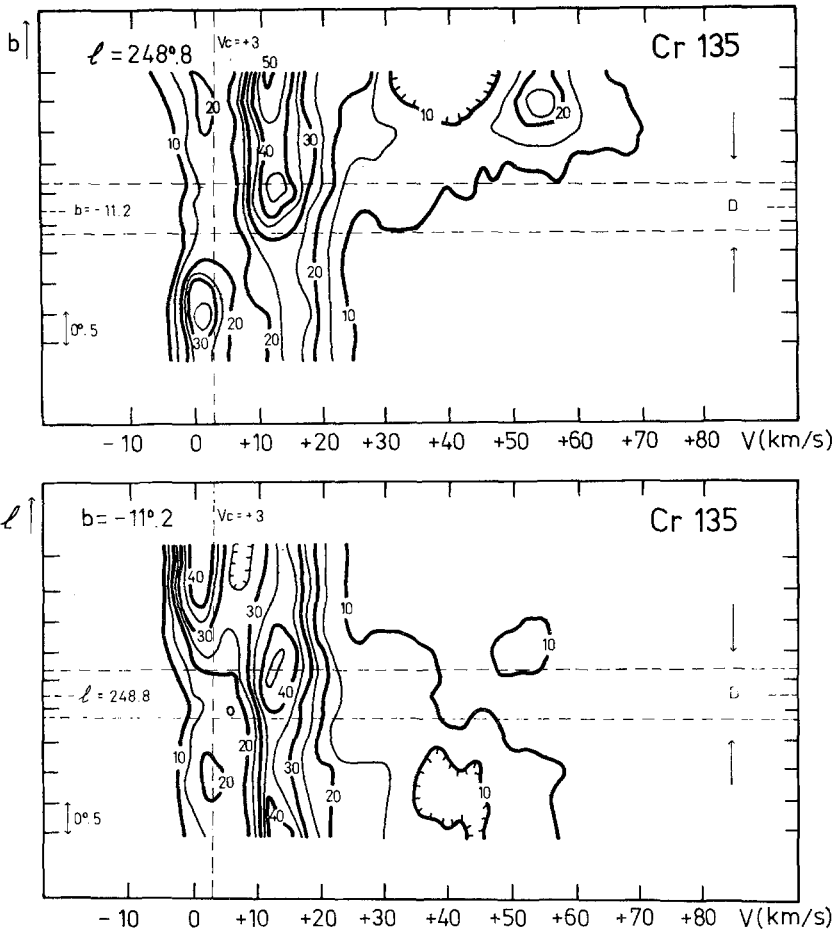


Fig. 8. Contour maps for the cluster Cr 135. The cluster's diameter as well as the velocity  $v_c$  are also indicated. The numbers on the isophotes indicate brightness temperatures in K. Contour intervals are 5 K.

Lindblad *et al.* (1973) to propose an expanding ring model for the Belt with an expanding age of just about  $6 \times 10^7$  years. The predicted radial velocity in the region of interest should be  $\sim -0.5 \text{ km s}^{-1}$ .

(b) The main part of the Gum nebula lies between  $l = 240^\circ$  and  $l = 270^\circ$ , from  $b \sim -18^\circ$  towards positive latitudes (Hawarden and Brand, 1976). According to Reynolds (1976), its distance should be  $\sim 400$  pc, while its age might be  $\sim 10^6$  years. It is also seen in the 21-cm line (McGee *et al.*, 1963).

(c) The existence of three loose *B*-associations in bright areas of the Gum nebula, all at distances of approximately 300 to 400 pc from the Sun, have been proposed by Upton (1971). The oldest of these should be about  $5 \times 10^7$  years.

(d) Finally, we have the 'other local feature' (Orion's 'arm' or Lindblad's (1967)

C/H feature). In the range of  $l = 235^\circ$  to  $l = 250^\circ$  its radial velocity should be  $\gtrsim +20 \text{ km s}^{-1}$ . Application of (1), as a rough estimate, gives distances longer than 1.3 kpc, locating the feature in the background of the clusters.

Inspection of the four profiles observed in the directions of the clusters (Figure 4) discloses, in all cases, the existence of a principal peak, whose velocity corresponds closely to Orion's arm. Besides, only a moderately small fraction of H I can be associated with  $v \sim 0$ . This seems to be confirmed by Bajaja and Colomb's (1973) contour diagram for  $b = -11^\circ$ , where a remarkable H I hole appears to exist for  $0 \leq v \leq +10 \text{ km s}^{-1}$  in the range of  $l$  from  $232^\circ$  to  $248^\circ$ . It would imply a relative scarcity of nearby H I in this region. We shall now analyze each cluster separately.

### Cr 121

The graphs of variation of  $T_b$  at constant velocity along both cross-arms are complex. Only one maximum, at  $v = +74 \text{ km s}^{-1}$  with half-widths  $\Delta l = 1^\circ$  and  $\Delta b \sim 0.6^\circ$ , can be clearly distinguished. However, gas at velocities  $v \geq 50 \text{ km s}^{-1}$  is seen in the contour maps of all the clusters (Figures 5 to 8). Its intensity increases towards the galactic plane, suggesting that it belongs to more distant features of the plane – for example, to Lindblad's (1967) L-feature (Perseus arm). Therefore we will disregard it. In Figure 4  $P_D$  shows a second significant maximum at  $v = +32 \text{ km s}^{-1}$ , which probably belongs to the Orion arm. At about the cluster's velocity the background variations are large. From  $P_F$ , the upper boundary for  $T_b$  is 6 K at a velocity of  $+18 \text{ km s}^{-1}$ , and much lower for  $v < +15 \text{ km s}^{-1}$ . Taking  $\Delta l = \Delta b \sim 1^\circ$ , the upper boundaries for the H I mass are, from (2),

$$18 \Delta v \text{ (km s}^{-1}\text{)} M_\odot, \quad v \sim +18 \text{ km s}^{-1},$$

and

$$5 \Delta v \text{ (km s}^{-1}\text{)} M_\odot, \quad -5 \leq v \leq +15 \text{ km s}^{-1}.$$

