

NGC 2359: VLA HI and radio continuum observations

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1. Introduction

NGC 2359, a H II region located at a distance of 5 kpc from the Sun (*e.g.*, Goudis *et al.* 1994), appears as a ring like nebula surrounding HD 56925, a Wolf-Rayet star of type WN4. The nebula consists of a filamentary shell, a southern *bar* and streamers of diffuse gas (*cf.* Schneps *et al.* 1981, SHWB). Here we report the results of HI 21-cm line and radio continuum observations in the direction of NGC 2359.

2. Observations

Our observations were performed with the NRAO⁷-VLA synthesis telescope. The radio continuum image, obtained at 1465 MHz using the C-and D-arrays, has an angular resolution of $\sim 30''$ and covers a region of $30''$. The HI 21-cm line data, obtained with the D-configuration, cover the same region with angular and velocity resolutions of $\sim 45''$ and 1.3 km s^{-1} . In addition, optical CCD images through narrow band filters centered at the nebular emission lines of H α , [OIII] and [SII], were obtained with the Curtis-Schmidt Telescope at CTIO, Chile. These images are $\sim 30'$ square.

3. Results

The radio continuum image of NGC 2359 shows an excellent correspondence with the optical features. Table 1 lists the emission measure EM , the electron density n_e and the ionized mass M_i together with the volume filling factor f derived for the filamentary shell, the southern bar, the streamers, and the weak radio continuum emission region (at a level of 1 mJy beam^{-1}) that surrounds the ring nebula. The amount of ionized gas in the filamentary shell indicates that it

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Table 1. Physical parameters of ionized gas in NGC 2359

component	S (Jy)	EM (10^3 pc cm^{-6})	f	n_e (cm^{-3})	M_i (M_\odot)
shell	0.85	3.8	0.03	120	70
southern bar	0.58	9.0	0.3–0.5	60	95–120
streamers	0.78	3.6	1	10–50	105–280
seak region	0.38	0.3	1	~ 3	~ 600

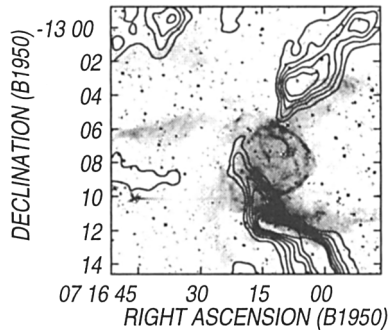


Figure 1. Contours of the H I 21-cm line emission distribution at 54 km s^{-1} superposed to the grey-scale optical H α image of NGC 2359. The contour lines correspond to 5, 15, 25, 35, 45 and 55 mJy beam^{-1} or 1.3, 3.9, 6.5, 9.1, 11.7 and 14.3 K . The synthesized beam is $57''.7 \times 40''.6$.

mostly consists of swept-up interstellar gas. The excitation parameter indicates that HD 56925 alone suffices to ionize the gas.

Analysis of the H I 21-cm line images reveals features connected with the ring nebula within the (LSR) velocity range from 46 to 67 km s^{-1} . Two H I structures appear most clearly related to the nebula. One of them, detected at the systemic velocity of 54 km s^{-1} is shown in Fig. 1 overlaid on a H α image (*cf.* Goudis *et al.* 1983), This H I feature indicates the location of the ionization front, similar to the optical [NII] emission, and appears also to be related to molecular gas at the same velocity (SHWB). A second H I structure, observed at 63 km s^{-1} , consists of clumps that surround a major part of the shell and the southern bar of NGC 2359. The dynamics of the nebula are consistent with the momentum conserving case or with an intermediate case between energy and momentum conservation.

Our results are in general agreement with the scenario for NGC 2359 described by Dufour (1989).

References

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