

What is happening in G357.96-0.16?

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Abstract. In order to answer this question, we examine the relationship between the two sites of maser activity in G357.96-0.16. We also propose future observations for examining the dust properties of this interesting region of massive star formation.

Keywords. masers, stars: formation

G357.96-0.16 in an intriguing region of star formation with various molecular masers and a possible HII region (Figure 1; Voronkov *et al.* 2011). The 6.7 GHz methanol maser data suggest the presence of two massive proto-stars, however, we are unsure as to the mechanism driving the radiation that is exciting the 6.7 GHz maser in the southern site.

1. Is the northern site the source of an outflow?

The 6.7 GHz methanol maser (square) in the northern site indicates the presence of a proto-star. Unusually, the 22 GHz water maser (cross) in the northern site has a large velocity spread over 180 km s⁻¹ wide (Breen *et al.* 2010) suggesting an outflow. The weak 25 GHz continuum emission (single contour at the northern site) suggests a possible HII region. Contours filling the 8.0 μm arc represent 16 cm continuum emission (obtained by A. Dicker, C-E. Green, and D. Compton as part of their summer vacation program). This site is considered to be more evolved than the southern site as it contains an OH maser (not shown) within 2" of the other masers (Forster *et al.* 1989).

2. Does a second proto-star exist in the southern site?

The 25 GHz methanol masers (solid circle) indicate a highly energetic shock in the southern site. The 6.7 GHz methanol maser (square) is unexpected here and would suggest the presence of a second proto-star. However, dust heated by the shock may also excite a 6.7 GHz methanol maser. We have recently observed 44 GHz methanol masers in the region and will use these to characterize the shock morphology. A 22 GHz water maser (cross) is also found in the southern site.

3. What is the relationship between the two sites?

Current wide-spread opinion is that a 6.7 GHz maser traces the exact location of a massive young stellar object (Minier *et al.* 2003, Xu *et al.* 2008). Therefore the presence of a 6.7 GHz maser at both sites in G357.96-0.167 would suggest the presence of two massive young stellar objects. Moreover, the velocities of both masers are similar suggesting the two sites might be related.

Methanol masers are also known to be associated with sub-millimetre and millimetre continuum emission, as observed by Walsh *et al.* (2003) and Hill *et al.* (2005). Therefore, we propose observations to estimate the mass at each site by examining the cold (T= 20 - 50 K) molecular dust in the 230 GHz continuum band. We have also searched for multiple 23 GHz ammonia lines using the Australia Telescope Compact Array, which we will use to estimate the temperature of the northern site.

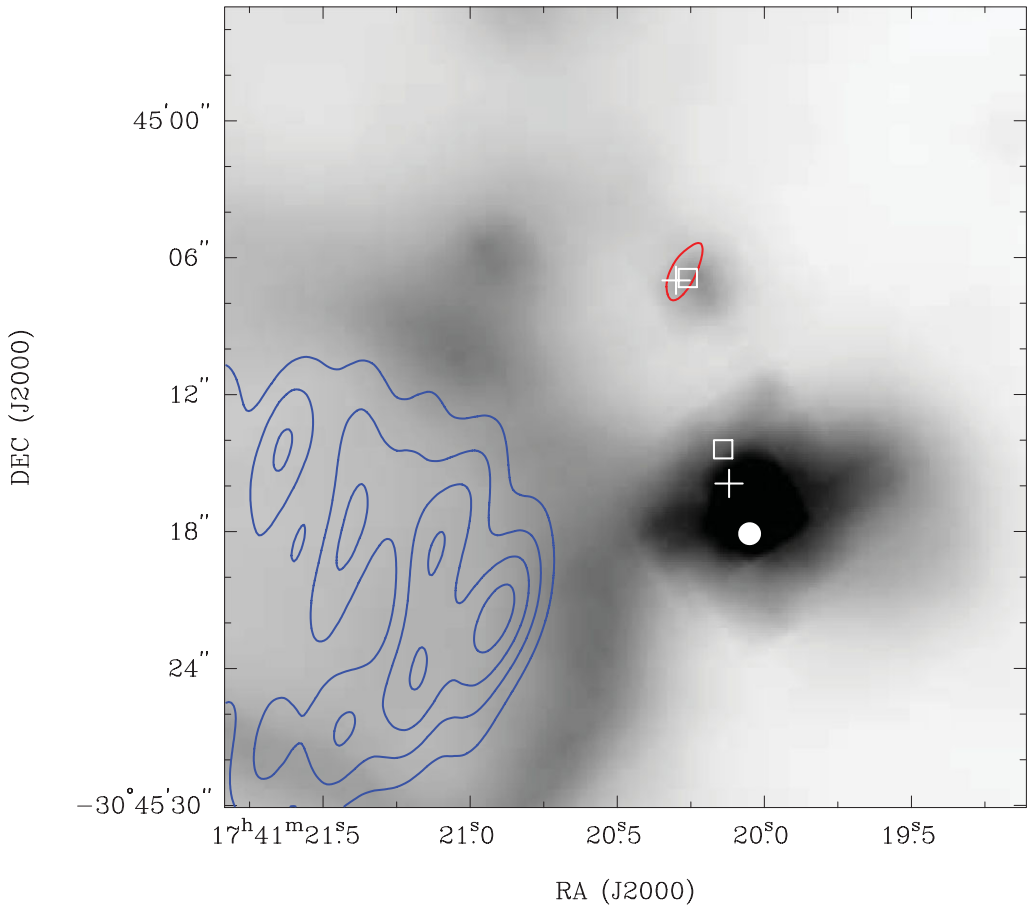


Figure 1. G357.96-0.16. The positions of 22 GHz water masers (crosses), 6.7 GHz methanol masers (squares), 25 GHz methanol masers (solid circle), 16 cm continuum emission (contours) and 25 GHz continuum emission (single contour at northern maser site) over laid on an 8.0 μm Spitzer image (grey scale background; Voronkov *et al.* 2011).

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