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THE DISTANCE AND NEUTRAL ENVIRONMENT OF THE MASSIVE STELLAR CLUSTER WESTERLUND 1

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Westerlund 1 (Wd 1) is a highly reddened, massive, compact cluster of post-main sequence stars, including OB supergiants and hypergiants, red and yellow supergiants, and Wolf-Rayet stars. We have examined observations of atomic hydrogen from the Southern Galactic Plane Survey (McClure-Griffiths et al. 2005) to determine the distance to Wd 1 and to investigate its neutral environment. Using the latest Galactic rotation model we derive a distance of 3.9±0.7 kpc, which is consistent with a location at the far side of the Scutum-Crux arm. We found a large interstellar bubble of diameter about 50 pc which was created early in the life of the cluster and small expanding bubbles, which we suggest consist of recombined material lost by cluster members through their winds. Additionally we compile a list of kinematic distances to nearby radio bright H II regions and SNRs.

To study the kinematics along the line of sight towards Wd 1 we used a flat rotation model for the Galaxy with a Galacto-centric radius of $R_\odot$ = 7.6 kpc and a circular velocity $\Theta_\odot$ = 214 km s^{-1} around the Galactic centre for the Sun. The distance to each spiral arm was taken from the electron density distribution model of Cordes & Lazio (2002) after appropriate scaling to account for our lower value for $R_\odot$. Included in this estimate is a very careful investigation of possible sources of error like non-circular velocity components due to streaming motion and the possible occurence of a spiral shock. This rotation curve successfully predicts the location of the Tangent point gas and the velocity of the Sagittarius Arm outside the solar circle on the far side of the Galaxy to within 4 km s^{-1}.

The HII region created by the members of Wd 1 is not bright enough to produce an HI absorption profile. Therefore, for each spiral arm along the line of sight we averaged the appropriate velocity channels. The resulting images indicate absorption by gas in the Local, Sagittarius, and Scutum-Crux arms. There is no evidence for absorption in the Norma arm or the Tangent point gas. This favors a location for Wd 1 in the Scutum-Crux arm.

TABLE 1

NEWLY DETERMINED DISTANCES TO H II REGIONS AND SNRS IN THE VICINITY OF WD 1.

Source	v_{sys} [km s^{-1}]	d_{lit} [kpc]	d_{new} [kpc]	Type
G337.8−0.1			11.2	SNR
G337.95−0.48	−41	3.1	$2.9^{+1.2}_{-0.4}$	H II region
G338.0−0.1 complex	−51	12.0	$10.7^{+1.4}_{-0.4}$	H II region
G338.41−0.24	−1	15.7	$14.0^{+4.5}_{-0.9}$	H II region
G338.4+0.1 complex	−32	13.1	$11.7^{+2.0}_{-0.5}$	H II region
G338.5+0.1			11.3	SNR
G338.8+0.6 complex	−62	4.3	$3.9^{+0.9}_{-0.4}$	H II region
G338.9−0.1	−38	3.1	$2.8^{+1.2}_{-0.6}$	H II region
G338.9+0.4			3.5	H II region
G339.13−0.41	−38	3.1	$2.8^{+1.2}_{-0.6}$	H II region
G339.6−0.4 (Wd 1)	−55	-	$3.6^{+1.0}_{-0.4}$	H II region
G339.58−0.12	−34	2.8	$2.6^{+1.3}_{-0.7}$	H II region
G339.84+0.27	−20	14.1	$12.5^{+2.7}_{-0.6}$	H II region
G340.2−0.2 complex	−50	3.7	$3.5^{+1.0}_{-0.5}$	H II region
G340.24−0.48	−61	4.4	$3.9^{+0.9}_{-0.3}$	H II region
G340.6+0.3			15.3	SNR

We carefully investigated the HI data in the velocity range for the Scutum-Crux arm. We found two small prominent features in velocity space centered at the position of Wd 1 at about −55 km s^{-1}, and a much larger bubble-like feature open to the south. Estimates for the dynamic ages for these features result in an upper limit of 600,000 yr for the small bubbles and a lower limit of 2.5×10^6 yr for the large bubble. The most likely explanation is that the large bubble was blown by the winds of the massive members of Wd 1, while they were still on the main sequence. The smaller bubbles were probably created after the last supernova pushed away all material inside the large bubble. In this case they originate from the combined winds and mass loss of the remaining stars.

The resulting distance of Wd 1 and a few newly determined distances of nearby H II regions and SNRs are listed in Table 1.

REFERENCES

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