### Cr 132a and b

Neither the graphs of type 1 nor the profile differences in Figure 4 show any remarkable feature above the fluctuations. The valley in  $P_D$  at  $v = +18 \text{ km s}^{-1}$  in Figure 4 is probably associated with a variation in the distribution of the hydrogen in the extensive feature seen in the contour maps (Figure 6), which is probably associated with the Orion arm. Therefore, we conclude that no detectable H I is related to Cr 132a or b. In the velocity interval 0 to  $+15 \text{ km s}^{-1}$  the upper boundary for  $T_b$  is rather low,  $\sim 2 \text{ K}$  (Figure 4). If we adopt  $\Delta l = \Delta b \sim 1^\circ$ , the upper boundaries for the H I masses by application of (2) are

$$\begin{array}{ll} 3.3 \Delta v \text{ (km s}^{-1}\text{)} M_\odot & \text{for Cr 132a,} \\ 1.1 \Delta v \text{ (km s}^{-1}\text{)} M_\odot & \text{for Cr 132b.} \end{array}$$

*Cr 140*

The graphs of the variation of  $T_b$  at constant velocity along the cross-arms show a maximum at  $v \sim +54 \text{ km s}^{-1}$ , displaced  $0.75$  in  $b$  from the cluster's center in the direction of the plane, and  $0.25$  in  $l$  in the direction of increasing values of  $l$ . We disregard this high-velocity feature for the same reasons as in the case of Cr 121. Besides, a minimum is seen at  $v \sim +28 \text{ km s}^{-1}$  with  $\Delta l = \Delta b = 0.25$ . It corresponds to the only significant feature in Figure 4 at  $v \sim +26 \text{ km s}^{-1}$ . Again, this feature is most probably associated with the Orion arm and we disregard it. In the velocity interval  $-12$  to  $+12 \text{ km s}^{-1}$  the upper boundary for  $T_b$  is rather low,  $\sim 2 \text{ K}$  (Figure 4). Therefore, with  $\Delta l = \Delta b \sim 1.5$ , the upper boundary for the H I mass will be

$$M_{\text{HI}} \sim 3.3 \Delta v (\text{km s}^{-1}) M_{\odot}.$$

*Cr 135*

Graphs of type 1 give some evidence for two maxima: one at  $v \sim +11 \text{ km s}^{-1}$  with  $\Delta b \sim 1^\circ$  and  $\Delta l \sim 1.5$ , and the other at  $v \sim +34 \text{ km s}^{-1}$  with  $\Delta l \sim \Delta b \sim 1.5$ . Besides, a minimum (also seen in Figure 8), somewhat displaced from the cluster's center, appears at  $v \sim 0 \text{ km s}^{-1}$  with  $\Delta l \sim 1.5$  and  $\Delta b \leq 2^\circ$ . Inspection of Figure 4 confirms these three features. Again, we shall disregard the feature at  $+34 \text{ km s}^{-1}$ , being probably related to the Orion arm.

Assuming the cluster's distance, we derive the following parameters for the feature at  $+11 \text{ km s}^{-1}$ :

$$T_b = 9 \text{ K}, \quad \Delta v = 6 \text{ km s}^{-1}, \quad M_{\text{HI}} \sim 45 M_{\odot}.$$

We cannot decide if this H I feature is related to the cluster. It could also be related to the Gum nebula. Radial velocities have been measured at H $\alpha$  in 82 small-scale clouds of the nebula by Hippelein and Weinberger (1975). The values are all less than  $12 \text{ km s}^{-1}$ . For example, at  $l = 249.3$ ,  $b = -10.0$ , overlapping with our H I feature they measured  $+10 \text{ km s}^{-1}$ .

Analogously, for the minimum at  $v = 0$  we derive

$$T_b = -15 \text{ K}, \quad \Delta v = 7 \text{ km s}^{-1},$$

which corresponds to a H I mass deficit of  $175 M_{\odot}$ . This minimum apparently corresponds to a real H I deficit as compared to its surroundings. It could be related to the cluster (due, for example, to ionization or sweeping off) as well as to a larger scale H I feature such as, for example, Gould's Belt. Actually, Cr 135 is connected to Gould's Belt according to Clariá (1976).

## 6. Conclusions

From the above results it appears that no neutral hydrogen is related to the clusters Cr 121, Cr 140, Cr 132a, b, Ru 3 and Ru 106. From these, only the first four clusters have the earliest spectral type determined: namely, B0 IV,  $\sim$ B3,  $\sim$ B3 and B9, respectively. Therefore, our results are in general agreement with the qualitative conclusion that interstellar H I should be expected only in relatively young clusters, although not

necessarily found there (see, for example, Tovmassian *et al.*, 1973). Referring now to future observations and in order to derive more quantitative conclusions, it appears that more optical work is certainly necessary. In particular, the determination of the earliest spectral type present and the radial velocity of clusters located above, say  $|b| = 8^\circ$ , would be very useful. It would also be very valuable to analyze a statistically complete and homogeneous set of clusters.

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