

ATOMIC HYDROGEN IN THE PLANETARY NEBULA IC 4997

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In the course of a sensitive search for atomic hydrogen emission associated with planetary nebulae having high velocities relative to Galactic HI (Schneider et al. 1986), we detected absorption in the spectrum of IC 4997 (PK 58-10.1). This is only the second definite detection of HI associated with a PN. The velocity of the feature coincides precisely with that expected if the gas is expanding with the measured optical expansion velocity of 14 km s^{-1} (Sabbadin 1984), strongly suggesting an association.

We observed IC 4997 with the Arecibo 305 m radiotelescope using the 21 cm dual-circular polarization feed and the 1008 channel autocorrelation spectrometer. Details of the observing procedure are given in Schneider et al. (1986),

Our results are presented in the figure. The upper panel shows the Galactic emission, the central panel the difference between the on-source spectrum and the average of the four off-source spectra, and the bottom panel the difference between the $\langle N+S \rangle$ and $\langle E+W \rangle$ averaged scans. The central panel represents our effort to remove Galactic HI emission from the spectrum of IC 4997. Cancellation is imperfect for the strongest Galactic emission, but beyond this region and over the entire velocity range of IC 4997 (centered around the velocity marked by an arrow), the $\langle N+S \rangle - \langle E+W \rangle$ spectrum shows a flat baseline. This indicates that variation in the Galactic HI emission is linear outside of the region around $V_{\text{LSR}}=0$. However, in the central panel there is a dip at $V_{\text{LSR}}=-64 \text{ km s}^{-1}$ which was independently confirmed in follow-up measurements.

After deconvolution with our 8 km s^{-1} resolution the line width for

IC 4997 is 18 km s^{-1} . This value is consistent with that expected from a spherical structure of neutral hydrogen which surrounds the continuum source and expands with the nebula.

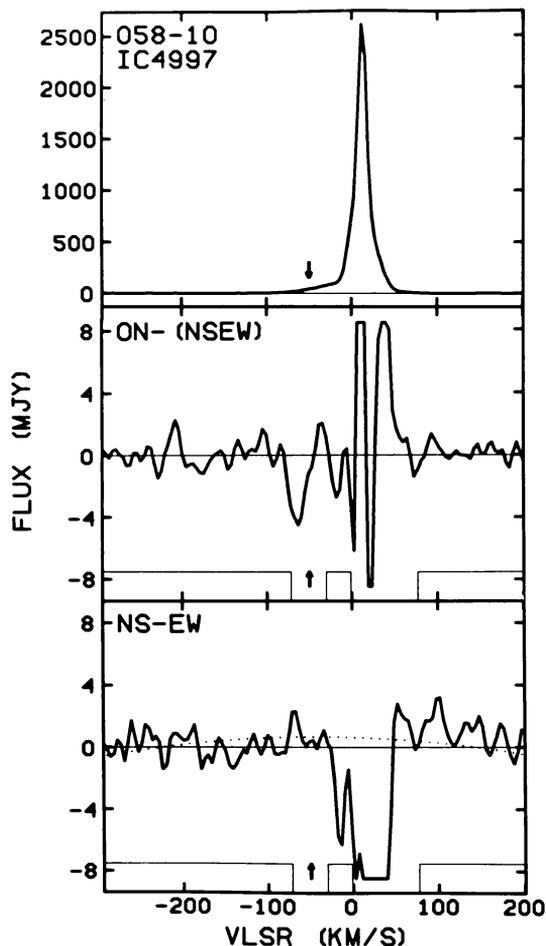
The neutral hydrogen mass $M_{\text{HI}} = 1.9 \pm 1.2 \cdot 10^{-3} M_{\odot}$ was computed assuming a spin-excitation temperature $T_{\text{ex}} = 100 \text{ K}$ and is twice the HI actually detected to allow, by symmetry, for gas on the far side of the nebula. We note that this value does not significantly increase the total computed mass of IC 4997.

Aside from other questions such as geometric corrections (discussed by Altschuler et al. 1986) a factor of two range in the distance scaling yields a factor of four uncertainty in M_{HI} . We therefore find it useful to compute the ratio of HI to ionized mass in the nebula ($M_{\text{HI}}/M_{\text{i}} = 0.39 \pm 0.08$) which is only weakly dependent on the distance and angular size. We used the formulation for M_{i} of Milne and Aller (1975), assuming a temperature of 18,000 K for the ionized gas, which appears appropriate for this very young nebula, and a standard helium abundance. Details of the computations, and a comparison of our results with other planetary nebula can be found in Altschuler et al. (1986).

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REFERENCES

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Spectra towards IC 4997