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THE H I BUBBLE SURROUNDING THE "FIELD" O-TYPE STAR HD 155913: DISCLOSING A NEW OB ASSOCIATION?

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RESUMEN

Estudiamos la distribución del gas neutro interestelar en la vecindad de la estrella HD 155913 del tipo O5Vn((f)), utilizando observaciones de la línea de 21 cm del H I. El mapa de la distribución del H I en los alrededores de la estrella O5 muestra una burbuja interestelar probablemente creada por el viento estelar. Otras estrellas tempranas ubicadas a distancia similar a la de la estrella O5 aparecen proyectadas sobre los bordes de la estructura de H I. Sugerimos que pueden pertenecer a una asociación OB no catalogada.

ABSTRACT

We study the distribution of the neutral gas in the neighbourhood of the O5 Vn((f)) star HD 155913 based on observations of the 21 cm H I line. The distribution of neutral gas in the environs of the O5 star shows an interstellar bubble probably created by the stellar wind. Several other early type stars at comparable distances, are seen projected onto the borders of the H I bubble. We suggest that they may belong to an unknown OB association.

Key words: **ISM: H I BUBBLES — STARS: EARLY TYPE — STARS: INDIVIDUAL (HD 155913)**

1. INTRODUCTION

Hot, massive stars (O, Of and WR) have a major impact on the surrounding interstellar medium (ISM) via their strong stellar winds. With mass-loss rates $\dot{M} = 10^{-7} - 10^{-5}\ M_{\odot}\ \mathrm{yr}^{-1}$ (e.g., Lamers et al. 1995; Leitherer et al. 1995) and terminal velocities of their winds $V_w = 1000 - 3000\,\mathrm{km\,s^{-1}}$ (cf. Prinja et al. 1990), these stars transfer a considerable amount of energy and momentum to the ISM and create interstellar bubbles in their surroundings.

Here we present an analysis of the neutral hydrogen (H I) distribution in the vicinity of the O-type star HD 155913, considered to be a field star (Gies 1987). This star, classified as O5Vn((f)) by Walborn (1973), is located at $(l, b) = (345.^{\circ}28, -2.^{\circ}30)$, and at a distance of $\simeq 2.0$ kpc (Garmany et al. 1982; Savage et al. 1985).

2. H I 21 CM LINE OBSERVATIONS

The field including HD 155913 was observed during October 1996 with the 30-m single dish antenna of the Instituto Argentino de Radioastronomía (IAR). The H I 21 cm line was observed in total-power mode, with a helium-cooled HEMT amplifier receiver ($T_{\mathrm{sys}} = 35$ K) with a 1008-channel autocorrelator. The HPBW is $0.^{\circ}5$. The data were obtained with a velocity resolution of $1.05\,\mathrm{km\,s^{-1}}$. The *rms* noise in brightness temperature is 0.15 K for a single spectral point.

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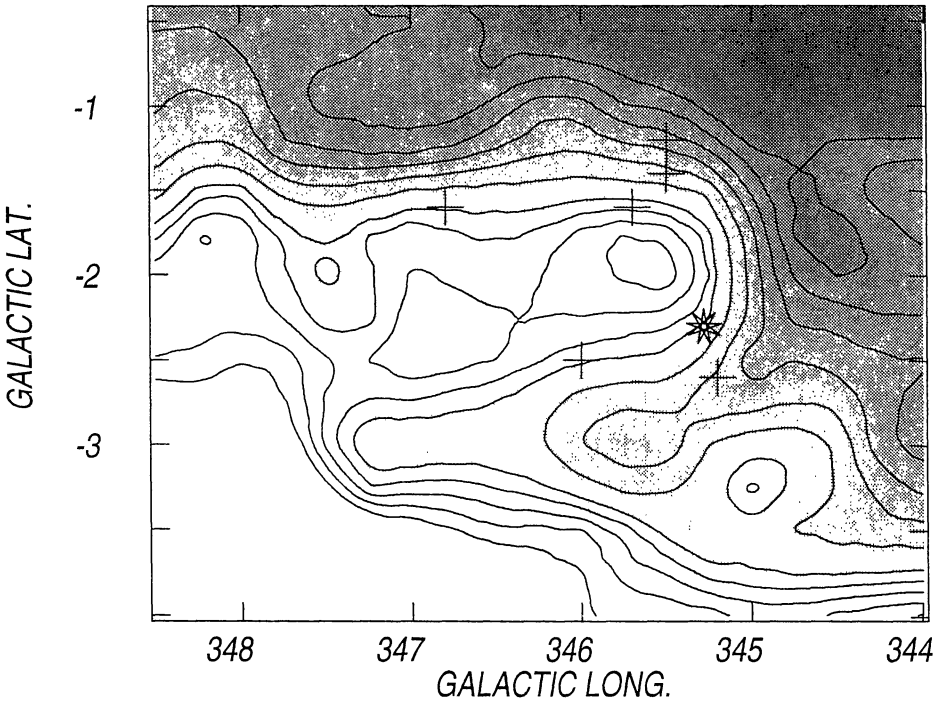

