OBSERVATIONS OF MASSIVE STARS AT 7 mm

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Young massive stars lose mass by means of a stellar wind. This loss affects the stellar evolution and the consequences are different depending on the degree of mass loss. As such, the better we know the mass loss rate the better we can understand stellar evolution.

To determine the mass loss rate, $\dot{M}$, we need only have the centimeter flux density, the terminal velocity, and the distance to the source. However, some early-type stars show strong, time-variable, nonthermal emission of poorly understood origin. The nonthermal emission is expected to become weaker with increasing frequency while the free-free radiation from the ionized wind should become stronger. At 7 mm one does not expect the radio continuum emission to be significantly contaminated by synchrotron emission. Thus, if we use the 7 mm flux density to obtain the mass loss rates for this type of stars, we expect to have a more reliable way to determine stellar mass loss rates.

In this work we present 6, 3.5, and 0.7 cm observations of three objects: Cyg OB2 No. 5, Cyg OB2 No. 9, and P Cyg. Observations were made with the VLA on April 17, 1994. The array was in the A-configuration, giving a similar angular resolution of $\sim 0.''3$ for the three frequencies. Data reduction was done using AIPS. We then determined flux densities from cleaned, natural-weighted maps. We detected free-free emission at 7 mm arising from the ionized wind of the stars P Cyg and Cyg OB2 No. 5, and marginally detected emission from Cyg OB2 No. 9 (flux densities of 27.4, 9.4 and 3.9 mJy respectively). The emission detected from the last object shows clear contamination by synchrotron emission at 6 and 3.5 cm. Spectral indices were obtained from the 6 and 3.5 cm flux densities and from the 3.5 and 0.7 cm flux densities. Distances and terminal velocities were taken from the literature. We use these data, together with the 7 mm flux densities, to derive the mass loss rate of each star. We expect these mass loss rate values for Cyg OB2 No. 5 and P Cyg (4.4×10^{-5} and 9.8×10^{-6} $M_\odot$ yr^{-1}, respectively) to be more reliable than values previously reported in the literature. The mass loss rate for Cyg OB2 No. 9 (2.3×10^{-5} $M_\odot$ yr^{-1}) has a large uncertainty.

We propose that a reliable method to derive mass loss rates for young massive stars is to use 7 mm radio continuum observations.

WARM MOLECULAR GAS ASSOCIATED WITH COMETARY H II REGIONS

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We present observations of the (J,K) = (2,2) and (3,3) inversion transitions of ammonia, made at $\sim 4''$ resolution with the VLA, in the direction of the star forming regions G32.80+0.19 and G61.48+0.09, which contain compact cometary as well as compact H II regions. Toward the G32.80+0.19 complex we identify three different ammonia components. In particular the Middle and the South ammonia clouds exhibit the (2,2) lines in absorption while the (3,3) lines are in emission. This situation is explained as blending, within the synthesized beam, of an emitting region of hot molecular gas and an absorbing region of cold gas in front of a continuum source. Toward G61.48+0.09 only the (3,3) main transition line was detected, and we distinguish two compact clouds. We found that the ammonia clouds are intimately associated with the brightest and most compact regions of ionized gas. The G32.80+0.19 A and G61.48+0.09 B2 compact H II regions seem to be embedded in dense molecular cores having molecular hydrogen densities of 5 and 3 × 10^4 cm^{-3}, and temperatures of 60 and 70 K, respectively. In both cases we found molecular gas close to the heads of the cometary-like H II regions. The ionized and molecular gas have similar velocities, supporting the champagne model.

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ROTATING MASSIVE STARS NEAR THE EDDINGTON LIMIT: η CARINAE

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A rotating, massive star, approaching the Eddington limit, begins to break up before it actually reaches the Eddington limit, due to the combination of radiation pressure and centrifugal forces acting on its surface. This simple physical argument favors the formation of highly bipolar nebulae around luminous blue variables even in the absence of companions. Our stellar evolution calculations for a rotating star of 100 $M_\odot$, which reproduce the luminosity of η Carinae, indicate that its great eruption in 1840 may have been due to the star reaching its break-up speed. Applying the wind-compressed zone model of Bjorkman & Cassinelli (1993, ApJ, 409, 429) to this sce-