**Goal:** Confirm the collision scenario for the formation of filaments.

**Name**

**G029.96:**
- $D = 4.7$ kpc
- Near the galactic plane.
- $M = 5600 \, M_{\text{sun}}$
We will show our study on the presence or absence of observational collision tracers → We have looked for SiO.

In addition, we will present our results on the detection of gas tracers which will allow us to study the kinematics of the region:

• \( \text{N}_2\text{H}^+ \) (dense gas)
• \( \text{C}^{18}\text{O} \)
Observation Preparation

- G029.96: RA = 18h 48m 49s, Declination = -3°00’ 30”
- 12 arcmin² coverage in four 2’ x 2’ maps
- Sensitivity 20 mK
- Velocity resolution Δv = 1 km/s
- EMIR in E090 (3mm) band with FTS200 backend. 8 x 4 GHz bandwidth channels.
- Time estimator: 4 hr in average (7 mm pwv) weather

SiO (1-0)  N₂H⁺(1-0)  C^{18}O(1-0)

| Frequency (GHz) |
|-----------------|-----------------|-----------------|
| 86.8            | 93.2            | 109.8           |
| 86.5            |                 |                 |
| LO              | LI              | f₀              |
|                 |                 | UI              |
|                 |                 | UO              |

IPAM 7th Summer School 2013
Group IV: Star formation
• Map areas in white boxes using on the fly, and single pointings on the red circles.
• Position switching used.
• ROOOOR iteration loop.
Observation Preparation

- \( \theta_{109.8 \text{ GHz}} = 22.9'' \)
- Sampling: \( S < \frac{\theta_{109.8 \text{ GHz}}}{2.44} = 9.39'' \) therefore choose \( S = 8.0'' \)
- In 120'', this corresponds to 15 x 15 beam positions
- Time on the fly = \( \frac{120''}{8''} \times T_{\text{phase}} = 15 \text{ seconds} \)
Observing

- Weather: 10 mm pwv
- Set Telescope: Receiver, backends, frequency
- Focus and pointing on Mars
- Secondary pointing on bright quasar: 1741-038 at similar elevation
- Source G029.96: pointing, mapping, pointing
- **Problem!** Wrong backend used for second map. Continuum backends in place after calibration
- **Problem!** Issue with offsets and off position
Observing

- 4 maps of the main region. Oh no!
- No problem! Gain sensitivity.
- Detection of SiO.
- Additional single pointing of main peak.
Data reduction

SINGLE POINT
* Eliminate bad spectra
* Doppler correction
* Average polarization
* Baseline
* Line identification

OTF MAP
* Eliminate bad spectra
* Doppler correction
* Average polarization
* Baseline
* Line identification
* Extract lines
* Data cube
* Momentum maps

\[ \frac{v - v_0}{c} = \frac{f - f_0}{f} \]

\[ v = c \frac{\Delta f}{f} \]

IRAM 7th Summer School 2013

Group IV: Star formation
Molecular line detection and abundances

<table>
<thead>
<tr>
<th>Species</th>
<th>$N$ (cm$^{-2}$)</th>
<th>$X$</th>
</tr>
</thead>
<tbody>
<tr>
<td>C$^{18}$O</td>
<td>$9.6 \times 10^{15}$</td>
<td>$1 \times 10^{-7}$</td>
</tr>
<tr>
<td>HCO$^+$</td>
<td>$1.8 \times 10^{13}$</td>
<td>$2 \times 10^{-10}$</td>
</tr>
<tr>
<td>SiO</td>
<td>$4.5 \times 10^{11}$</td>
<td>$6 \times 10^{-12}$</td>
</tr>
</tbody>
</table>
## Molecular lines

<table>
<thead>
<tr>
<th>Molecular Line</th>
<th>Frequency (GHz)</th>
<th>Critical density (cm⁻³)</th>
<th>What does it trace?</th>
</tr>
</thead>
<tbody>
<tr>
<td>C¹⁸O (1-0)</td>
<td>109.7821734</td>
<td>2x10⁴</td>
<td>Extended emission</td>
</tr>
<tr>
<td>HCO⁺ (1-0)</td>
<td>89.1885247</td>
<td>2x10⁵</td>
<td>Dense gas</td>
</tr>
<tr>
<td>H¹³CO⁺ (1-0)</td>
<td>86.7542884</td>
<td>2x10⁵</td>
<td>Dense gas</td>
</tr>
<tr>
<td>C₂H (1-0)</td>
<td>87.3168980</td>
<td>2x10⁵</td>
<td>Dense gas</td>
</tr>
<tr>
<td>HNC (1-0)</td>
<td>90.6635680</td>
<td>3x10⁵</td>
<td>Dense gas</td>
</tr>
<tr>
<td>N₂H⁺ (1-0)</td>
<td>93.1733922</td>
<td>3x10⁵</td>
<td>Dense gas</td>
</tr>
<tr>
<td>CH₃CN (5-4)</td>
<td>91.9853141</td>
<td>4x10⁵</td>
<td>Dense gas</td>
</tr>
<tr>
<td>HC₃N (10-9)</td>
<td>90.9790230</td>
<td>5x10⁵</td>
<td>Dense gas, hot core</td>
</tr>
<tr>
<td>HCN (1-0)</td>
<td>88.6316022</td>
<td>3x10⁶</td>
<td>Very dense gas</td>
</tr>
<tr>
<td>HNCO (4-3)</td>
<td>87.9252370</td>
<td>1x10⁶</td>
<td>Very dense gas, shocks</td>
</tr>
<tr>
<td>SiO (2-1)</td>
<td>86.8469600</td>
<td>2x10⁶</td>
<td>Very dense gas, shocks</td>
</tr>
</tbody>
</table>
Geometry

H$^{13}$CO$^+$

HCN

HC$_3$N

C$^{18}$O
HCO+: gas dense and the 2 clouds
HCO+: kinematics
HNC: kinematics
C$^{18}$O: kinematics

1st cloud

2nd cloud
SiO: shock tracer

Single point detection @ 4.1

Map detection @ 3.7