A GIANT STELLAR-WIND SHELL AND STAR FORMATION NEAR THE H II REGION M16

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A large radio continuum loop of diameter 1°.2 was discovered at G16.5+0.7 on the Bonn 2.7 GHz and NRO 10 GHz galactic plane surveys. The loop is associated with the H II region M16, and the diameter is 60 pc at a distance of 2.8 kpc. Figure 1 shows the loop at 2.7 GHz in gray scale. The spectrum is thermal and the total H II mass is estimated at 3×10^3 $M_\odot$. If the loop is due to a shell of the same diameter, the mean electron density on the shell is about 4 cm^{-3}. The total thermal energy is about 6×10^{48}ergs. The characteristics are summarized in Table 1.

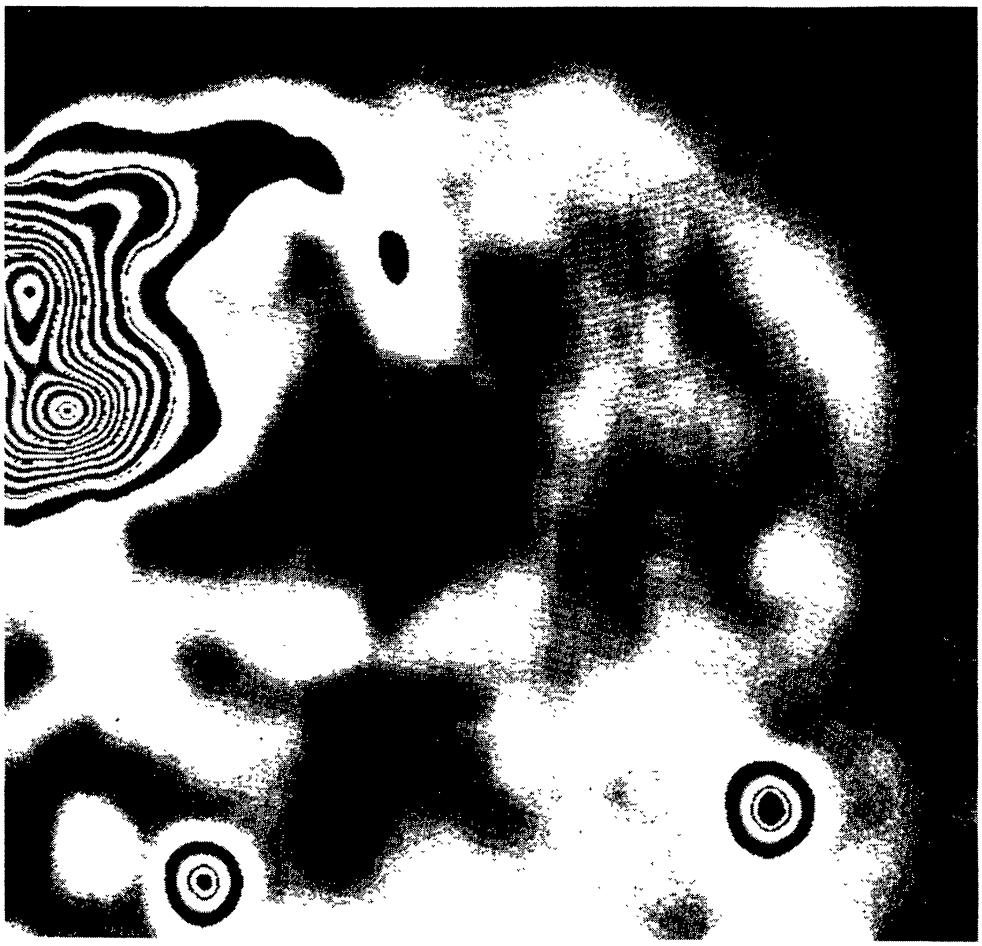

Fig. 1. A stellar wind shell associated with the H II regions M16 (left corner). The center of the figure is G16.5+0.7 and the width is 1°.5. The shell diameter is 1°.2.

