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## MODELING THE BUILDING BLOCKS OF WATER MASERS IN CEPHEUS A

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**Recent VLBA observations of water maser emission from the star-forming region Cepheus A have shown that this emission actually comes from a set of coherent features or “building blocks”.**

These building blocks are small linear structures of water maser spots that conform a larger configuration with a well-defined linear/arcuate shape. In small angular regions, the VLBA observations (Torrelles et al. 2001) show that:

1. The water maser spots form a well-defined linear chain in the plane of sky.
2. A single spectral line with a width of 0.5 to 1 km s<sup>-1</sup> in the flux density vs. velocity graph.
3. A coherent structure and a well-defined velocity gradient in the position-velocity diagrams.

A conspicuous example of these results is the R5-a block containing the strongest maser spot of the entire region ( $\sim 200$  Jy beam<sup>-1</sup>, see Figure 1).

This building block is modeled as a thin disk of radius  $r$ , and thickness  $h$ , of material flowing in the direction  $\theta$  with a linear velocity gradient  $a$ . The observer is in the disk plane.

The following equation was used to express the intensity from each point of the disk at a given velocity:

$$I(v, y, z) = I_0 \exp \left\{ \int \kappa_0 e^{-(v-v_r)^2/\Delta v^2} dx \right\}, \quad (1)$$

where the term in brackets is the optical depth and  $v_r$  is the radial velocity of the flow at the position  $(x, y)$ .  $I_0$ ,  $\kappa_0$ , and  $\Delta v$  are supposed homogeneous throughout the disk. Once the parameters are specified, we compute the flux density,  $F(v)$ , and the coordinates of the emission centroid at velocity  $v$ ,  $y_c(v)$  and  $z_c(v)$ . The results are compared with the observed maser spots of the R5-a block (Figure 2).

### REFERENCES

Torrelles, J. M., et al. 2001, ApJ, 560, 853

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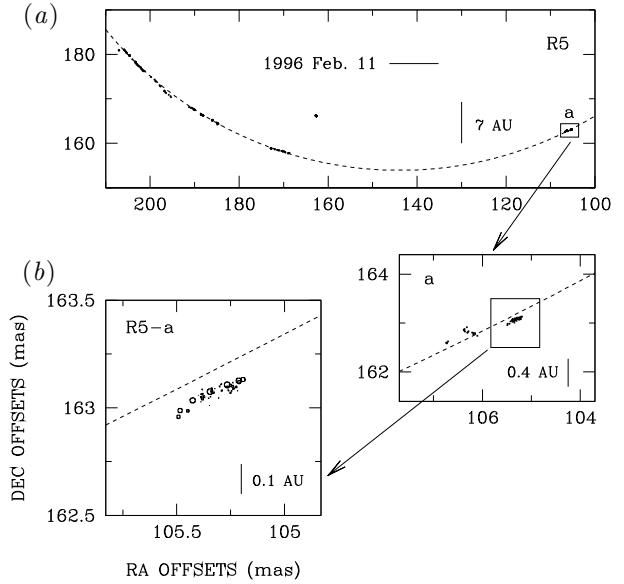


Fig. 1. (a) R5 water maser offset positions on 1996 February 11. The dash line shows the least-squares fitted circle. (b) Close-up of the R5-a block. The sizes of the circles are proportional to the maser spot intensity.

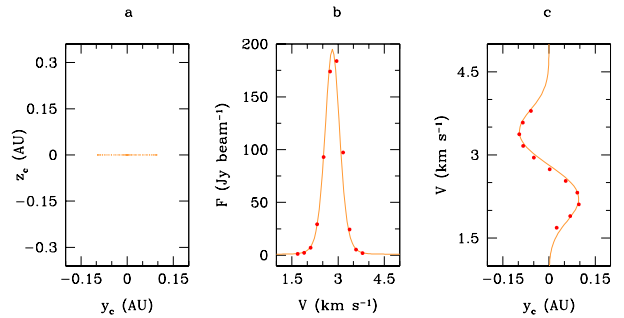


Fig. 2. (a) Emission centroid positions on the plane of the sky, (b) flux density as a function of velocity, and (c) position-velocity diagram: solid line—model, dots—observations. The observed positions are measured along an axis with position angle  $\simeq -63^\circ$ . The zero position corresponds to the geometrical center of the R5-a block. Model parameters:  $I_0 = 2.25$  Jy beam<sup>-1</sup> AU<sup>-2</sup>,  $\kappa_0 = 2.24$  AU<sup>-1</sup>,  $\Delta v = 0.67$  km s<sup>-1</sup>,  $v_0 = 2.85$  km s<sup>-1</sup>,  $r = 1.5$  AU,  $h = 0.15$  AU,  $a = 0.29$  km s<sup>-1</sup> AU<sup>-1</sup>,  $\theta = 9^\circ$ .