Submillimeter Array Imaging of the Maser Emission from the H30α Radio Recombination Line in MWC 349A

J. Weintroub, J. M. Moran, D. J. Wilner, K. Young, R. Rao, and H. Shinnaga

Abstract.

We used the Submillimeter Array to map the angular distribution of the H30α recombination line (231.9 GHz) in the circumstellar region of the peculiar star MWC349A. The resolution was 1.2", but because of high signal-to-noise ratio, we measured the positions of all maser components to accuracies better than 0.01", at a velocity resolution of 1 km s^{-1}. The two strongest maser components (called high-velocity components) at velocities near −14 and 32 km s^{-1} are separated by 0.048" ± 0.001" (60 AU) along a position angle of 102° ± 1°. The distribution of maser emission at velocities between and beyond these two strongest components were also provided. The continuum emission lies at the center of the maser distribution to within 10 mas. The masers appear to trace a nearly edge-on rotating disk structure, reminiscent of the water masers in Keplerian rotation in the nuclear accretion disk of the galaxy NGC 4258. However, the maser components in MWC 349A do not follow a simple Keplerian kinematic prescription with $v \sim r^{-\frac{1}{2}}$ but have a larger power-law index. We explore the possibility that the high-velocity masers trace spiral density or shock waves. We also emphasize caution in the interpretation of relative centroid maser positions where the maser is not clearly resolved in position or velocity, and we present simulations that illustrate the range of applicability of the centroiding method.
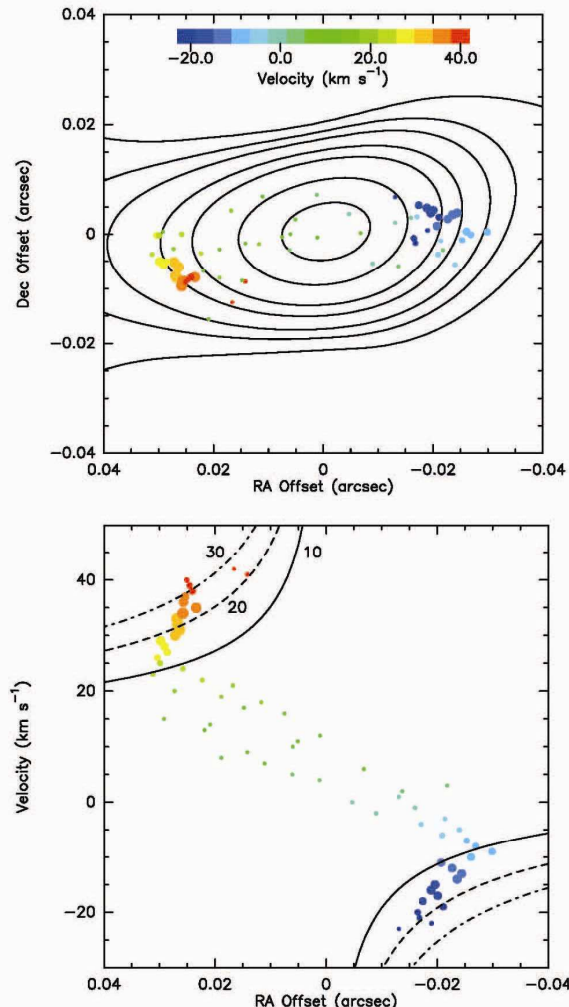
FIG. 4.— *Top*: Distribution of maser spots with respect to the position of the unresolved 230 GHz continuum emission. This relative alignment is accurate to 0.01″. An angular offset of 0.05″ corresponds to a linear dimension of 60 AU or 0.9×10^{15} cm for a distance of 1200 pc. Areas of the spots are proportional to their flux densities and color coded by velocity. Error bars, shown in Fig. 3, are omitted here for clarity. Contours represent the 2.27 μm IR emission from Danchi et al. (2001). The IR image is nominally aligned with the continuum position. *Bottom*: The *p-v* diagram, where right ascension is used as the position axis. High-velocity data points (velocities in the range 21−42 and −5 to −21 km s^{-1}) are overlaid with Keplerian curves for central masses of 10, 20, and 30 $M_\odot$. The high-velocity wings are considerably steeper than expected for Keplerian motion at a fixed azimuth angle.