Fig. 1. A contour map of the H I 21 cm line brightness temperature distribution in the vicinity of HD 155913 (indicated with a star symbol). The positions of the OB stars listed in Table 2 are marked (+). The greyscale corresponds from 32 to 110 K, and contour lines from 30 to 42 K in steps of 3 K, thereof in steps of 5 K.

3. RESULTS AND DISCUSSION

Figure 1 displays a contour map of the observed H I brightness temperature distribution as seen at the (LSR) velocity of $-21\,\mathrm{km\,s^{-1}}$. The map shows an elongated low emission region with two small H I cavities centered at $(l, b) = (345.^{\circ}8, -2.^{\circ}0)$ and $(l, b) = (346.^{\circ}8, -2.^{\circ}3)$, which are detected within the velocity interval -26 to $-18\,\mathrm{km\,s^{-1}}$. The whole region appears surrounded by a thick envelope. HD 155913 is seen projected onto one of the higher density borders of the H I void. The increase in brightness observed in the region separating both minima is minor; therefore, we consider the whole H I feature as a single object, i.e., an interstellar bubble probably blown by the strong wind of HD 155913.

The main parameters of the H I bubble are listed in Table 1. Circular galactic rotation models predict that gas at a systemic velocity of $-21 \pm 1\,\mathrm{km\,s^{-1}}$ is placed at a kinematical distance $d \simeq 2.5\,\mathrm{kpc}$. Within errors, this value agrees with the stellar distance. Since kinematical distances have large uncertainties for the galactic longitudes where the H I bubble is observed, we adopt the stellar distance $d = 2.0\,\mathrm{kpc}$. This H I bubble appears similar to the ones disclosed surrounding other O and Wolf-Rayet type stars (see Cappa et al. 1993, 1996, and references therein).

To create an H I bubble, the stellar wind energy has to overpower the observed kinetic energy (E_k) of the bubble. In order to estimate the mechanical energy E_w of the stellar wind, and since no published stellar wind parameters were found for HD 155913, we have adopted from the literature the mean values of the mass-loss ($\dot{M}$) and of the terminal velocity of the wind (V_w), corresponding to the spectral type. The adopted values are $\dot{M} = 2\,10^{-6}\ M_{\odot}\,\mathrm{yr}^{-1}$ (de Jager et al. 1988) and $V_w = 2800\,\mathrm{km\,s^{-1}}$ (Prinja et al. 1990). The resulting mechanical energy of the stellar wind $E_w = 190\,10^{48}$ erg appears much higher than the kinetic energy of the bubble (cf. Table 1). In fact, $E_k = 0.02\,E_w$, indicating that the wind of the O star alone is able to blow the observed H I bubble.