Table 1. Radio Shell Associated with M16

Center position	l = 16.3°, b = 0.6°
.... RA_{1950}	= 18h 15.3m
....Dec_{1950}	= -14.4°
Distance	2.8 kpc
Major diameter (continuum/H I)	1.2° (59 pc)/1.4° (68 pc)
Minor diameter (continuum/H I)	0.9° (44 pc)/1.1° (54 pc)
Shell thickness (continuum/H I)	≦ 3 pc/ ≦ 10 pc
Radio spectrum	flat
V_{LSR} of H I shell center	28 km s^{-1}
Expansion velocity	4 km s^{-1}
Velocity dispersion in the shell	4 km s^{-1}
Age (= radius/expansion velocity)	7×10^6 y
H II density	≧ 4 cm^{-3}
H I density	≧ 5 cm^{-3}
H II mass	2.5×10^3 $M_\odot$
H I mass	$\sim 10^4$ $M_\odot$
Total mass	$\sim 10^4$ $M_\odot$
Kinetic energy of the shell	$\sim 2\times10^{48}$ergs
Thermal energy of the shell	$\sim 6\times10^{48}$ergs

The radio shell is surrounded by an H I shell 68 pc in diameter with an H I mass of 10^4 $M_\odot$. The H I shell is expanding at a velocity of 4 km s^{-1}. This leads to a total kinetic energy of 2×10^{48} ergs and an age (radius/expansion velocity) of 7×10^6y. The H II region M16 is in contact with the NW wdge of the radio and H I shells as illustrated in Figure 2. A giant molecular complex is associated with M16 and is also in contact with the shell.

The shell structure associated with young stars in M16 agrees with that predicted by a stellar-wind bubble model: the innermost region is a cavity dominated by a wind from OB stars and is bounded by the shocked H II gas (thermal radio shell). The H II shell is further surrounded by a cooled H I shell consisting of swept-up interstellar gas. The radius of a wind bubble may be related to an ejection rate of kinetic energy L_k by the stellar wind (*e.g.* Tomisaka *et al.* 1981). For an estimated age of 7×10^6 y and a radius 60 pc, which is taken to be equal to the distance of the farthermost side of the shell from the M16 core, we obtain $L_k \sim 3\times10^{36}$ ergs s^{-1} for an ambient gas density of 1 cm^{-3}. If the wind velocity is typically 2000 km s^{-1}, we have a mass loss rate of $\dot{M} \sim 3\times10^{-6} M_\odot$ yr^{-1}, which is typical for an O star in the active wind phase.

The geometrical relationship of the expanding wind shell with the GMC (Figure 2) suggests that the shell will hit the GMC in 10^{6-7} y. This interaction could trigger a shock compression of the cloud which would lead to further star formation there. Moreover, if similar wind bubbles from M16 occurred in the past, which is most likely from the observed multi-shell structure (Figure 1), they may have triggered the star formation in M17, the youngest star forming region in the cloud

complex. A detailed description of the observations, results, and models are given in Sofue *et al.* (1986).

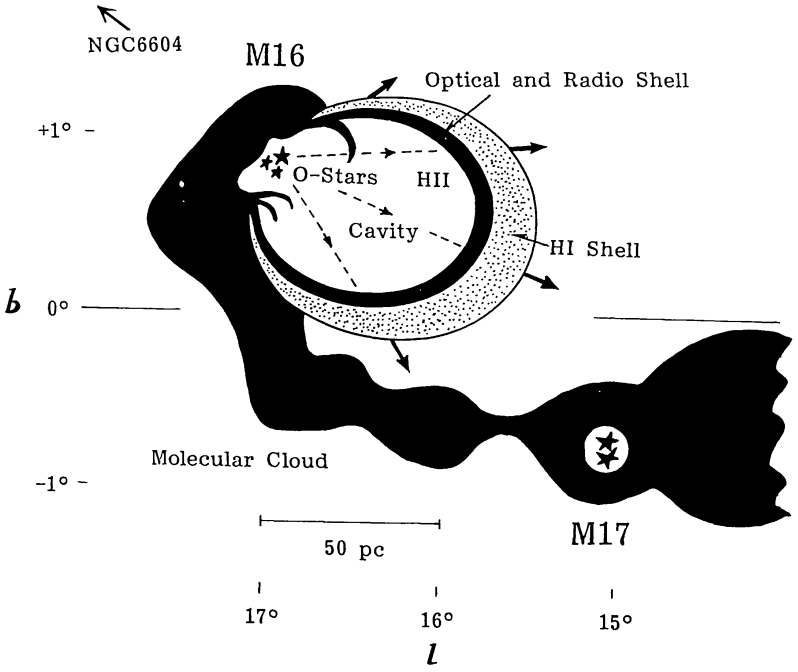

Fig. 2. Schematic illustration of the relationship of the optical, radio and H I shells to the star-forming site M16 and M17 in the large molecular cloud complex.

REFERENCES

Sofue, Y., Handa, T., Fürst, E., Reich, W,, and Reich, P.: 1968, Publ. Astron. Soc. Japan, in press.
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S201: THE IONIZED SKIN OF A MOLECULAR BLOB

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S201 is an optically visible H II region whose ionizing star is hidden to the sight by heavy obscuration. The radio continuum surface