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VLBA Imaging of 12.2 GHz Methanol Masers

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Abstract. We have used the VLBA to image the 12.2 GHz (2_0-3_{-1} E) masing transition of methanol toward the massive star formation region G345.01+1.79. The maser spots are distributed in a curved structure with a near monotonic velocity distribution along the curve. The cluster of maser emission covers an area of approximately 200 milli-arcseconds in right ascension and 70 milli-arcseconds in declination.

Comparison of the positions of the 12.2 GHz methanol maser spots in G345.01+1.79 as determined from the 1995 VLBA observations with 1988 Parkes-Tidbinbilla Interferometer observations shows that the relative positions of the maser spots detected in both epochs has changed by less than 5 milli-arcseconds during that interval. Assuming a distance of 2.3 kpc to G345.01+1.79 implies an upper limit on the relative tangential velocities of the maser spots of 7 km s^{-1}.

1. Introduction

The two strongest class II methanol masers are the 6.7 GHz 5_1-6_0 A^+ transition and the 12.2 GHz 2_0-3_{-1} E transition. Initial searches focused toward known sites of star formation and detected both 6.7 and 12.2 GHz methanol masers toward a large fraction, particularly those also containing OH masers (see for example Batrla et al. 1987; Menten 1991).

To date there are relatively few published high resolution images of either the 6.7 or 12.2 GHz methanol maser transitions. However, observations by Norris et al. (1988, 1993) of approximately a dozen strong sources show that a significant fraction have a linear or simple curved spatial morphology. This is in contrast to OH and H_2O masers observed toward star formation regions which typically have complex distributions. We are in the process of measuring the relative proper motion of a small sample of 12.2 GHz methanol masers in order to test models of the masers (see the paper by Norris et al., these Proceedings, p. 377). To date we have two epochs of data, the first in May 1995 and the second in January 1997. The data presented here has been collected as part of that project.

2. Results & Discussion

G345.01+1.79 is a nearby massive star formation region with relatively strong 6.7 and 12.2 GHz methanol maser emission. Figure 1 shows the spatial distribution of the 12.2 GHz methanol masers in G345.01+1.79 determined from VLBA observations along with the 6.7 GHz methanol masers and 8.4 GHz radio continuum emission imaged with the ATCA. The masers are offset by approximately 0.5 arcsecond from the a marginally resolved ultra-compact HII region. With the exception of the four most red-shifted maser spots the 12.2 GHz emission follows a simple curve with a near monotonic velocity gradient. A similar spatial distribution is seen in the 6.7 GHz masers, but there are several blue-shifted spots at velocities where there is no 12.2 GHz emission.

Comparison of the distribution of the 6.7 and 12.2 GHz maser spots shows that at least 4 are coincident (to within the relative positional errors) at the two frequencies. Comparison with a 6.7 GHz VLBI image when it is made will probably reveal a larger number of coincident spots which are blended in the large synthesised beam of the ATCA observations. G345.01+1.79 was one of the sources mapped by Norris et al. (1988) using the Parkes-Tidbinbilla Interferometer (PTI). Comparing the 4 spots detected in the 1988 PTI observations with spots at the same velocity from the 1995 VLBA observations shows that none of the positions have changed by more than 5 milli-arcseconds during that interval, which places a limit of 0.7 milli-arcseconds per year on the proper motion of the masers. This corresponds to a upper limit on the relative tangential velocities of the spots of 7 km s^{-1} (assuming a distance of 2.3 kpc).

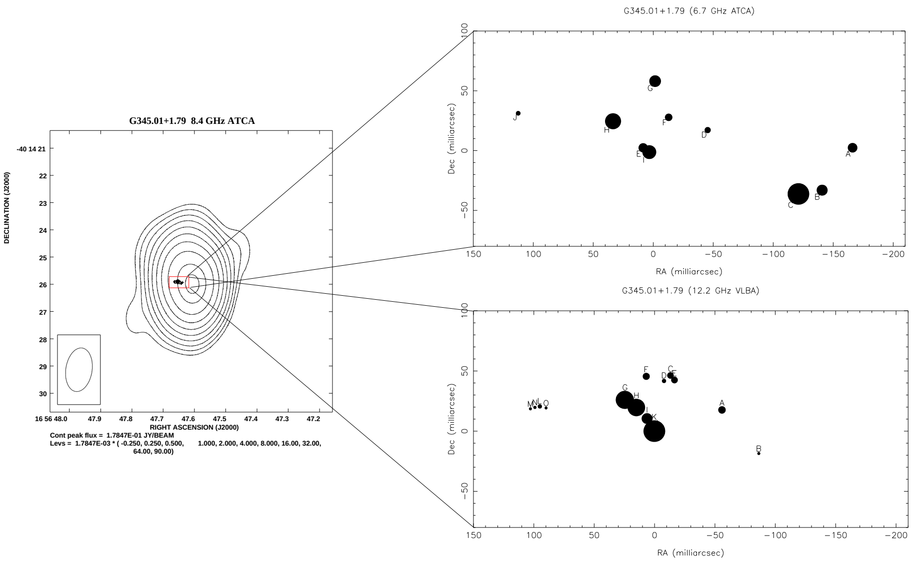

Figure 1. The distribution of the 6.7 and 12.2 GHz methanol masers in G345.01+1.79 shown on the same spatial scale. The area of the circles used to represent each spot is proportional to the flux density. The letters used to label the spots represent the velocity (with "A" being the most blue shifted).

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