Although HD 155913 has been previously considered to be a "field" star (Gies 1987), we also searched for other OB stars which might have contributed in creating the H I bubble. Table 2 lists six early type stars with their locations, spectral types, V magnitudes, $B-V$ colors, which we found projected onto the H I void at distances comparable with that of HD 155913. Some of them have probably added to the sweeping of gas in the H I bubble shown in Fig. 1. An inspection of the $B-V$ values for these stars (cf. Table 2) strongly suggests

TABLE 1

MAIN PARAMETERS OF THE OBSERVED H I BUBBLE

(l, b) position of the center	$345\overset{\circ}{.}8, -2\overset{\circ}{.}0$
Velocity interval (km s^{-1})	$-26, -16$
Systemic velocity (km s^{-1})	-21 ± 1
Adopted distance (kpc)	2.0
Semiaxes of the H I void (pc)	37 x 15
Outer radius of the H I envelope (pc)	52
Radius of the H I bubble (pc)	45
H I mass deficiency ($M_\odot$)	223
H I mass in the shell ($M_\odot$)	6800
Swept-up H I mass ($M_\odot$)	3500
Ambient gas density (cm^{-3})	0.4
Expansion velocity (km s^{-1})	≤ 10
Dynamical age t (10^6 yr)	2.5
Kinetic energy of the bubble E_k (10^{48} erg)	3.8

TABLE 2

OTHER OB STARS IN THE REGION OF THE H I BUBBLE

Name	(l, b)	Sp.Cl.	V	$B-V$	d(kpc)
HD 155051	$345\overset{\circ}{.}5, -1\overset{\circ}{.}2$	B1 Ib	7.93	0.46	2.2
HD 155134	$345\overset{\circ}{.}5, -1\overset{\circ}{.}4$	B1-2 II	8.82	0.45	2.0
HD 155873	$345\overset{\circ}{.}2, -2\overset{\circ}{.}6$	B0 Ib	8.25	0.64	2.1
HD 155959	$346\overset{\circ}{.}8, -1\overset{\circ}{.}6$	B1 II	8.60	0.64	1.7
HD 156172	$346\overset{\circ}{.}0, -2\overset{\circ}{.}5$	O9 V	8.18	0.40	2.6
LSS 3964	$345\overset{\circ}{.}7, -1\overset{\circ}{.}6$	OB$^-$	10.47	0.51	2.2

that they belong to an unknown OB association. Further optical studies are needed to investigate this OB association.

4. SUMMARY

Our analysis of the H I gas distribution in the neighbourhood of the O5 Vn((f)) star HD 155913 has disclosed an interstellar bubble probably blown by the stellar wind. This bubble of 45 pc in radius is expanding at a velocity ≤ 10 km s^{-1}, thus implying a dynamical age of $\simeq 2.5\,10^6$ yr. Only a few percent of the mechanical energy of the stellar wind has been transformed into kinetic energy of the H I shell, indicating that HD 155913 alone is able to create the observed bubble.

Several other OB stars were found to be located within the borders of the H I bubble. Some of these stars may have contributed in the formation of the bubble. Their $B-V$ values suggest that these OB stars belong to an unknown OB association.

REFERENCES

Cappa, C. E., Niemela, V. S., & Benaglia, P. 1993, ASP Conf. Ser., Vol. 35, Massive Stars: Their Lives in the Interstellar Medium, ed. J. P. Cassinelli & E. B. Churchwell (San Francisco: ASP), 286
Cappa, C. E., Niemela, V. S., Herbstmeier, U., & Koribalski, B. 1996, A&A, 312, 283
Garmany, C. D., Conti, P. S., & Chiosi, C. 1982, ApJ, 263, 777
Gies, D. R. 1987, ApJS, 64, 545
de Jager, C., Nieuwenhuijzen, H., & van der Hucht, K. A. 1988, A&AS, 72, 259
Lamers, H.J.G.L.M., Snow, T. P., & Lindholm, D. M. 1995, ApJ, 455, 269
Leitherer, C., Chapman, J. M., & Koribalski, B. 1995, ApJ, 450, 289
Prinja, R. K., Barlow, M. J., & Howarth, I. D. 1990, ApJ, 361, 607
Savage, B. D., Massa, D., Meade, M., & Wesselius, P. R. 1985, ApJS, 59, 397
Walborn, N. R. 1973, AJ, 78, 1067