Simultaneous 3mm and 7mm Observations of SiO Masers around R Cassiopeiae using VLBI

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What are Masers?

- Microwave Amplification by Stimulated Emission of Radiation
- Occur around either very young or very evolved stars
- Three most common types: OH, H$_2$O, and SiO
What is R Cas?

- Long period variable red giant
- Pulsation period of 430 days
- ~160 pc away
- $m_v$ 5 to 12
- known maser source
Data Correlation in Socorro, New Mexico
Our work in Socorro

• Correlation of 27 April 2001 data on the VLBA correlator
• Image processing and study of the 3mm data…some of NRAO’s first
• Presentation to NRAO of the preliminary 3mm data results
My work at Haystack

- Calibration and imaging of 7mm data using AIPS (Astronomical Image Processing System) and continued work on 3mm
  - reference feature location (spectral phase-referencing method relies on it)
  - image improvement by self-cal techniques
- Investigation of three different transitions
- Spatial Registration of Images
The Images

43 GHz (7mm): $v=1, J=1 \ [ 0$

86 GHz (3mm): $v=1, J=2 \ [ 1$

43 GHz (7mm): $v=2, J=1 \ [ 0$
7mm v=1

5 AU

24 25 28 30 32 34
KILO METR/SEC
3mm v=1
7mm $v=2$
7mm $v=1$ Doppler movie

27.7 km/s

5 AU
7mm v=1

5 AU

24 25 26 28 30 32 34
KILO METR/SEC
3mm v=1
The Results: Support or Refute Current Theory?

- Do the images improve on earlier images?
- How the images compare to current models
- Same velocities but very different line ratios found in two different transitions...what does it mean?
**Measured 7mm/3mm Line Ratios between the v=1 transitions**

<table>
<thead>
<tr>
<th>Position</th>
<th>7mm</th>
<th>3mm</th>
<th>Line Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE feature</td>
<td>7.55 Jy</td>
<td>10.1 Jy</td>
<td>.75</td>
</tr>
<tr>
<td>SW feature</td>
<td>12.6 Jy</td>
<td>15.2 Jy</td>
<td>.83</td>
</tr>
<tr>
<td>Selected part of NW feature</td>
<td>65.5 Jy</td>
<td>&lt; .2 Jy</td>
<td>&gt;300 (!)</td>
</tr>
</tbody>
</table>
Conclusions and Follow-up

• Simultaneous observations of 3mm and 7mm with the VLBA can be successful
• Our measured line ratios should help the SiO maser community derive a more realistic model
• Further observations of R Cas need to be made at a variety of stellar phases
Acknowledgements

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